Prototypical Head Loss Testing And Near Field Effects

Presented

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Purpose of the presentation

- Identify an issue related to industry's head loss tests – "near field effect"
- Provide staff expectations

Background

- **Safety Evaluation - Head Loss**

  1. NUREG-CR/6224 correlation is not appropriate for many PWR LOCA debris types, e.g, Cal-Sil. It is a useful tool for scoping analysis
  2. Plant-specific tests are needed for many PWRs

- **Industry Approach**

  PWR licensees are performing plant-specific prototypical head loss tests. Five vendor teams have developed test programs to meet the need

Background – Plant Specific Testing

Industry's Approaches:

- **Prototypical head loss test combined with near field transport**
- **Prototypical head loss test with no debris settlement upstream**
- **Plant-specific head loss correlation development coupled with conservative debris distribution assumptions**

NRC Staff Responses:

Pilot audits, audits and observation trips

Issues Identified:

- **Near field effect**
- **Scaling**
- **Testing procedures**
- **Combined head loss testing and downstream bypass testing**

Near Field Effect

Prototypical Head Loss Testing With Upstream Debris Settlement

Testing a scaled section of the replacement strainer design in a tank of water where the test strainer module is connected to a recirculation loop that pumps water from the tank through the test strainer and returns the water back into the tank

Observed Upstream Settling Phenomenon

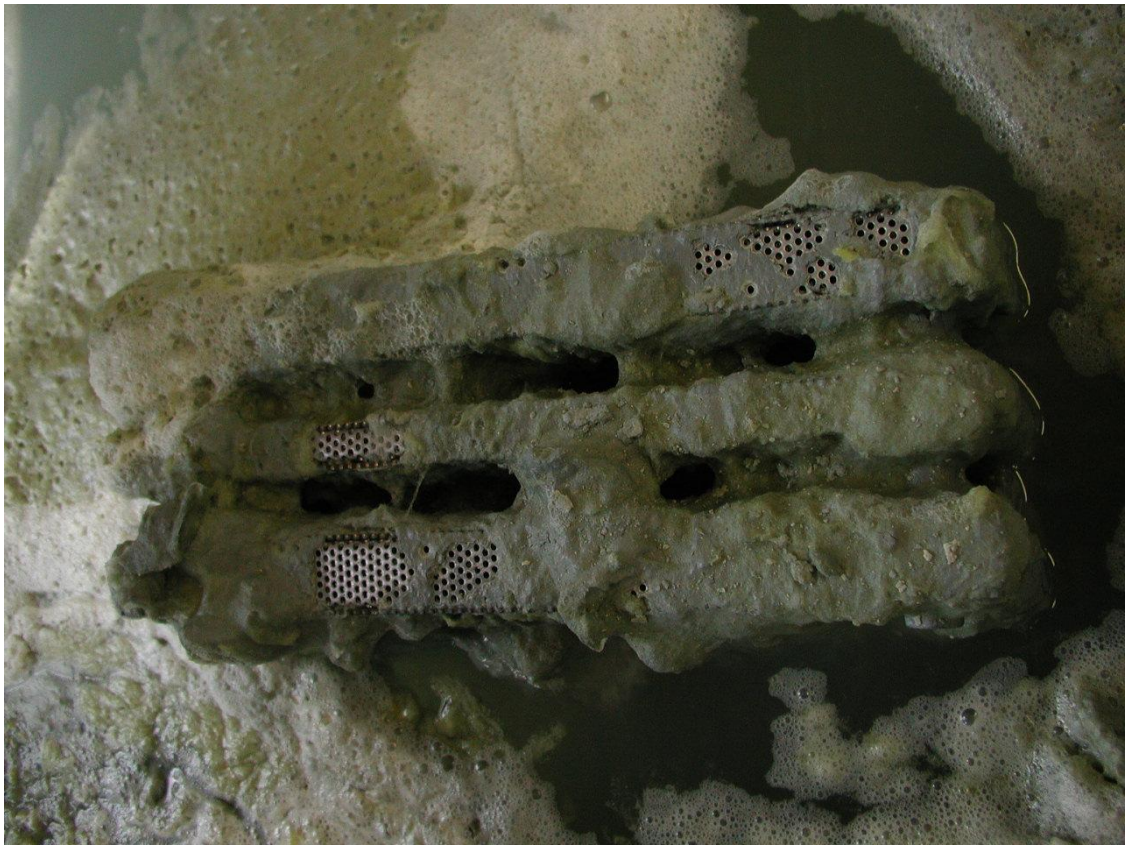
Large quantity of tested debris does not transport to the strainer surface and settles upstream from the testing module

Results

Significant head loss reduction results in smaller strainer size or lower head loss than a design following NRC SE and NEI Guidance Report

Near Field Effect – Debris Loading On The Strainer

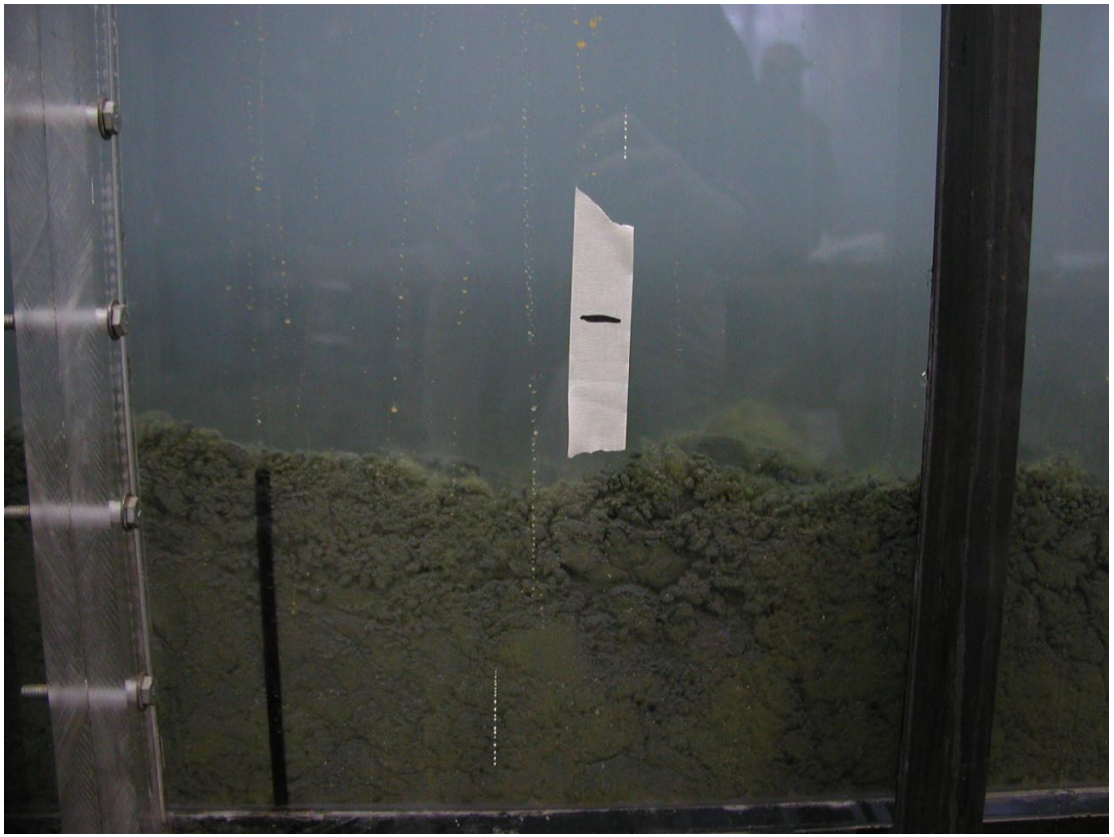
High fiber/particulate loading head loss test



Debris Loading On
The Strainer Surface

Near Field Effect – Debris Settlement Upstream Of Strainer

High fiber/particulate loading head loss test



Debris Settled Away From The Strainer Surface

Near Field Effect – Issues Identified

Staff Concerns

Multiple vendors and licensees have decided to design the new strainers that take credit for near field debris settlement

- Proper scaling analysis is needed

  Computational Fluid Dynamics (CFD) analysis has generally been performed for the current sump layout before GSI-191 fixes

  Little similarity between the test facility set up and the actual strainer lay out.

  Need to define the boundary of the area to be simulated by the test facility, where the debris near field settlement occurs

Near Field Effect – Issues Identified

Staff Concerns

- Proper testing procedures are needed to produce conservative test results.

  Varying debris addition rates, sequences and locations may cause different debris settlement and agglomeration

  Test loop circulation timing and termination criteria

Staff Expectations – Near Field Effects

Licensees to provide the following in their SE supplemental responses if the near field effect is present during the head loss tests.

- Similitude of debris materials

  In addition to hydraulic resistance, evaluate the similarity of surrogate material transportability

- Scaling between the test strainer module/tank and the plant replacement strainer/pool conditions

  Geometric conditions: New strainer layout, nearby structures and, water level

  Hydraulic conditions: fluid velocity field and turbulence

Staff Expectations – Near Field Effects

- Cold water test data extrapolation

  Evaluate the head loss and transportability of the debris due to different temperature between the test facility and the actual containment pool environment

- Proper timing and location of the debris introduction

  Evaluate the impact on both the head loss and the transportability

- Sufficient testing matrix covers the important potential variations in testing procedures and debris accumulations

- Reconcile with debris transport calculation

  Apply proper boundary conditions to the testing set up based on consistent Computational Fluid Dynamics (CFD) calculations or other transport calculations