VOGTLE GSI-191 PROGRAM CHEMICAL EFFECTS TESTING STRAINER HEADLOSS TESTING NRC PUBLIC MEETING

NOVEMBER 6, 2014

SOUTHERN COMPANY

AGENDA

- Introductions
- Objectives for Meeting
- *Discussion of Integrated Chemical Effects Test Plans
- *Discussion of Strainer Head Loss Test Plans
- Feedback on Documents Provided for Review Prior to Meeting
- Staff Questions and Concerns

*Presentation provides topic highlights only, more detailed information is contained in other documents provided.

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SNC ATTENDEES

- Ken McElroy - Licensing Manager
- Ryan Joyce – Licensing
- Phillip Grissom – Program Manager GSI-191
- Tim Littleton – Lead Engineer Vogtle Design
- Franchelli Febo – Vogtle Site Design
- Owen Scott – Risk Informed Engineering

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OBJECTIVES OF THE MEETING

- Provide an overview of Vogtle plans for future large scale chemical effects and strainer headloss testing, and receive any comments, concerns, or feedback from NRC staff

- Receive any NRC observations or feedback on documents provided for review prior to this meeting

VOGTLE BACKGROUND

Vogtle Description

- Westinghouse 4-Loop PWR, 99% NUKON Insulation
- ~ 6 ft3 of Interam fire barrier
- GE Stacked Disk Strainers for ECCS and Containment Spray (4/unit)
- 765 ft2 per each of 2 ECCS trains, separate CS strainers (2)
- TSP Buffer

Vogtle Status

- Strainer Head Loss and In-vessel issues remain open
- Previous chemical effects testing provided very promising results, but not accepted by NRC
- Vogtle elected to follow Option 2B (risk-informed resolution) of SECY-12-0093, as being piloted by STP

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DOCUMENTS PROVIDED FOR REVIEW PRIOR TO MEETING

- ***Strainer Headloss***
  - SNCV083-PR-05, Rev 0, "Risk-Informed Head Loss Test Strategy", October 2014
- **Chemical Effects**
  - CHLE-SNC-001, Rev. 2, "Bench Test Results for Series 1000 Tests for Vogtle Electric Generating Plant", September 2013
  - CHLE-SNC-007, Rev. 2, "Bench Test Results for Series 3000 Tests for Vogtle Electric Generating Plant", January 2014
  - CHLE-SNC-008, Rev. 3, "Column Chemical Head Loss Experimental Procedures and Acceptance Criteria", March 2014
  - CHLE-SNC-020, Rev 0, "Test Plan-Vogtle Risk Informed GSI-191 CHLE Test T6, T7 and T8", October 2014

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INTEGRATED CHEMICAL EFFECTS TESTING

UNIVERSITY OF NEW MEXICO
ENERCON
ALION SCIENCE AND TECHNOLOGY

CHEMICAL EFFECTS TESTING OVERVIEW

- 30-Day Integrated Tank Test w/Debris Bed System (T8)
  - Similar to STP Test T2, but with Vogtle Specifics
  - Prototypical Water Chemistry for Vogtle During LOCA
  - Based on Double Ended Guillotine Break of the 29" Hot Leg Piping on Loop 4 of the RCS (Weld# 11201-004-6-RB)
- Additional Chemical Effects Testing
  - Bench Scale Tests
  - Prototypical Water Chemistry Tank Test w/o Debris Beds (T6)
  - Forced Precipitation Tank Test w/Debris Beds (T7)

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30-DAY INTEGRATED TANK TEST (T8)

- Objective:
  - Determine and characterize chemical precipitates generated during a simulated LOCA event
  - Investigate effects of potential chemical products on head loss
  - Generate test results for a simulated break case to compare with the chemical effects model
  - Based on Double Ended Guillotine Break of the 29" Hot Leg Piping on Loop 4 of the RCS (Weld# 11201-004-6-RB)
- Includes:
  - CHLE Corrosion tank
    - Prototypical Vogtle Water Chemistry
    - Corrosion and Ancillary Materials
  - Vertical Column System
    - Multi-Particulate Debris Beds

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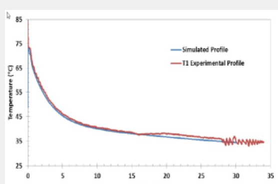
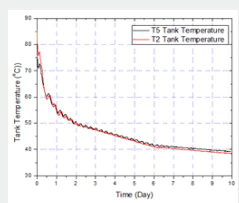
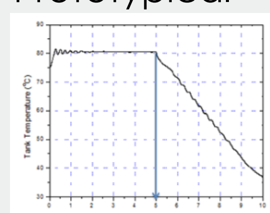
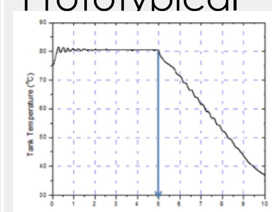
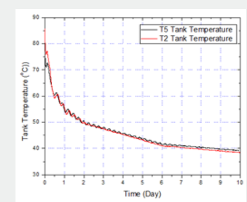
SUMMARY OF PREVIOUS TESTING (STP)

	T1	T2	T3	T4	T5
Corrosion materials	- Al scaffolding - Fiberglass	- Al scaffold - Fiberglass - GS, Zn coupons - Concrete	- Al, GS, Zn coupons - Fiberglass - Concrete	- Al coupons - Fiberglass	- Al scaffold - Fiberglass - GS, Zn coupons - Concrete
Avg Vel (ft/s)	0.01	0.01	0.01	0.01	0.01
pH	7.22	7.32	7.22	7.22	7.25
Temperature profile	MB-LOCA 	LB-LOCA 	Non-Prototypical 	Non-Prototypical 	LB-LOCA 
Testing Per.	30-day	30-day	10-day	10-day	10-day
Bed prep.	NEI	NEI	Blend & NEI	Blend & NEI	Blender

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SUMMARY OF PROPOSED TESTING (SNC)

	T6	T7	T8
Corrosion materials	- Al, GS, Cu, CS - Fiberglass - Concrete - MAP, Interam, Dirt - Epoxy, IOZ	- Al, GS coupons - Fiberglass - Concrete - IOZ	- Al, GS, Cu, CS - Fiberglass - Concrete - MAP, Interam, Dirt - Epoxy, IOZ
Velocity (ft/s)	0.013	0.013	0.013
Target pH	7.2	7.2	7.2
Temperature profile	Modified LB-LOCA	Non-Prototypical	Modified LB-LOCA
Testing period	30-day	10-day	30-day
Bed type	None	Multi-Constituent Particulate	Multi-Constituent Particulate

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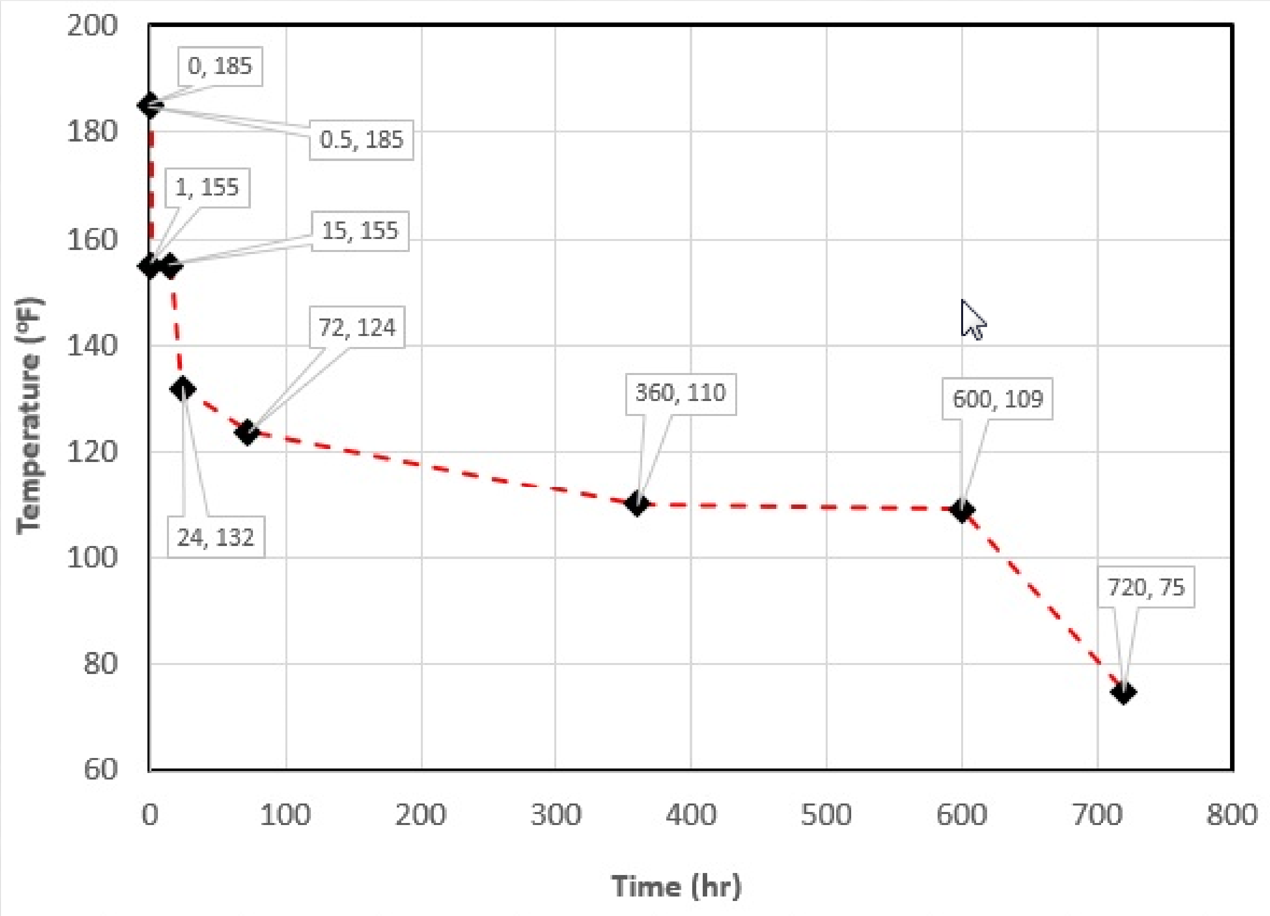
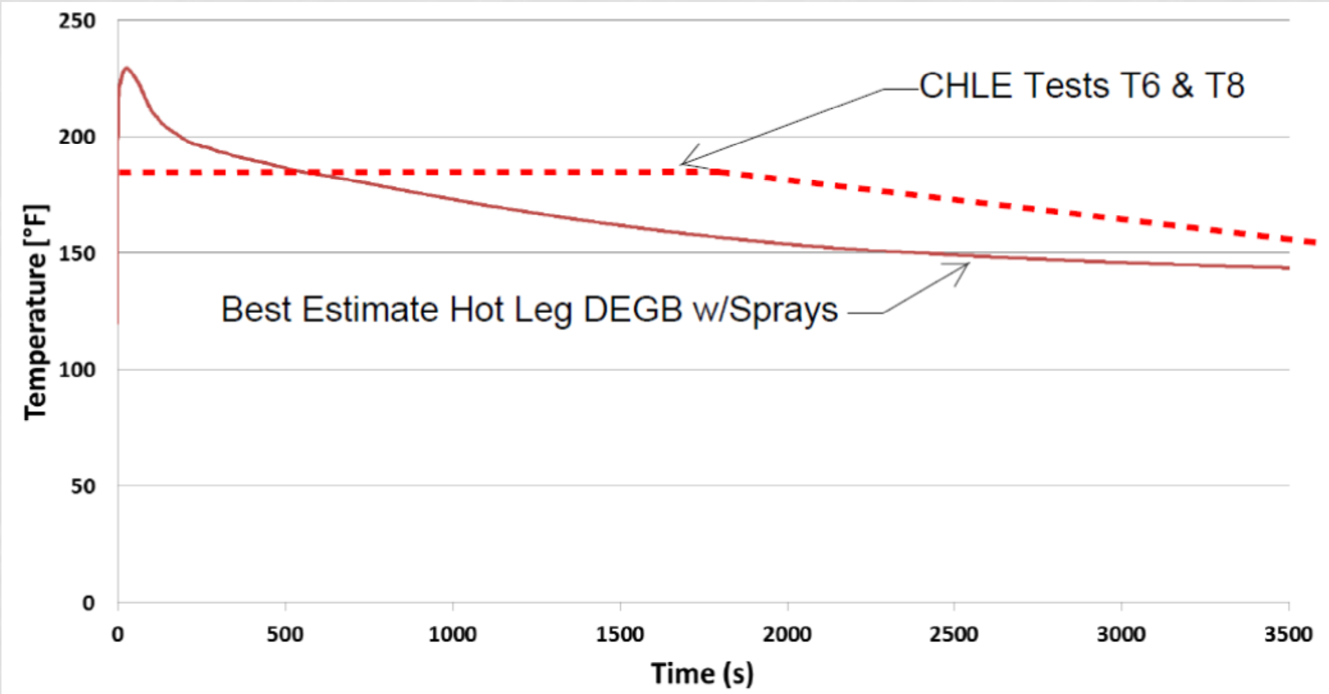
TEMPERATURE PROFILE: T8



TEMPERATURE PROFILE: T8



- T6/T8 Temperature Profile (initial hour)
  - Best Estimate case is below 185°F within ~10 min
  - T6/T8 materials are immediately submerged and exposed to sprays
    - No credit taken for the time to activate sprays and fill the sump
    - No credit taken for thermal lag of materials in containment

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CHEMICAL EFFECTS TESTING OVERVIEW

- 30-Day Integrated Tank Test w/Debris Bed System (T8)
  - ***Vertical Column Head Loss System***
  - CHLE Corrosion Tank
  - Prototypical Water Chemistry for Vogtle During LOCA
- Additional Chemical Effects Testing
  - Bench Scale Tests
  - Prototypical Water Chemistry Tank Test w/o Debris Beds
  - Forced Precipitation Tank Test w/Debris Beds

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CHLE – VERTICAL HEAD LOSS TESTING

- UNM Testing Facility
- Previous Testing (NEI and Blender Beds)
- Head Loss Results
  - Debris Beds with Acrylic Particulates
    - Head loss - Repeatability
    - Head loss - Stability & variability
    - Bed sensitivity, Hysteresis & detectability
  - Debris Beds with Epoxy Particulates

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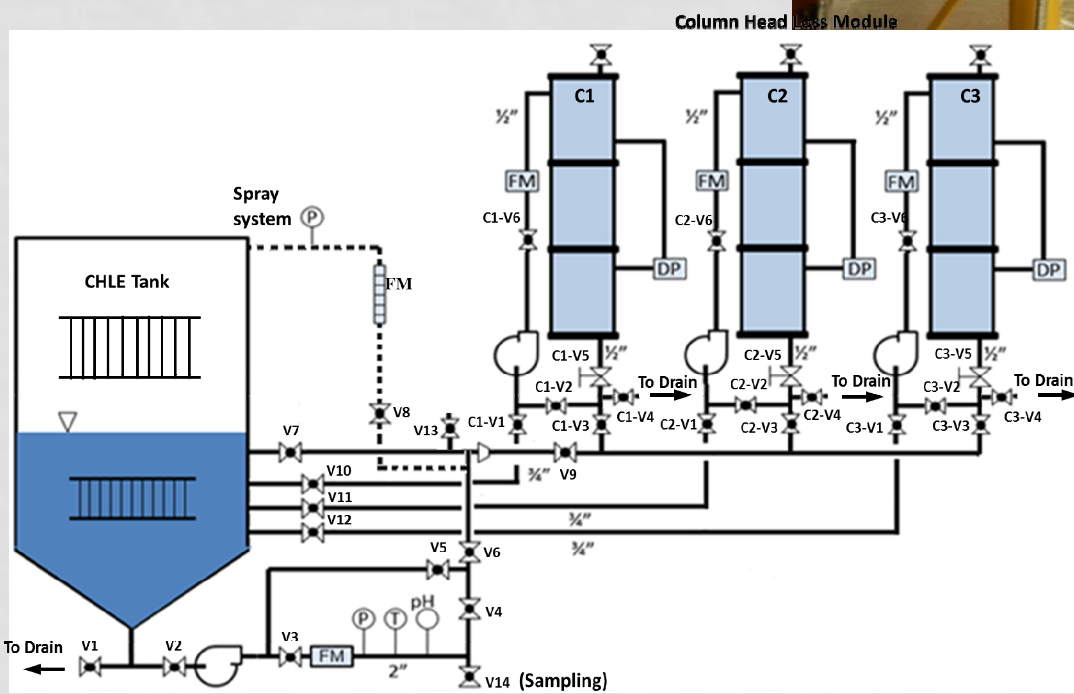
CHLE UNM Testing Facility



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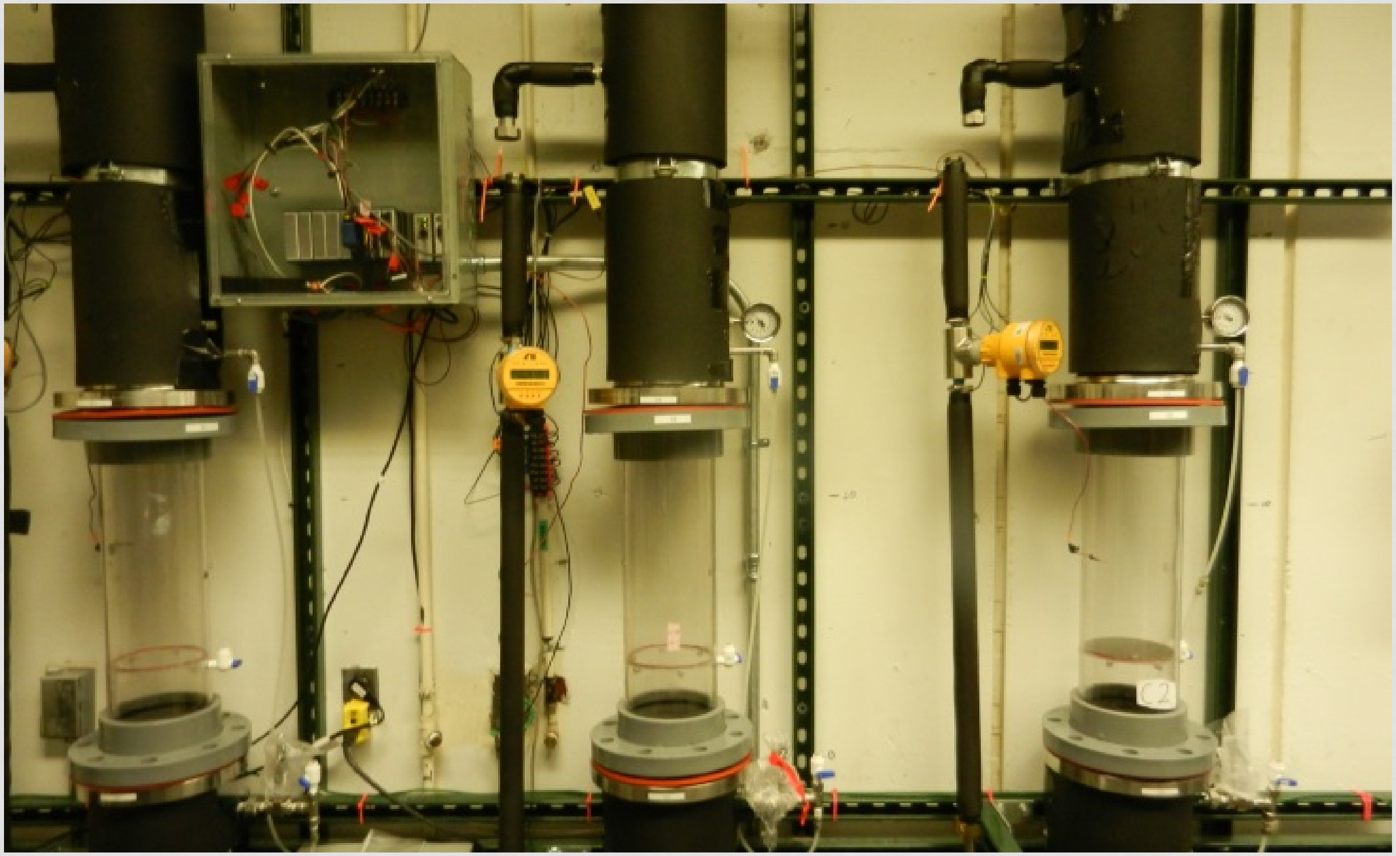
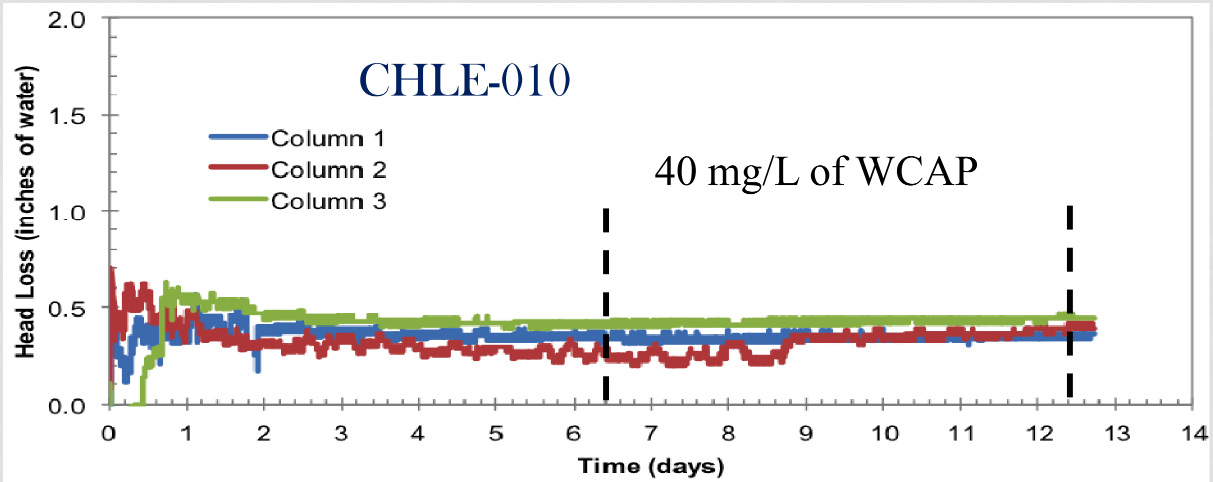
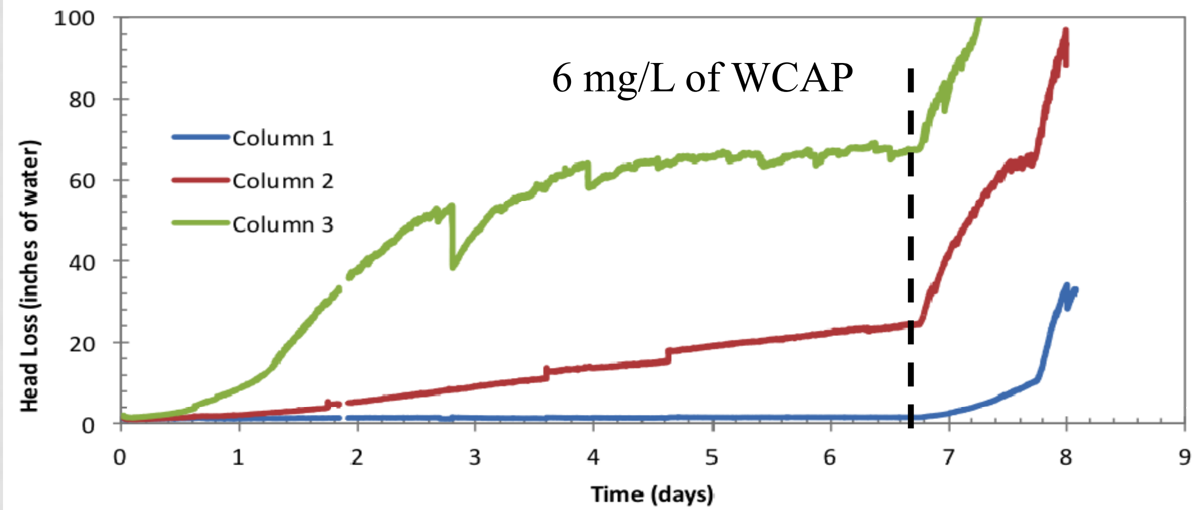
CHLE VERTICAL HEAD LOSS MODULES

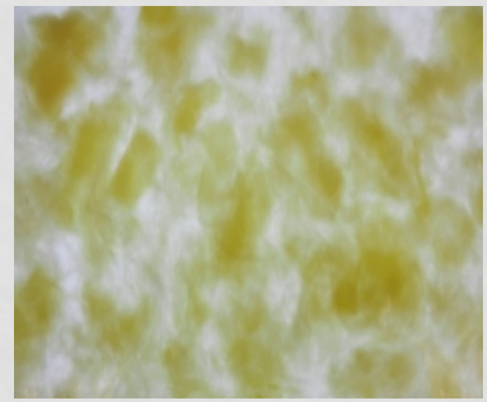


CHLE PREVIOUS TESTING





- NEI - Beds



- Blender Bed

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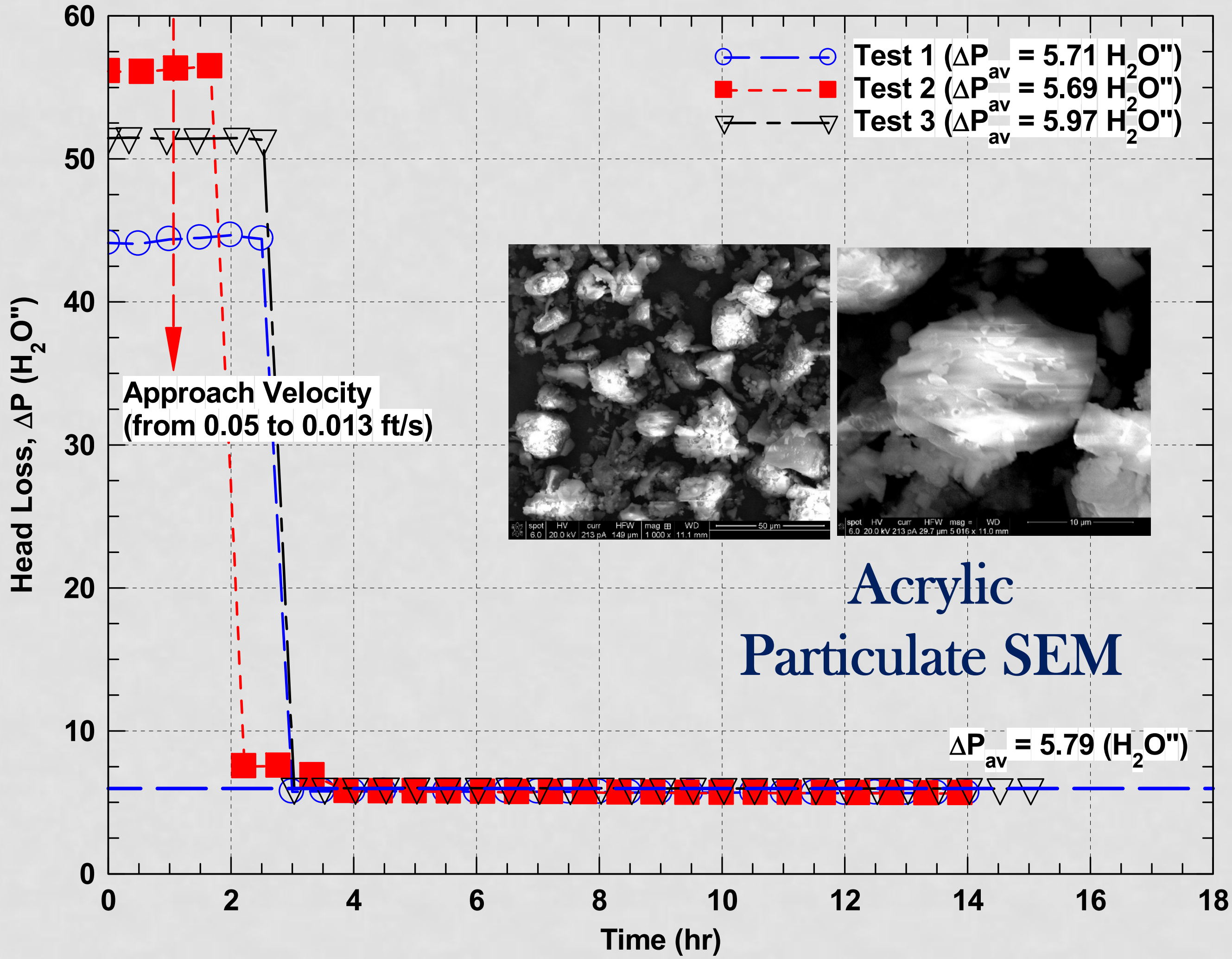
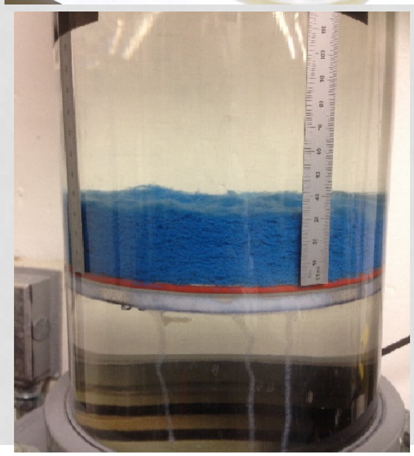
CHLE Results: Repeatability

Test #1, 2, and 3 - Paint/Fiber (40/20)

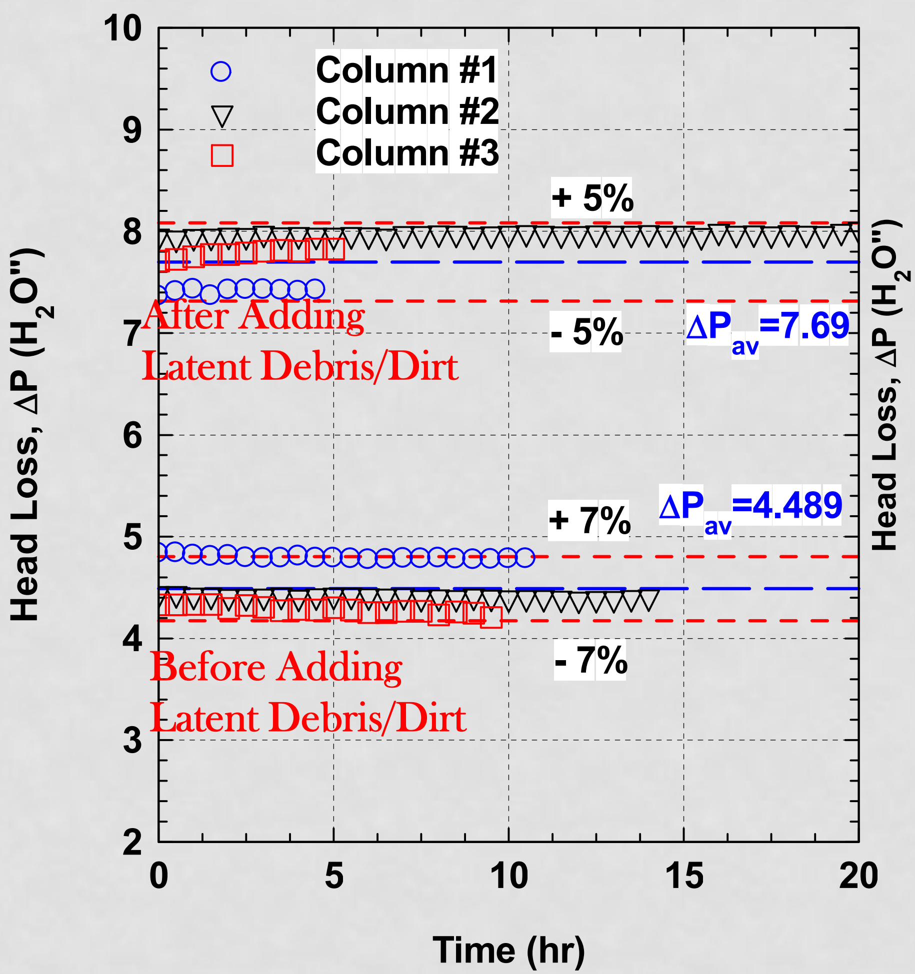


Acrylic
Particulate SEM

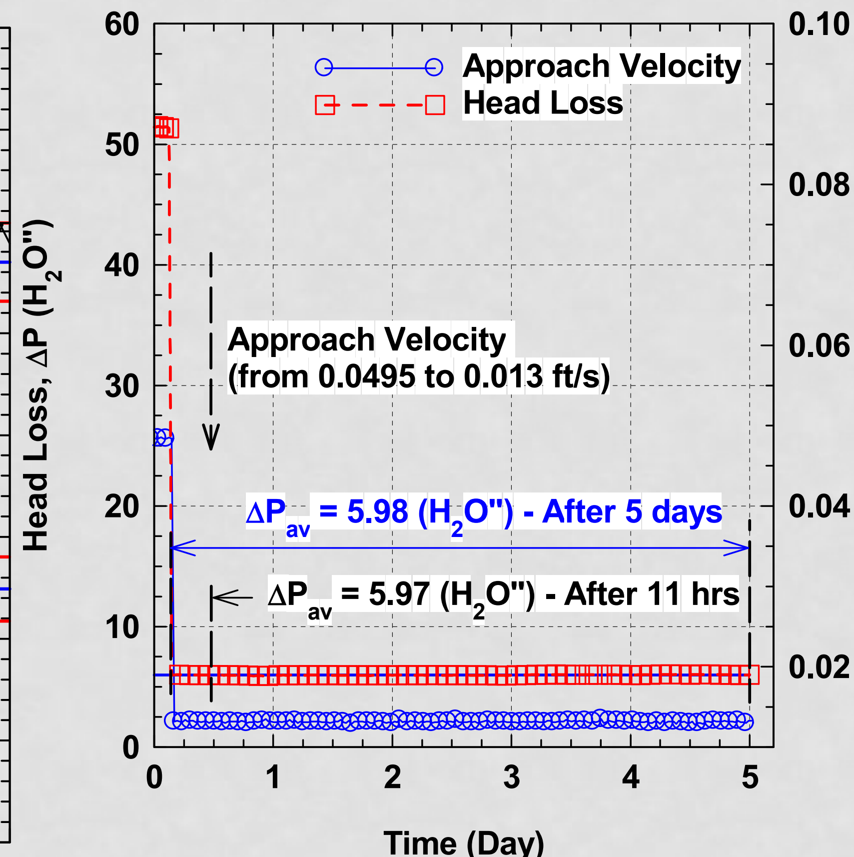


CHLE Results: Stability and Variability

Test #1, 2, and 3 - Paint/Fiber (40/20)



Test #3 – Paint/Fiber (40/20) - Long term test



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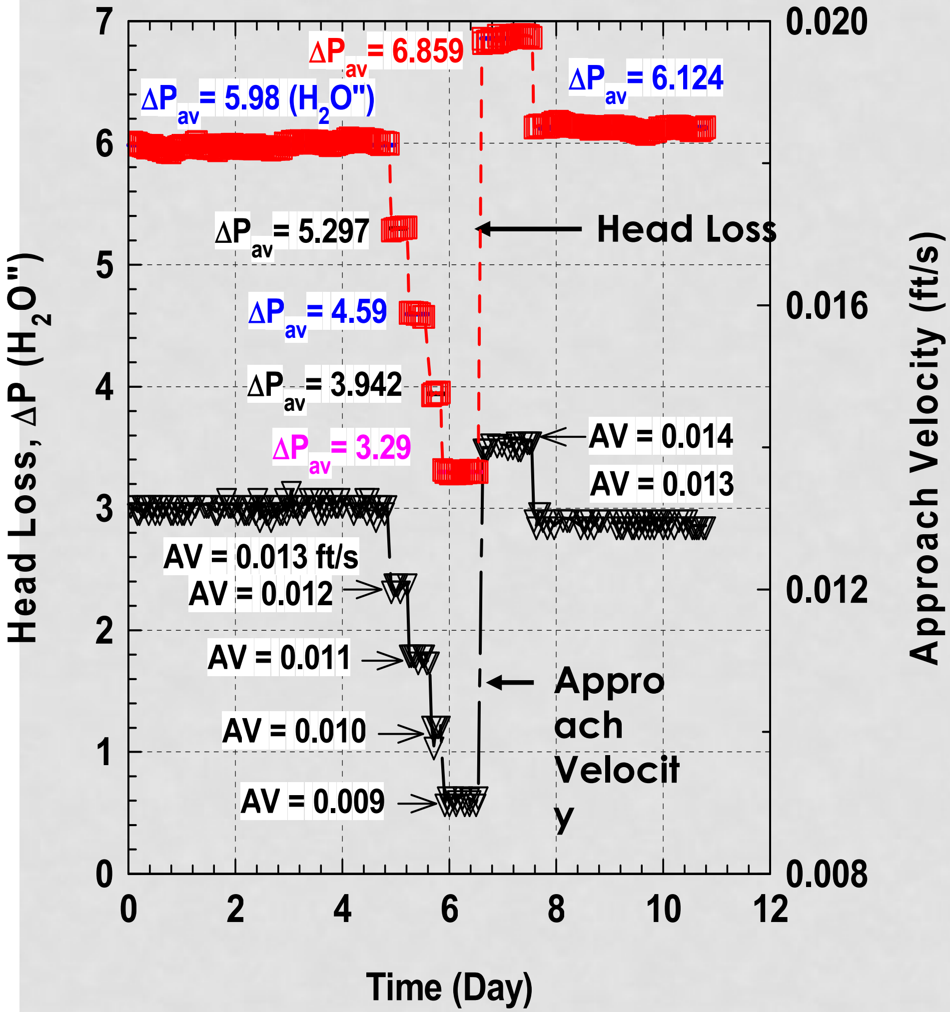
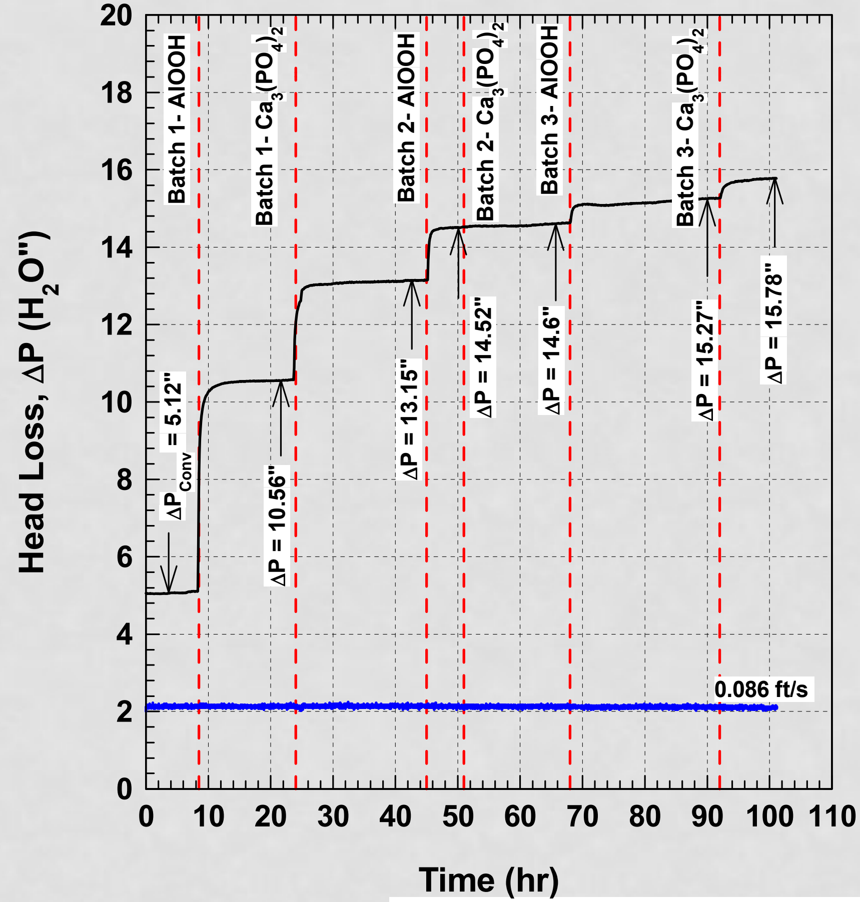
CHLE Results: Sensitivity, Hysteresis & Chemical Detectability





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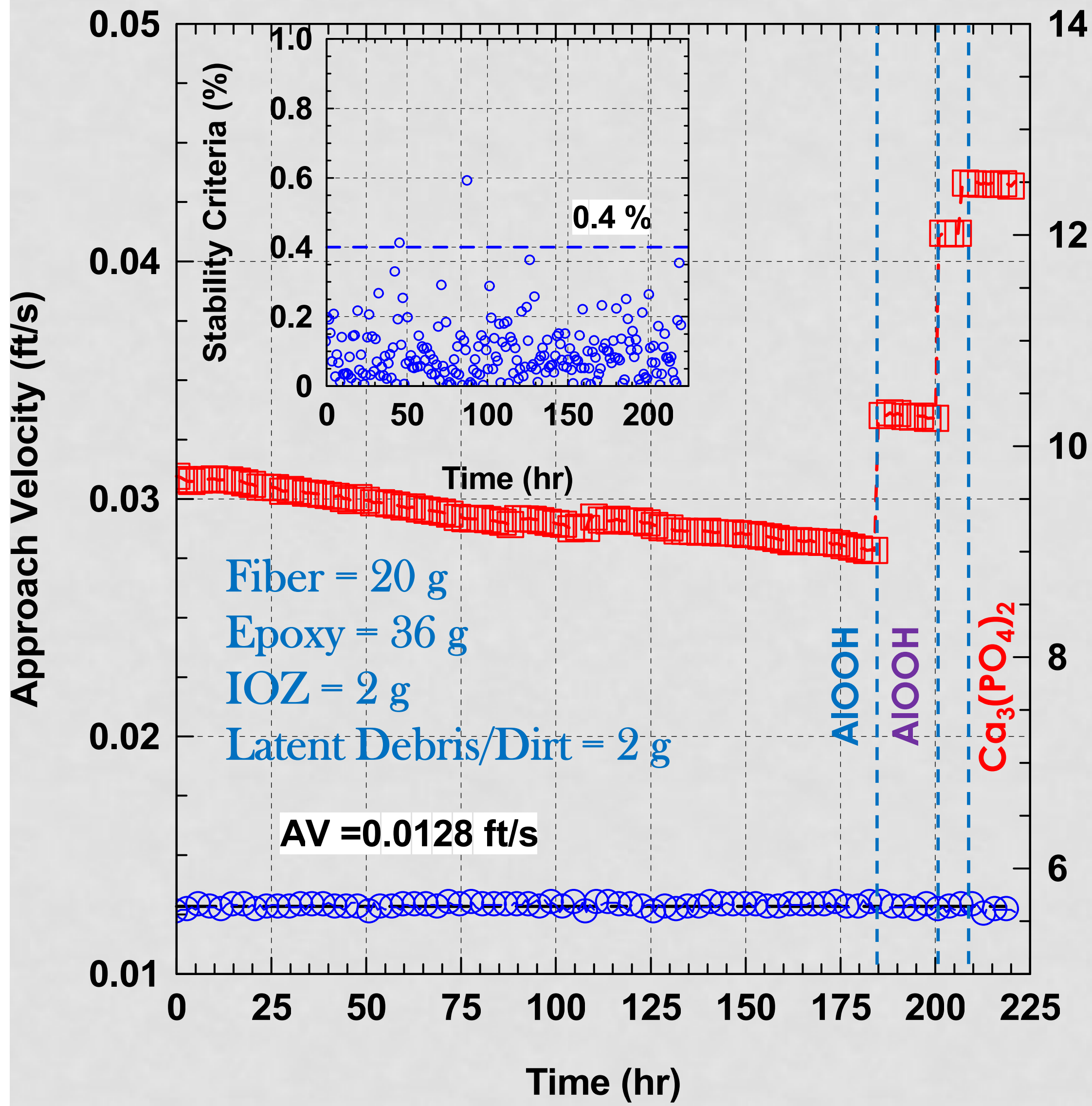
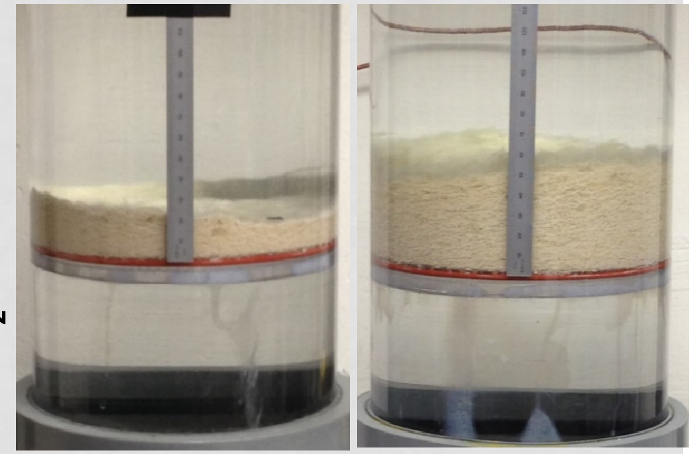
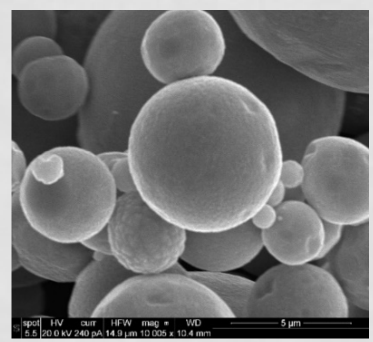
CHLE – Results: Detectability with Epoxy



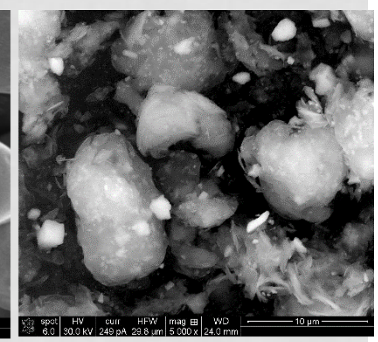
Medium – Thick Beds with Epoxy



SEM - IOZ



SEM - Epoxy



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CHEMICAL EFFECTS TESTING OVERVIEW

- 30-Day Integrated Tank Test w/Debris Bed System (T8)
  - Vertical Column Head Loss System
  - CHLE Corrosion Tank
  - ***Prototypical Water Chemistry for Vogtle During LOCA***
- Additional Chemical Effects Testing
  - Bench Scale Tests
  - Prototypical Water Chemistry Tank Test w/o Debris Beds
  - Forced Precipitation Tank Test w/Debris Beds

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PROTOTYPICAL CHEMICALS: CHLE TANK

Chemical Type	Vogtle Quantity (mM)	CHLE Tank Quantity (g)	Significance
H_3BO_3	221.4	15546	Initial Pool Chemistry
LiOH	0.0504	1.372	
HCl	2.39	99	Radiolysis Generated Chemicals
HNO_3	0.0873	6.2	
TSP	5.83	2582	Containment Buffering Agent

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CHEMICAL ADDITION PROTOCOLS

- Initial Pool Chemistry
  - Boric Acid
  - Lithium Hydroxide ([Li]=0.35 mg/L)
- TSP metered in continuously during first two hours of test to desired final concentration
- Radiolysis generated materials added throughout test
  - Batch addition at 1, 2, 5, 10, 24 hours initially
  - Continued additions periodically thereafter

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PROTOTYPICAL MATERIALS: CHLE TANK (1 OF 2)

Material Type	Vogtle Quantity	300 gal CHLE Test Quantity*
Aluminum (submerged)	54 ft^2	0.026 ft^2 (3.7 in^2)
Aluminum (exposed to spray)	4,003 ft^2	1.91 ft^2
Galvanized Steel (submerged)	19,144 ft^2	9.13 ft^2
Galvanized Steel (exposed to spray)	191,234 ft^2	91.2 ft^2
Copper (submerged)	149.8 ft^2	0.0715 ft^2 (10.3 in^2)
Fire Extinguisher Dry Chemical – Monoammonium phosphate (MAP)	357 lb_m	0.170 lb_m (77.2 g)
Interam™ E-54C (submerged)	4.448 ft^3	2.12×10^{-3} ft^3 (3.67 in^3)

PROTOTYPICAL MATERIALS: CHLE TANK (2 OF 2)

Material Type	Vogtle Quantity	300 gal CHLE Test Quantity*
Carbon Steel (submerged)	548.0 ft^2	0.261 ft^2 (37.6 in^2)
Carbon Steel (exposed to spray)	367.5 ft^2	0.175 ft^2 (25.2 in^2)
Concrete (submerged)	2,092 ft^2	0.998 ft^2 (144 in^2)
IOZ Coatings Zinc Filler (submerged)	50 lb_m	0.024 lb_m (11 g)
Epoxy Coatings (submerged)	2,785 lb_m	1.33 lb_m (603 g)
Latent Dirt/Dust (submerged)	51 lb_m	0.024 lb_m (11 g)
Fiberglass (submerged)	2,552 ft^3	1.218 ft^3

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MATERIAL ADDITION PROTOCOLS

- Submerged metal coupons
  - Arranged in a submergible rack system within tank
- Unsubmerged metal coupons
  - Secured individually to a rack system within tank
- Loose materials
  - Concrete affixed to a submerged coupon rack
  - Interam, MAP, latent dirt/dust, fiberglass and IOZ* will be loosely packed in wire mesh 'bags' submerged front of one of the tank headers
    - * Total inventory of IOZ may be added to the vertical columns instead of to the tank if it is determined to be too fine to contain in a mesh bag

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COUPON RACKS

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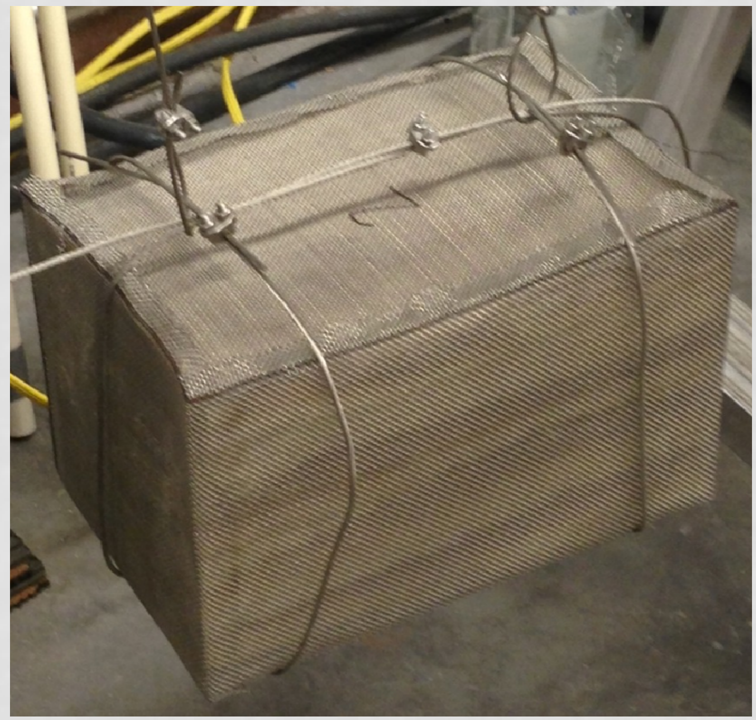
MATERIAL BAGS



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PROTOTYPICAL MATERIALS: DEBRIS BEDS

Material Type	300 gal CHLE Test Quantity*	Quantity per Column (g)
IOZ Coatings Zinc Filler	0.014 lb_m (6.4 g)	2.13
Epoxy Coatings	0.236 lb_m (107.2 g)	35.74
Latent Dirt/Dust	0.014 lb_m (6.4 g)	2.13
Fiberglass	0.055 ft^3 (60 g)	20

- Debris Bed Materials are loaded into columns before connection to tank solution with loaded tank materials
- Connection between tank and column system occurs once beds reach criteria for stability

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CHEMICAL EFFECTS TESTING OVERVIEW

- 30-Day Integrated Tank Test w/Debris Bed System
  - Vertical Column Head Loss System
  - CHLE Corrosion Tank
  - Prototypical Water Chemistry for Vogtle During LOCA

- Additional Chemical Effects Testing
  - ***Bench Scale Tests***
  - Prototypical Water Chemistry Tank Test w/o Debris Beds
  - Forced Precipitation Tank Test w/Debris Beds

BENCH SCALE TESTS: ALUMINUM

- Objectives
  - Time-Averaged Corrosion due to Variations in pH, Temperature, Phosphate (TSP)
  - Corrosion and release rates over a range of temperature and pH values
    - Comparison with WCAP correlation for Al
  - Effects on Al Corrosion due to Other Corrosion Materials Present During LOCA
    - Zinc, Copper, Iron, Chlorine

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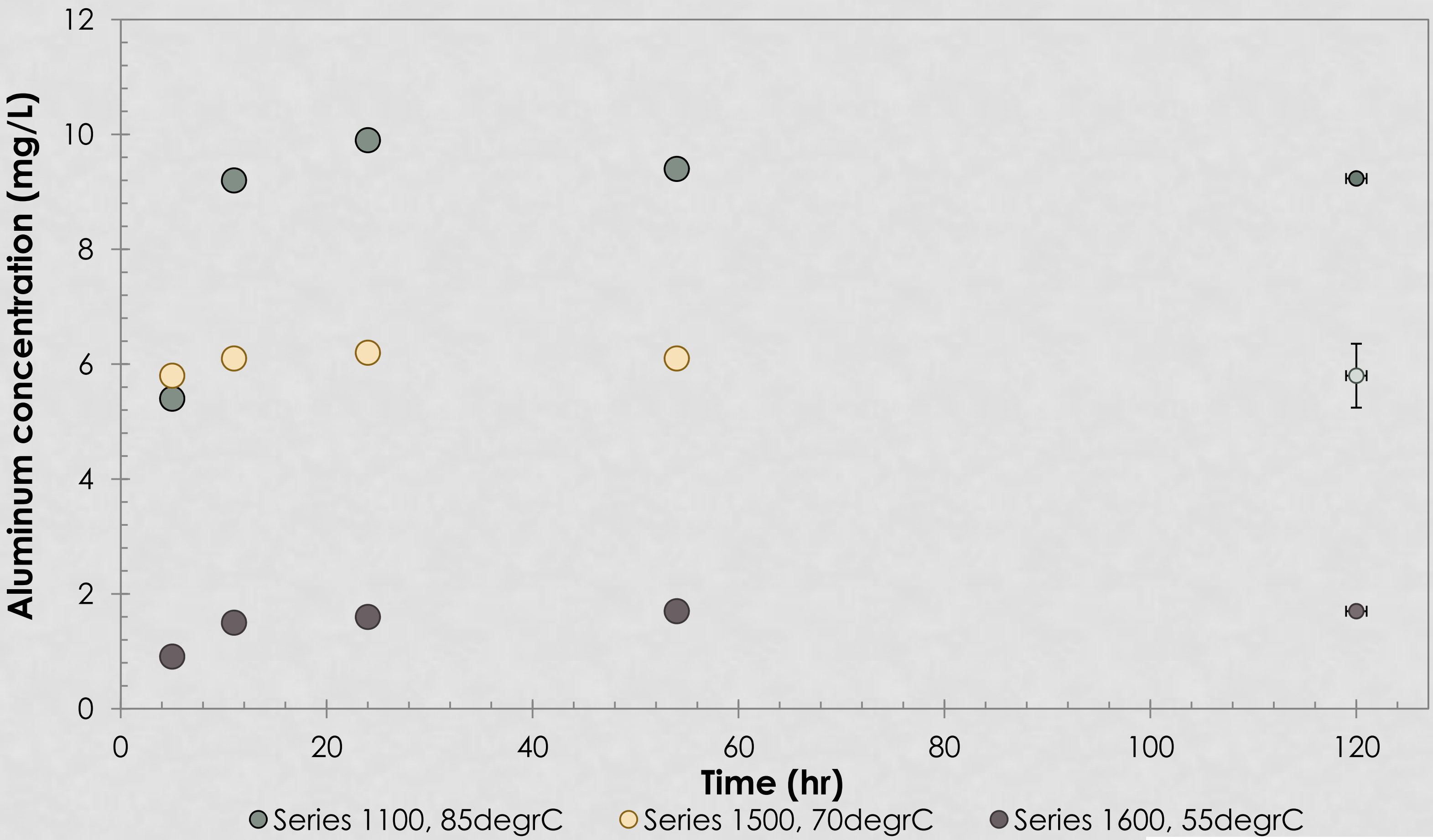
BENCH SCALE RESULTS: ALUMINUM

- Time-averaged corrosion rate reached maximum within 5 hours
- Passivation of aluminum occurred within 24 hours (stabilized rate of release)
- Direct correlation between corrosion rate and higher temperature/pH values (next two figures)

BENCH SCALE RESULTS: ALUMINUM



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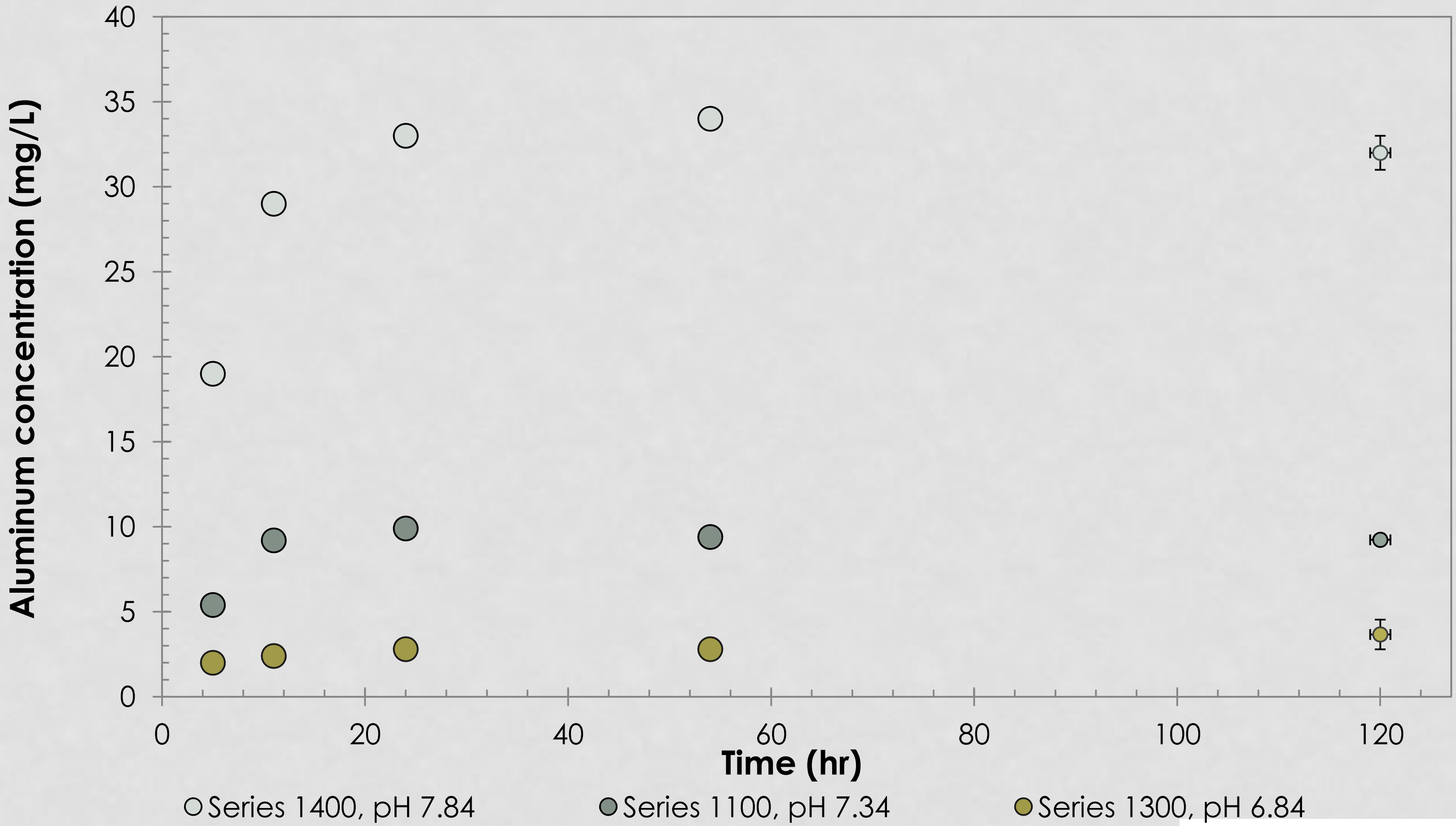
BENCH SCALE RESULTS: ALUMINUM



BENCH SCALE RESULTS: ALUMINUM

- Presence of zinc inhibits the corrosion of aluminum
- Presence of copper, chloride and iron ions have little appreciable effect on corrosion of aluminum
- 24-hour release of aluminum is reduced by a factor of 2-3 compared to the WCAP-16530 equations by including passivation in the TSP environment

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CHEMICAL EFFECTS TESTING OVERVIEW

- 30-Day Integrated Tank Test w/Debris Bed System
  - Vertical Column Head Loss System
  - CHLE Corrosion Tank
  - Prototypical Water Chemistry for Vogtle During LOCA

- Additional Chemical Effects Testing
  - Bench Scale Tests
  - ***Prototypical Water Chemistry Tank Test w/o Debris Beds (T6)***
  - Forced Precipitation Tank Test w/Debris Beds

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ADDITIONAL CE TANK TESTS

- 30-Day Recirculatory Tank Test (T6)
  - Objective:
    - Investigate isolated effects of water chemistry on plant materials during a LOCA
  - No vertical column system or debris beds
  - Prototypical Vogtle Water Chemistry
  - Temperature Profile Identical to T8

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CHEMICAL EFFECTS TESTING OVERVIEW

- 30-Day Integrated Tank Test w/Debris Bed System
  - Vertical Column Head Loss System
  - CHLE Corrosion Tank
  - Prototypical Water Chemistry for Vogtle During LOCA

- Additional Chemical Effects Testing
  - Bench Scale Tests
  - Prototypical Water Chemistry Tank Test w/o Debris Beds
  - ***Forced Precipitation Tank Test w/Debris Beds (T7)***

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ADDITIONAL CE TANK TESTS

- 10-Day Integrated Tank Test (T7)
  - Objective:
    - Investigate material corrosion and any resulting effects on head loss under forced precipitation conditions using Vogtle quantities for boron, TSP, concrete, galvanized steel, and zinc
  - Corrosion Tank
  - Vertical Column Head Loss System
  - Excess aluminum submerged in CHLE Tank (parallel to T3 test for STP)
  - Different Temperature Profile than T6/T8

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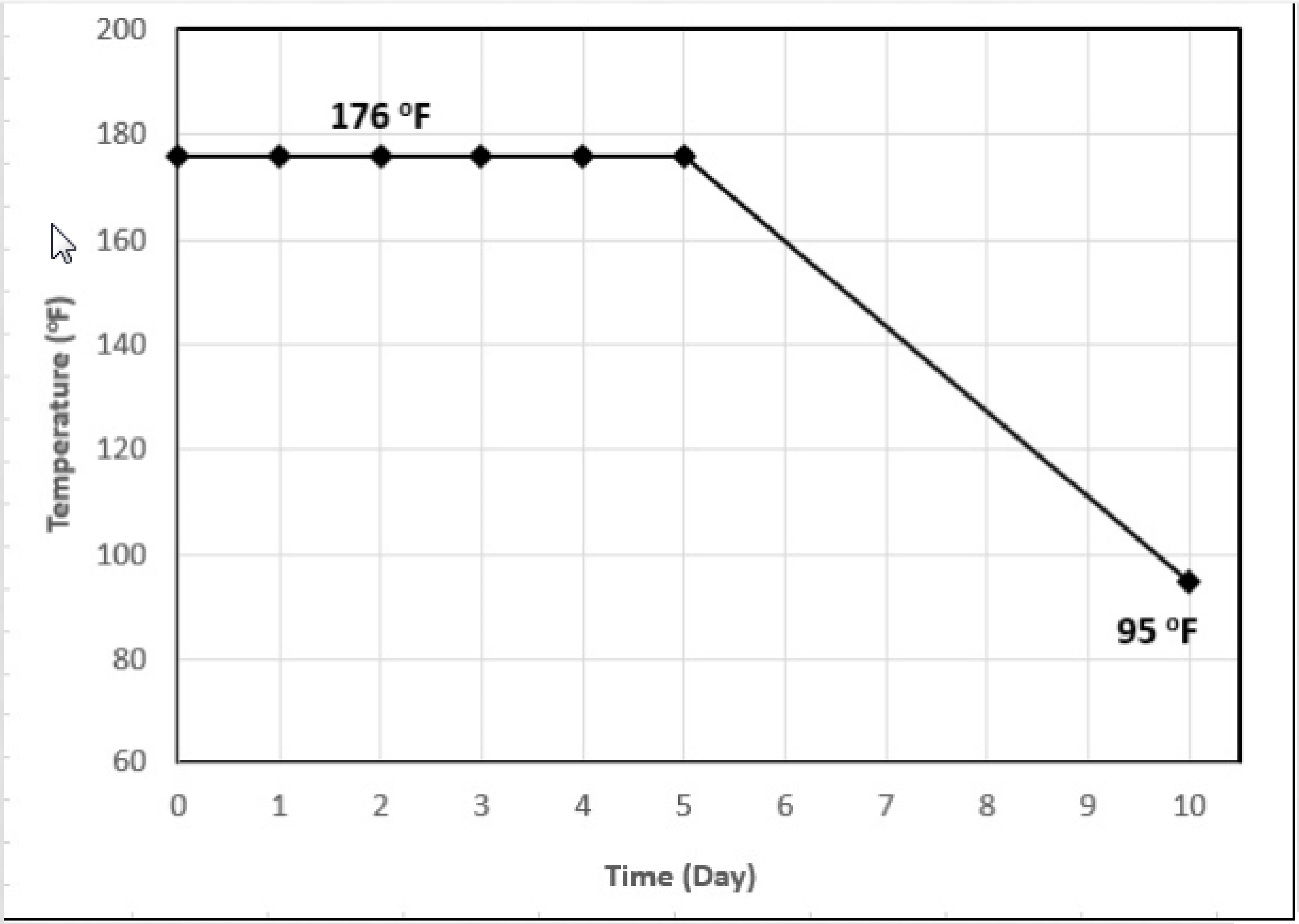
TEMPERATURE PROFILE: T7



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NEXT STEPS…

- Vertical Column Head Loss
  - Explore effects of chemical surrogates on measured head loss for various fiber/particulate ratios (thin, medium, and thick debris beds)
- Tank Tests
  - Perform T6, T7, T8 tests
- Bench Scale Tests
  - Zinc
  - Calcium

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REFERENCES

- CHLE-SNC-001 (Bench Tests: Aluminum)
- CHLE-SNC-007 (Bench Tests: Aluminum w/other metals)
- CHLE-SNC-008 (HL Operating Procedure)
- CHLE-SNC-020 (Test Plan for T6, T7 & T8)

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STRAINER HEAD LOSS TEST PLAN

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RISK-INFORMED CONVENTIONAL HEAD LOSS TEST STRATEGY

- Enercon Services, Inc.
  - Tim Sande
  - Kip Walker
- Alden Research Laboratory
  - Ludwig Haber

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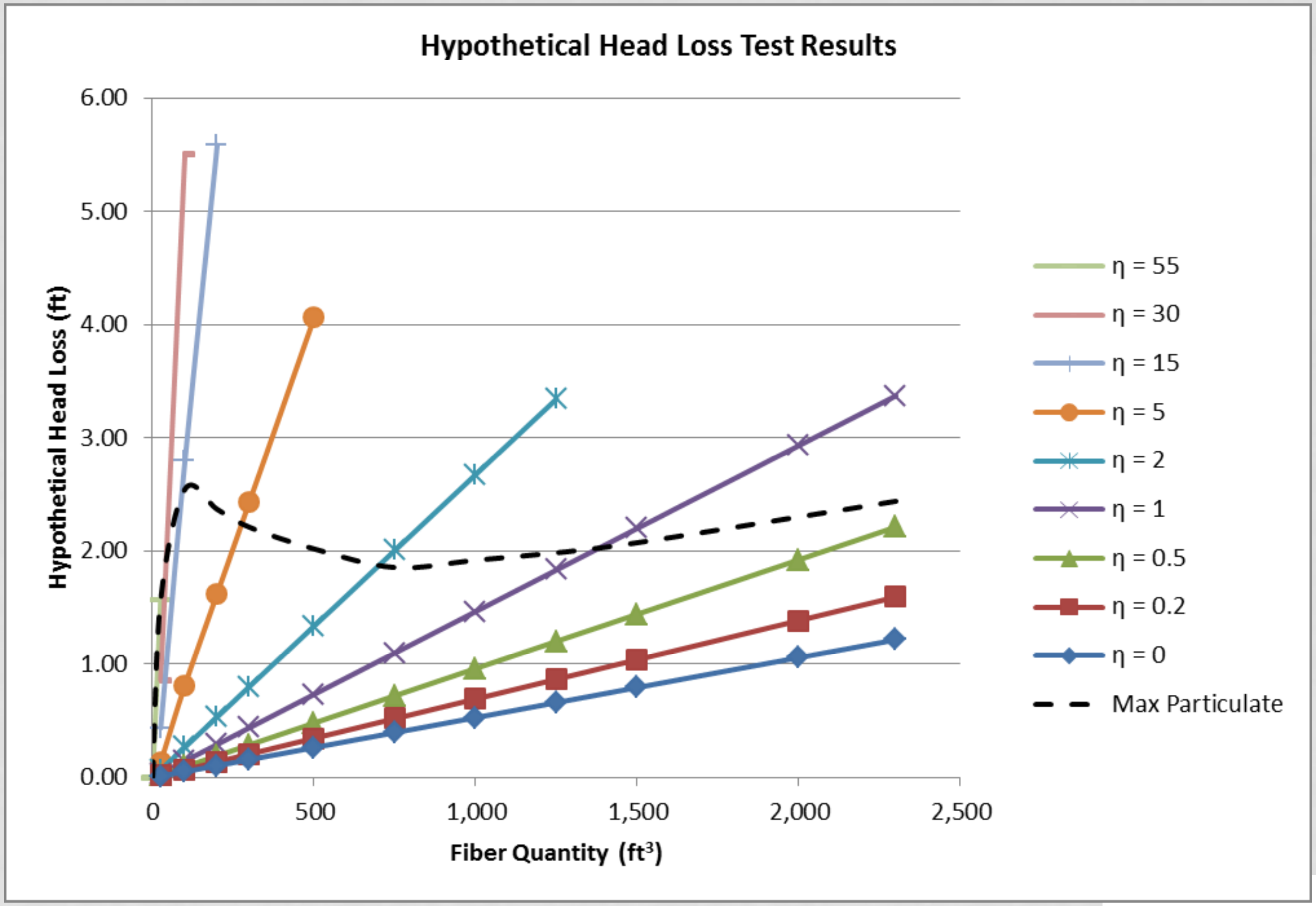
HEAD LOSS MODEL

- Why is a head loss model necessary?
  - Thousands of break scenarios
    - Each with unique conditions (break flow rate, sump water level, debris loads, etc.)
    - Parameters that change with time
  - It is not practical to conduct a head loss test for every scenario
- Approaches for developing a risk-informed head loss model
  - Correlation approach has some advantages, but very difficult to implement
  - Rule-based approach is focused on prototypical conditions for a given plant, which makes it more practical
  - Hybrid approach uses rule-based head loss data to create an empirical correlation
- An overall head loss test strategy is presented which includes some Vogtle-specific implementation information. Other plants are evaluating and may use all or parts of this strategy.

HYPOTHETICAL TEST RESULTS



η = particulate/fiber ratio

PRACTICAL CONSIDERATIONS

- "Conservatisms" required to limit test scope
  - Reduce all particulate types to one bounding surrogate
  - Reduce all fiber types to one bounding surrogate
  - Reduce all water chemistries to one bounding chemistry
- Notes:
  - Surrogate properties include the debris type, size distribution, density, etc.
  - Bounding refers to a parameter value that maximizes head loss within the range of plant-specific conditions
  - Test details will be fully developed in a plant-specific test plan

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PRACTICAL CONSIDERATIONS

- Definition of testing limits based on plant-specific conditions
  - Maximum fiber quantity
  - Maximum particulate quantity
  - Maximum particulate to fiber ratio (max η)
- Use of small-scale testing
  - If a small-scale version of the prototype strainer can be shown to provide the same head loss results as a large-scale strainer, test program will utilize small-scale head loss values to build model
  - Reduced cost and schedule would allow more data to be gathered

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OVERVIEW OF TEST PROGRAM

- Test Series
  - Large-scale test with thin-bed protocol
  - Large-scale test with full-load protocol
  - Validation of small-scale testing
  - Small-scale sensitivity tests
  - Small-scale tests with full-load protocol
- Need to determine minimum fiber and maximum particulate quantity (i.e., maximum η) required to generate "significant" conventional debris head loss
  - Significant head loss subjectively defined as 1.5 ft
  - Vogtle's NPSH margin ranges from 10 ft to over 40 ft, depending on pool temperature and containment pressure
  - Head loss below 1.5 ft is not likely to cause failures under most circumstances even if future chemical effects testing results in significant head loss

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LARGE-SCALE TEST WITH THIN-BED PROTOCOL

- Purpose
  - Identify minimum fiber load required to develop "significant" conventional head loss (maximum η)
  - Obtain prototypical head loss data for use in validating the small-scale strainer
  - Measure bounding strainer head loss for thin-bed conditions
- Test Protocol
  - Use buffered and borated water at 120 °F
  - Perform flow sweep to measure clean strainer head loss
  - Add prototypical mixture of particulate debris (max quantities)
  - Batch in prototypical mixture of fiber debris (one type at Vogtle) in small increments (1/32nd inch equivalent bed thickness)
  - Measure stable head loss and perform flow sweep between each batch
  - Continue adding fiber until a head loss of 1.5 ft is observed
  - Perform temperature sweep
  - Batch in chemical precipitates (quantity and form to be determined by separate analysis/testing)

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LARGE-SCALE TEST WITH FULL-LOAD PROTOCOL

- Purpose
  - Identify fiber quantity required to fill the interstitial volume
  - Obtain prototypical head loss data for use in validating the small-scale strainer
  - Measure bounding strainer head loss for full-load conditions
- Test Protocol
  - Use buffered and borated water at 120 °F
  - Perform flow sweep to measure clean strainer head loss
  - Utilize η value corresponding to bounding fiber debris quantity with same particulate load used for large-scale thin-bed test
  - Batch in prototypical mixture of fiber and particulate debris maintaining the desired η value for each batch
  - Measure stable head loss and perform flow sweep between each batch
  - Repeat batches and flow sweeps until full fiber and particulate load has been added
  - Perform temperature sweep
  - Batch in chemical precipitates (quantity and form to be determined by separate analysis/testing)

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VALIDATION OF SMALL-SCALE TESTING

- Design small-scale strainer using proven scaling techniques
- Test small-scale strainer under conditions similar to large-scale testing (both thin-bed and full-load protocols)
- Adjust strainer or tank design as necessary to appropriately match large-scale test results
- Note: If small-scale testing cannot be validated due to competing scaling factors, the remaining tests could be performed using the large-scale strainer

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SMALL-SCALE SENSITIVITY TESTS

- Purpose
  - Reduce all particulate types to a single bounding surrogate
  - Reduce all fiber types to a single bounding surrogate (Vogtle only has one fiber type)
  - Reduce range of prototypical water chemistries to a single bounding chemistry
  - Tests will be run with a variety of representative parameters to identify the parameters for use in remaining tests
  - Gather data for head loss caused by various types of chemical surrogates

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SMALL-SCALE TESTS WITH FULL-LOAD PROTOCOL

- Purpose of these tests are to gather data necessary to build the head loss model
- Test Protocol will be similar to large-scale, full-load test except that the small-scale tests will be conducted using the bounding surrogates for fiber, particulate, and water chemistry
- Perform series of tests (e.g., 9 tests) at different η values with equivalent fiber batch sizes for each test

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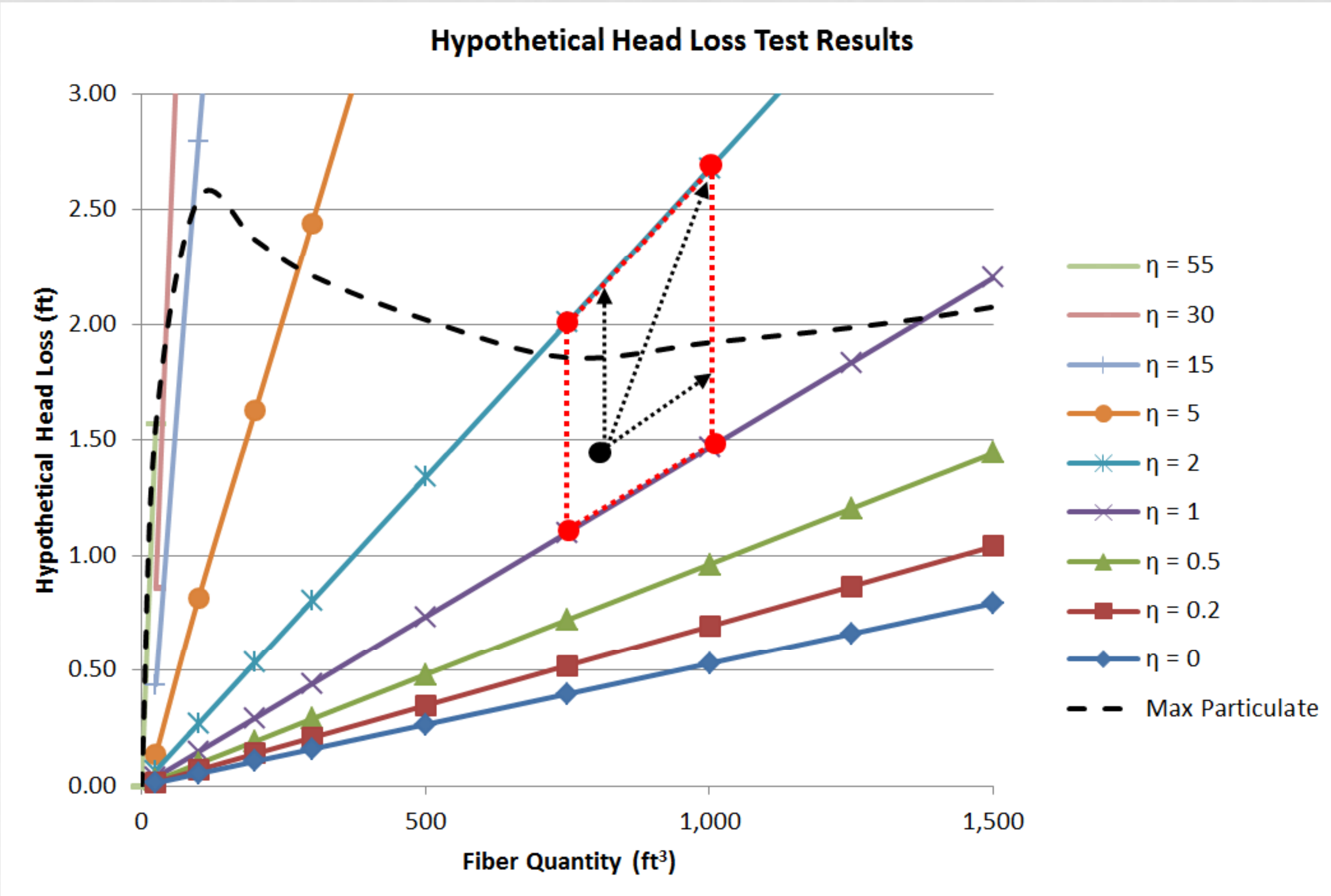
RULE-BASED IMPLEMENTATION



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OPTIONS FOR IMPLEMENTATION

- Select head loss value for bounding fiber quantity and η value
- Interpolate between two fiber values and use bounding η value
- Interpolate between all four points

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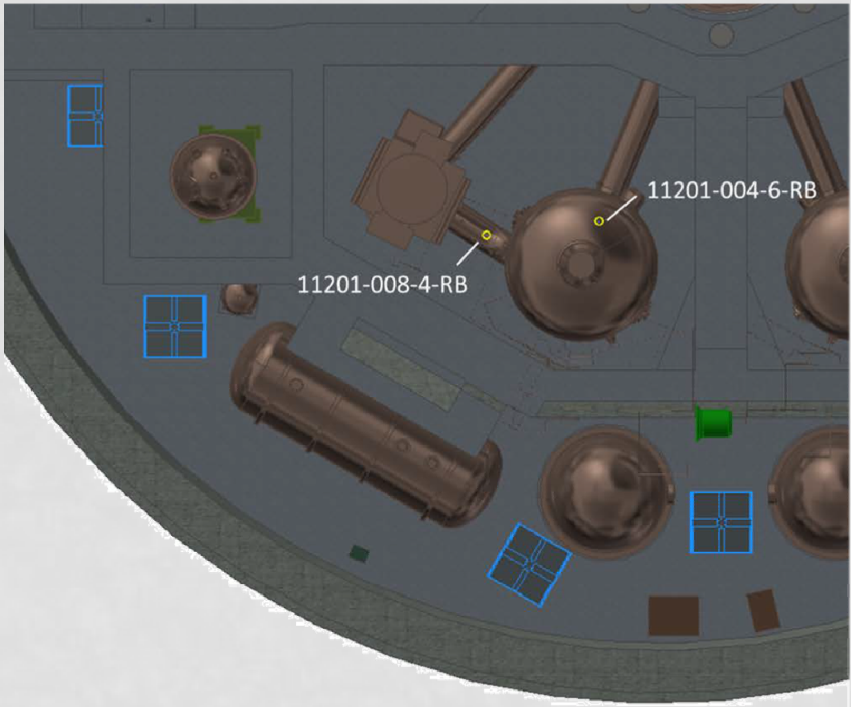
VOGTLE DEBRIS GENERATION

- Debris quantities vary significantly for different weld locations and break sizes
- Max Fiber (11201-004-6-RB, Hot leg at base of SG)
  - Nukon: 2,235 ft^3
  - Latent fiber: 4 ft^3
  - Total: 2,239 ft^3
- Max Particulate (11201-008-4-RB, Crossover leg)
  - Interam: 183 lb_m
  - Qualified epoxy: 188 lb_m
  - Qualified IOZ: 61 lb_m
  - Unqualified epoxy: 2,602 lb_m
  - Unqualified IOZ: 25 lb_m
  - Unqualified alkyd: 32 lb_m
  - RCS Crud: 23 lb_m
  - Latent dirt/dust: 51 lb_m
  - Total: 3,165 lb_m



VOGTLE DEBRIS TRANSPORT

- Debris transport varies significantly depending on several parameters
  - Break location (compartment)
  - Debris size distribution
  - Number of pumps/trains in operation
  - Whether containment sprays are activated
  - Location of unqualified coatings
  - Time when containment sprays are secured
  - Failure time for unqualified coatings
  - ECCS/CSS pump flow rates
  - Recirculation pool water level

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VOGTLE FIBER TRANSPORT FRACTIONS TO ONE RHR STRAINER*

Debris Type	Size	1 Train w/ Spray	2 Train w/ Spray	1 Train w/out Spray	2 Train w/out Spray
Nukon	Fines	58%	29%	23%	12%
	Small	48%	24%	5%	2%
	Large	6%	3%	7%	4%
	Intact	0%	0%	0%	0%
Latent	Fines	58%	29%	28%	14%

* Preliminary values

SOUTHERN COMPANY

VOGTLE PARTICULATE TRANSPORT FRACTIONS TO ONE RHR STRAINER*

Debris Type	Size	1 Train w/ Spray	2 Train w/ Spray	1 Train w/out Spray	2 Train w/out Spray
Unqualified Epoxy	Fines	58%	29%	44%	22%
	Fine Chips	0%	0%	0%	0%
	Small Chips	0%	0%	0%	0%
	Large Chips	0%	0%	0%	0%
	Curled Chips	58%	29%	5%	7%
Unqualified IOZ	Fines	58%	29%	12%	6%
Unqualified Alkyd	Fines	58%	29%	100%	50%
Interam	Fines	58%	29%	23%	12%
Qualified Epoxy	Fines	58%	29%	23%	12%
Qualified IOZ	Fines	58%	29%	23%	12%
Latent dirt/dust	Fines	58%	29%	28%	14%
RCS Crud	Fines	58%	29%	23%	12%

* Preliminary values

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DEBRIS TRANSPORT W/O CONTAINMENT SPRAYS

- Blowdown transport fractions are not changed
- Distribution of debris prior to recirculation remains unchanged
- 5% of fines assumed to be washed down due to condensation in containment

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VOGTLE FIBER TRANSPORT TO ONE RHR STRAINER, 1 TRAIN W/SPRAY*

Debris Type	Size	DG Quantity (ft^3)	Transport Fraction	Quantity (ft^3)
Nukon	Fines	290.5	58%	168.5
	Small	1,001.1	48%	480.5
	Large	453.6	6%	27.2
	Intact	489.4	0%	0.0
	Total	*2,234.7*		*676.3*
Latent	Fines	3.8	58%	2.2
Total		**2,238.5**		**678.4**

* Preliminary values

VOGTLE PARTICULATE TRANSPORT TO ONE RHR STRAINER, 1 TRAIN W/SPRAY*

Debris Type	Size	DG Quantity (lb_m)	Transport Fraction	Quantity (lb_m)
Unqualified Epoxy	Fines	319.5	58%	185.3
	Fine Chips	968.7	0%	0.0
	Small Chips	245.4	0%	0.0
	Large Chips	534.2	0%	0.0
	Curled Chips	534.2	58%	309.8
	Total	*2,602.0*		*495.2*
Unqualified IOZ	Fines	25.0	58%	14.5
Unqualified Alkyd	Fines	32.0	58%	18.6
Interam	Fines	182.9	58%	106.1
Qualified Epoxy	Fines	187.6	58%	108.8
Qualified IOZ	Fines	61.3	58%	35.6
Latent dirt/dust	Fines	51.0	58%	29.6
RCS Crud	Fines	23.0	58%	13.3
Total		**3,164.8**		**821.6**

* Preliminary values

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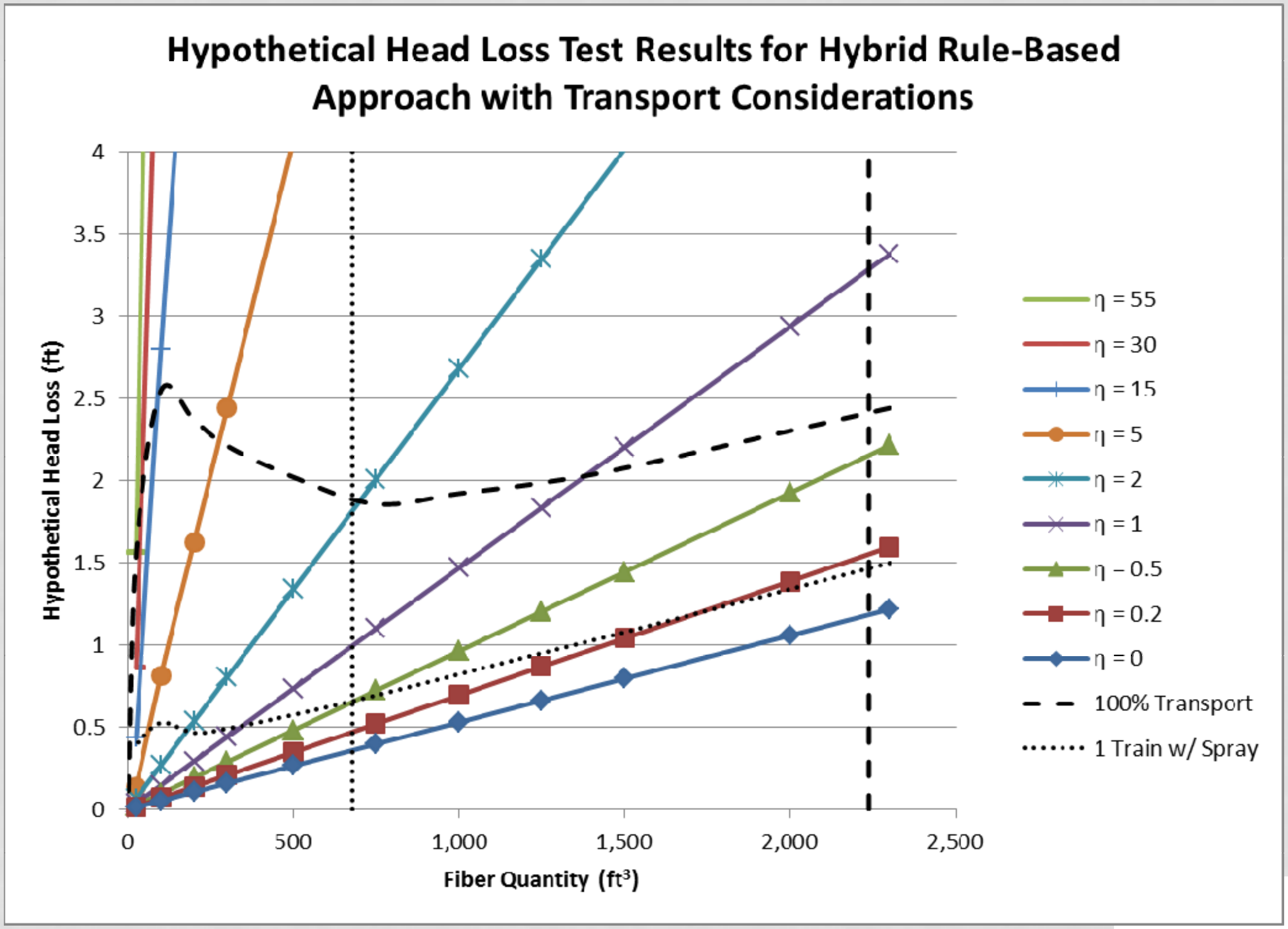
HYPOTHETICAL TEST RESULTS WITH TRANSPORT CONSIDERATIONS



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SUMMARY

- A comprehensive test program is necessary to quantify head loss for thousands of break scenarios
- The rule based approach is a more practical option than a full correlation or test for every break scenario
- Simplifications of fiber type, particulate surrogate, and water chemistry are necessary to develop a practical test matrix
- Small-scale testing may be utilized to gather a majority of the data

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CHEMICAL EFFECTS BACKUP SLIDES

CHEMICAL EFFECTS TESTING OVERVIEW

- 30-Day Integrated Tank Test w/Debris Bed System (T8)
  - Vertical Column Head Loss System
  - ***CHLE Corrosion Tank***
  - Prototypical Water Chemistry for Vogtle During LOCA

- Additional Chemical Effects Testing
  - Bench Scale Tests
  - Prototypical Water Chemistry Tank Test w/o Debris Beds
  - Forced Precipitation Tank Test w/Debris Beds

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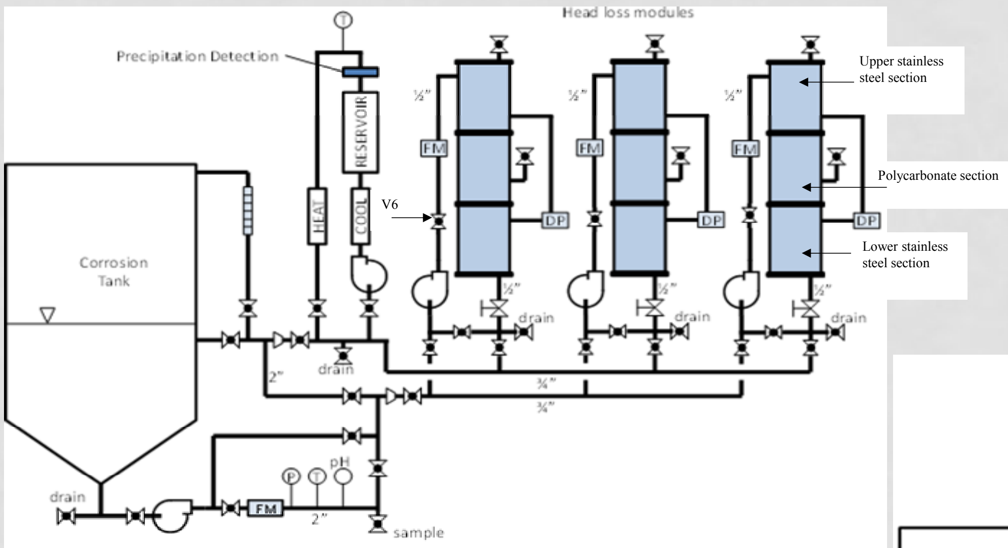
CHLE TROUBLESHOOTING APPROACH

- **Modifications to CHLE Tank & Column System**

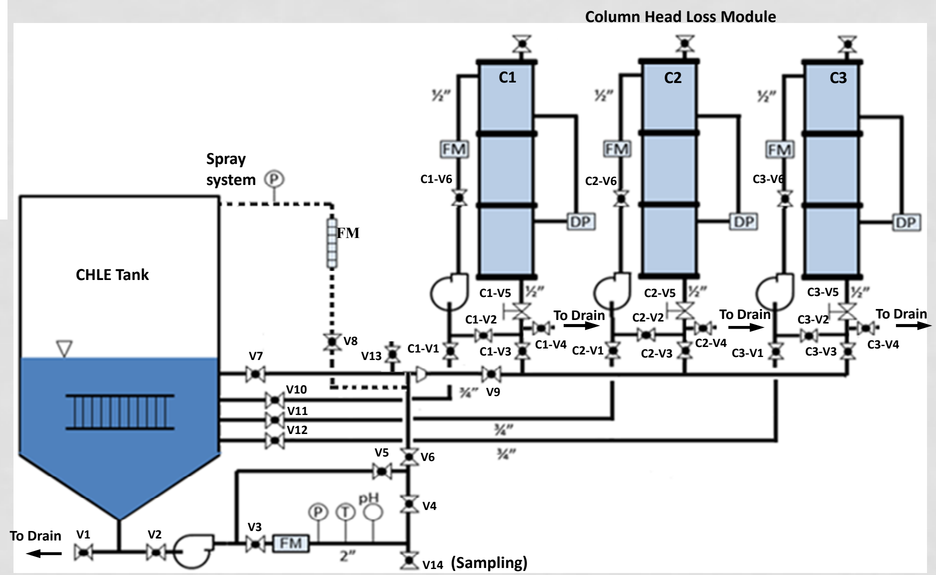
1. Single flow header for each column
2. Unified suction and discharge plumbing arrangement
3. Improved flow distribution sparger
4. Develop a new procedure for debris bed preparation and loading [CHLE-SNC-008]
   - Stable head loss
   - Repeatable head loss (single column)
   - Minimum variability
   - Chemical detection

CHLE TANK AND COLUMN MODIFICATIONS

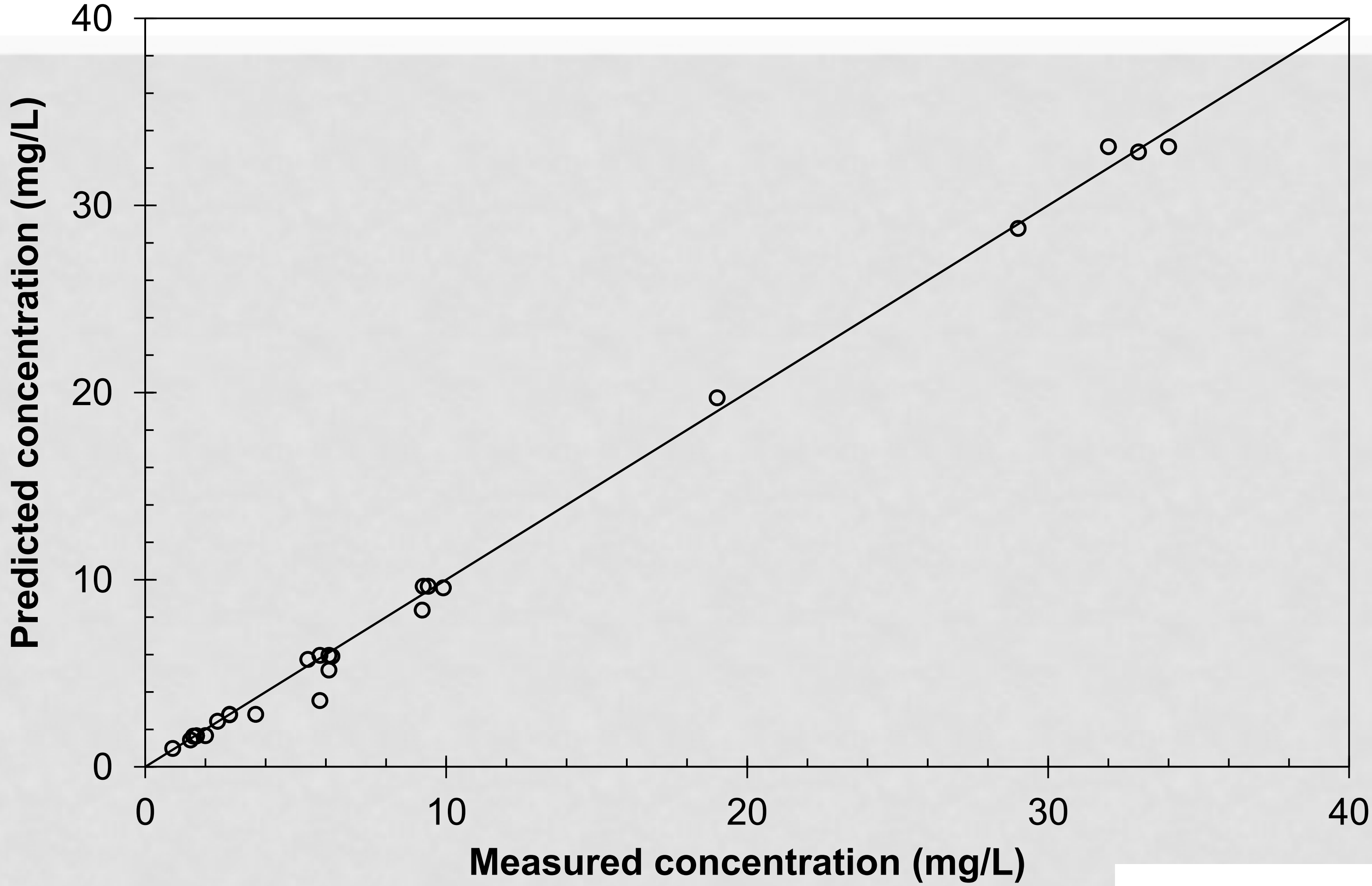


CHLE System Before Modifications

CHLE System After Modifications



ALUMINUM CORRELATION DATA: BEST FIT



STRAINER HEADLOSS BACKUP SLIDES

INTRODUCTION

- 35 Years of History and Lessons Learned
  - USI A-43 (opened in 1979)
    - Head loss testing/correlations for fiber and RMI (no particulate)
    - Resolved without major plant modifications
  - Bulletins 93-02 and 96-03
    - Incident at Barsebäck in 1992 and similar events at Perry and Limerick showed that mixtures of fiber and particulate can cause higher head loss than previously evaluated
    - BWR research and plant-specific evaluations led to strainer replacements at all U.S. BWRs
    - Issue resolved in early 2000s.

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INTRODUCTION

- 35 Years of History and Lessons Learned, Cont.
  - GSI-191 and GL 2004-02
    - Based on BWR concerns, GSI-191 was opened in 1996 to address ECCS strainer performance for PWRs
    - Chemical effects identified as an additional contributor to strainer head loss
    - PWR research and plant-specific evaluations led to strainer replacements at all U.S. PWRs
    - Complexities in evaluations have delayed closure for most plants
    - NRC head loss guidance issued in March 2008

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3M INTERAM E-50 SERIES

- MSDS and observations indicate that it is 30% fiber and 70% particulate
- Non-QA testing with NEI fiber preparation protocol indicates that it is more robust than Temp-Mat
  - 11.7D ZOI can be justified
- Testing indicates that 50% fines and 50% small pieces would be conservative (i.e.. smaller than actual)
- Transport metrics can be developed based on density and particle sizes, similar to other types of debris

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