Technology MATTERS™

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CCI Chemical Testing Strategy and Methodology

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Contents

- Basic requirements of WCAP-16530-NP
- CCI chemical testing strategy
- Labororatory bench testing by Niutec
- Short description of strainer geometries
- Overview of done Chemical Testing

Basic WOG document for chemical tests

- WCAP-16530-NP, Evaluation of Post Accident Chemical Effects in Containment Sump Fluids to Support GSI-191, Rev.0, Feb. 2006
  - Containment Materials
  - Test Plan (Dissolution, Precipitation)
  - Bench Testing (Dissolution, Precipitation)
    - Settling Rates, Sizes, Filterability
  - Chemical Model
  - Particulate generator

Importance of Elements in Solution

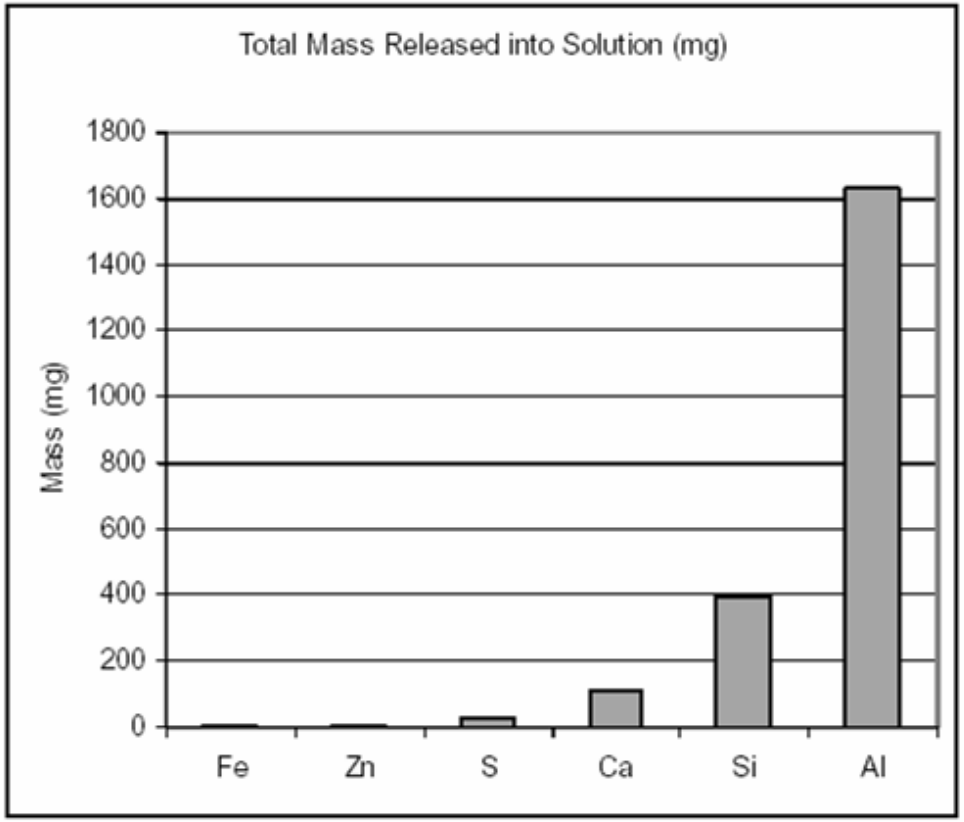
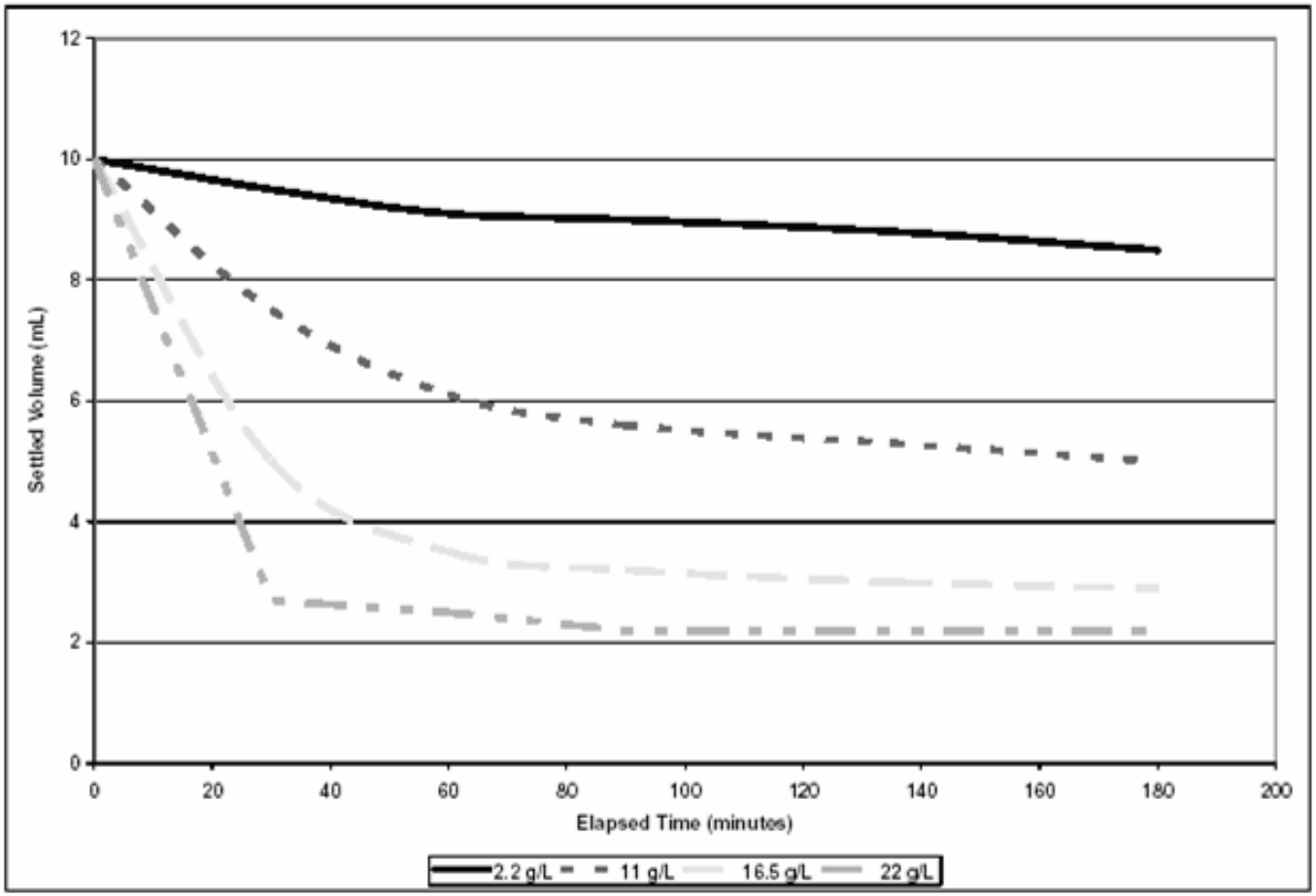


Figure 5.2-10: Comparison of Total Mass Released during Dissolution Testing by Element

Figure 7.6-1: Settling Rate of 2.2 g/L AlOOH as a Function of Mix Tank Concentration



Importance of precipitate concentration in WCAP

7.7 CONCLUSIONS FROM PARTICULATE GENERATOR TESTS

Testing of the particulate generator demonstrated that simulated particulates can be successfully generated for use in sump screen testing. Generation of the particulates is generally straightforward, and can be performed using readily available equipment and materials. The testing confirmed that the quality and temperature of the water used to prepare the particulates, and that used in the screen test loop, is not critical. No special water chemistry control is required to use the generated particulates in screen testing. The most critical parameter determined during the testing was the limitation on the degree of concentration of the particulates in the mixing tank. In the event that large quantities of particulates are required, the particulates may be prepared in batches or in multiple mixing tanks.

Strategy of CCI Chemical Testing

- Use whole loop as precipitate generator
- Advantages :
  - Precipitate concentration is closest to real plant conditions
  - Minimal Effect of coagulation of precipitates
  - Minimal effect on settling rate
  - No contradiction to WCAP (>20% loop volume for chemical generation)
  - No interferences with components (pumps, pipes etc.) of another separate generator
  - Chemistry is more easily controllable
  - 1 volume or step less is to analyze and verify chemically
  - AND ….DEFENDABLE CONTROL OF WATER LEVEL !!!

Chemical Materials

Test Chemicals	Boric Acid (and nitric acid ?)	Sodium Aluminate (and TSP if applicable)	Calcium Chloride	Sodium Silicate
Precipitates		Aluminum Hydroxide (as surrogate for Oxihydroxide)	Calcium Aluminum Silicate (and ? Calcium Phosphate)	Sodium Aluminum Silicate
pH control	Lowering pH	Rising pH		

Laboratory Bench Tests

- Purposes :
  - Determine quality of chemicals (assays)
  - Determine necessary amounts of chemicals for HL test
  - Determine influence of tap water vs deionized water
  - Determine influence of other debris types like stone flour
  - Determine characteristics of precipitates (settling rate, sizes, filterability, viscosity)
  - Compare precipitate properties with WCAP values

Laboratory Bench Tests - Steps

- Chemical Assays (all chemicals and stone flour)
- Solubility of stone flour in boric acid (no stirring)
- Solubility of stone flour in boric acid (with stirring)
- Mixing Test for whole simulation (deionized water)
- Mixing Test for whole simulation (tap water)
- Mixing Test with stone flour (deionized water)
- Mixing Test with stone flour (tap water)
- Analysis of stone flour

Laboratory Bench Tests – Steps (Continued)

- Determination of Boron in Boric Acid Solution
- Determination of Total Suspended Solids (TSS)
- Determination of Sodium, Calcium and Aluminum
- Alternate determination of boron
- Determination of Chloride and Sulfate
- Determination of pH
- Alkalinity determination
- Determination of Silica
- Determinations of Viscosity, Settling Rate, Size and Filterability

CCI overall testing experience

Type of Test Loop	Small	Large	MultiPurpose
Number of pockets (typically)	6	120	40
Flow rate capacity (gpm, approx.)	440	440	880
Experience in total test days for USA plants	30	80	190
Experience in chemical testing (from above)	10	5	65

ICET Test Program at Los Alamos

Buffer Agent	100% Fiberglass	80% CalSil 20% Fiberglass
Sodium Hydroxide	Test 1	Test 4
Trisodium Phosphate	Test 2	Test 3
Sodium Tetraborate	Test 5	

Overview of done Chemical testing

- Exelon Byron/Braidwood
  - NaOH buffer, ICET # 1 chemistry
- Salem
  - NaOH buffer, ICET # 1 chemistry
- ANO
  - NaOH buffer, ICET # 4 chemistry
- Palo Verde
  - TSP buffer, ICET # 2 chemistry

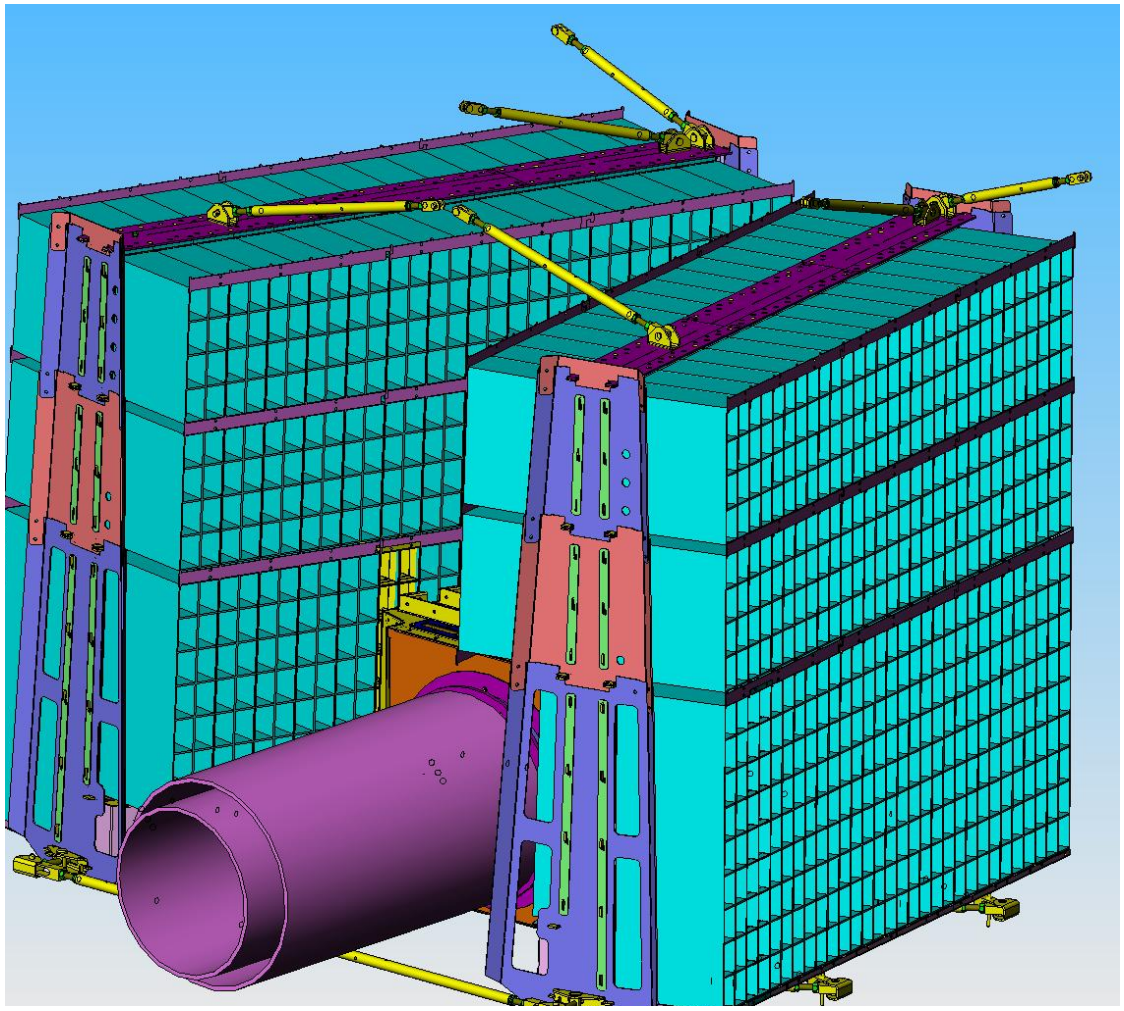
Comparison of test data

Plant	Test screen (m2)	Test Flow rate (m3/h)	Screen Penetration Velocity (mm/s)	Approach Velocity (mm/s)
Byron/ Braidwood	5.0	64.22	3.57	44.4
Salem	2.49	13.18/7.48	1.47/0.83	18.3/10.3
ANO	5.0	48.95	2.71	33.7
Palo Verde	4.5	46.33	2.86	35.6

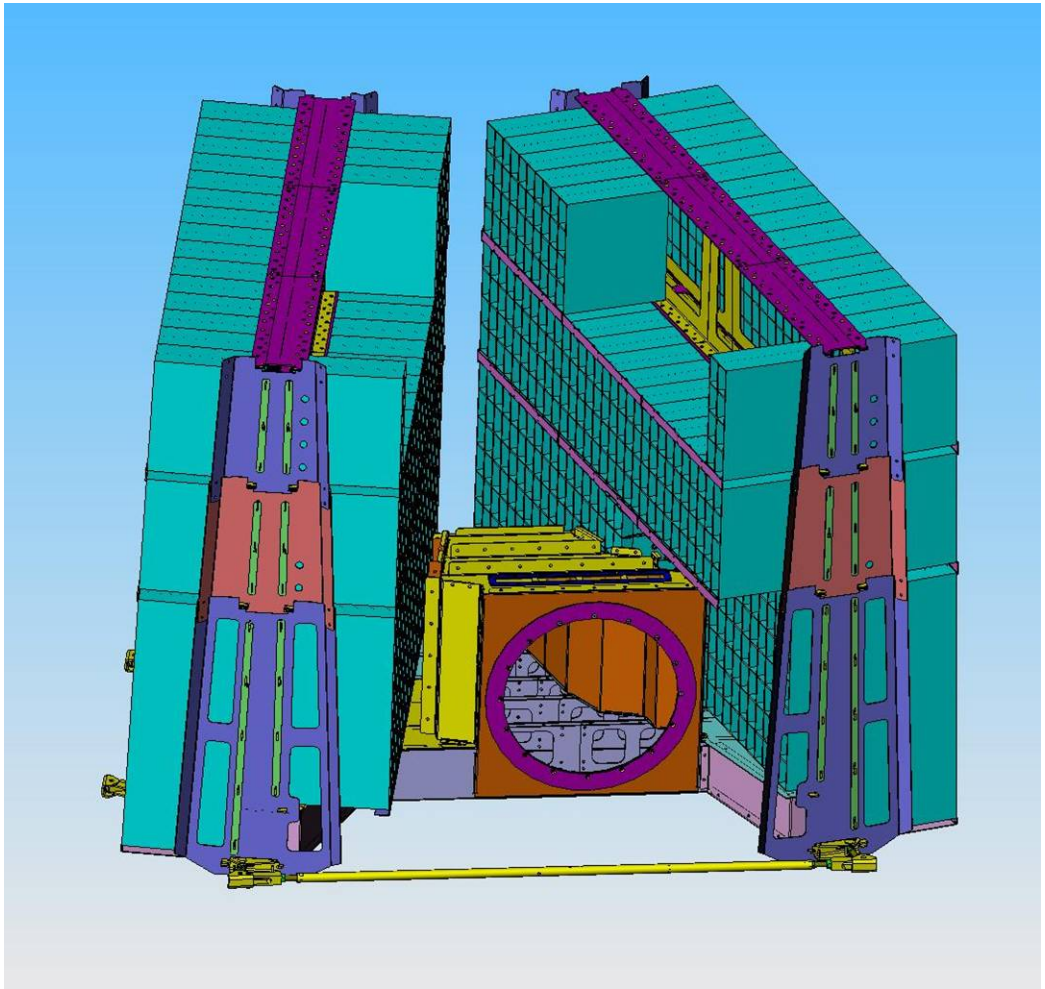
Comparison of test data (kg)

Plant	Fiber amount	CalSil amount	RMI amount	Coatings/ Particulate amount
Byron/ Braidwood	0.25	0	Large amount	155
Salem	4.6/3.2	0	0.2/0.8	6.6/12.0
ANO	0.7	8.1	9.5	22
Palo Verde	2.1	0	0	21

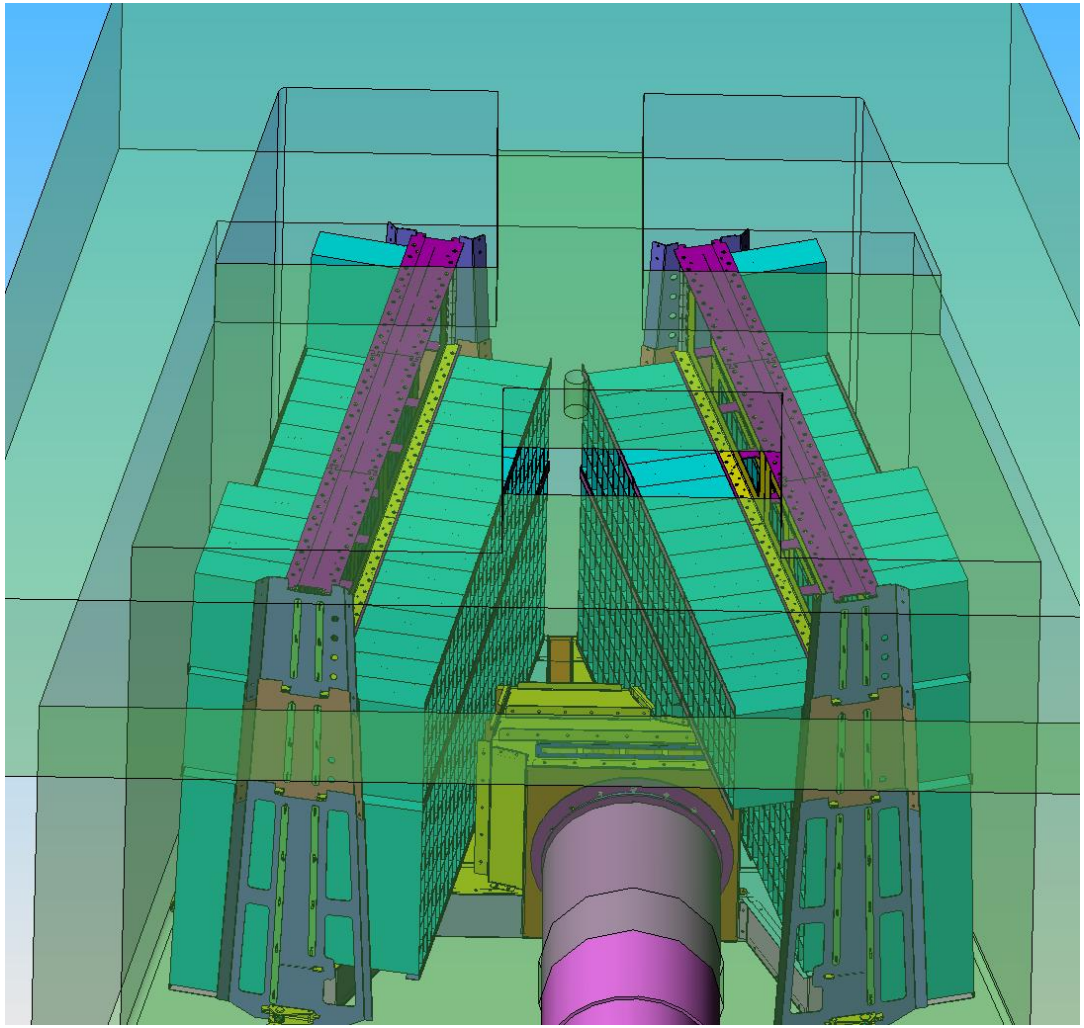
Byron/Braidwood Strainer Installation

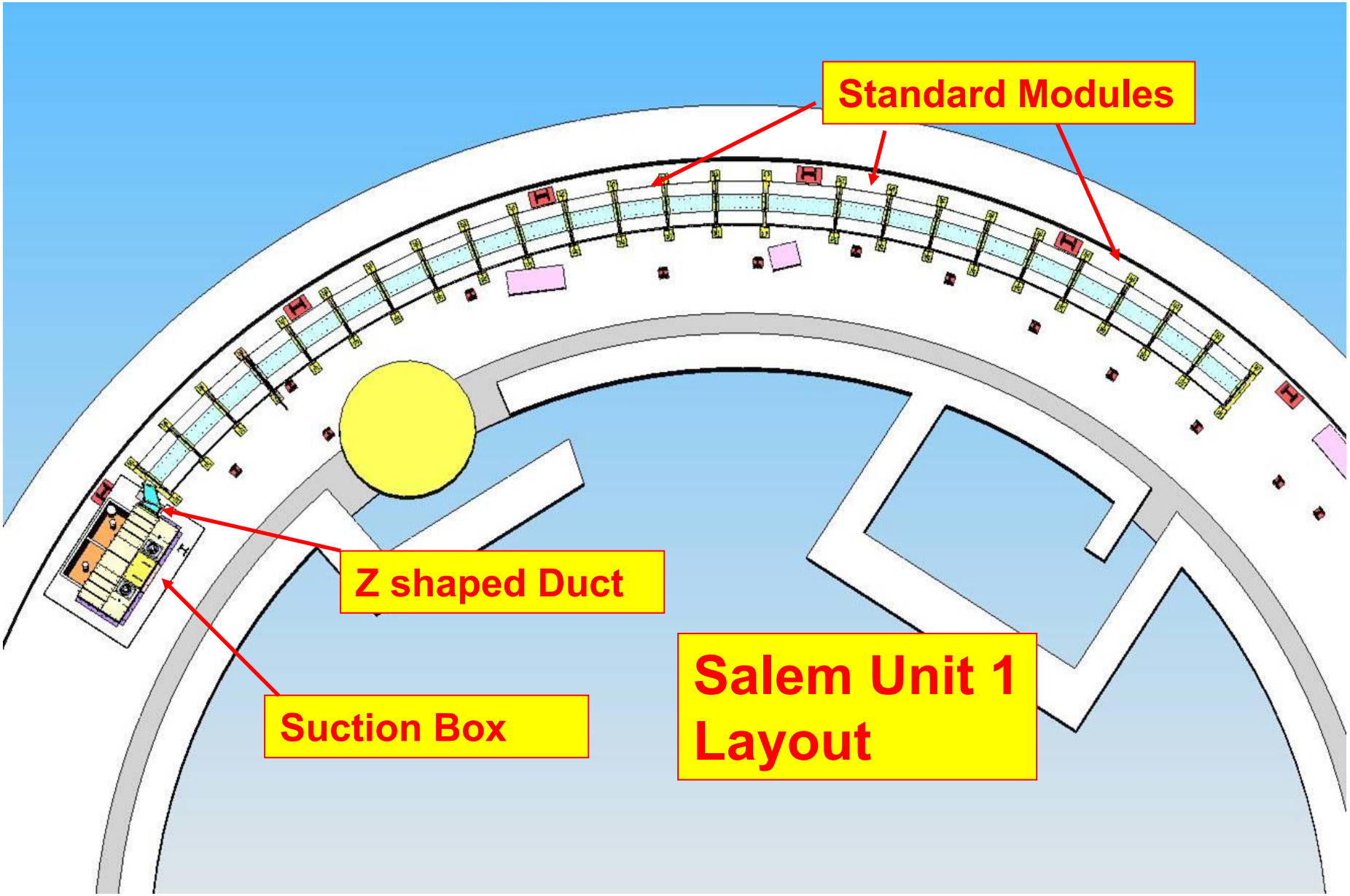


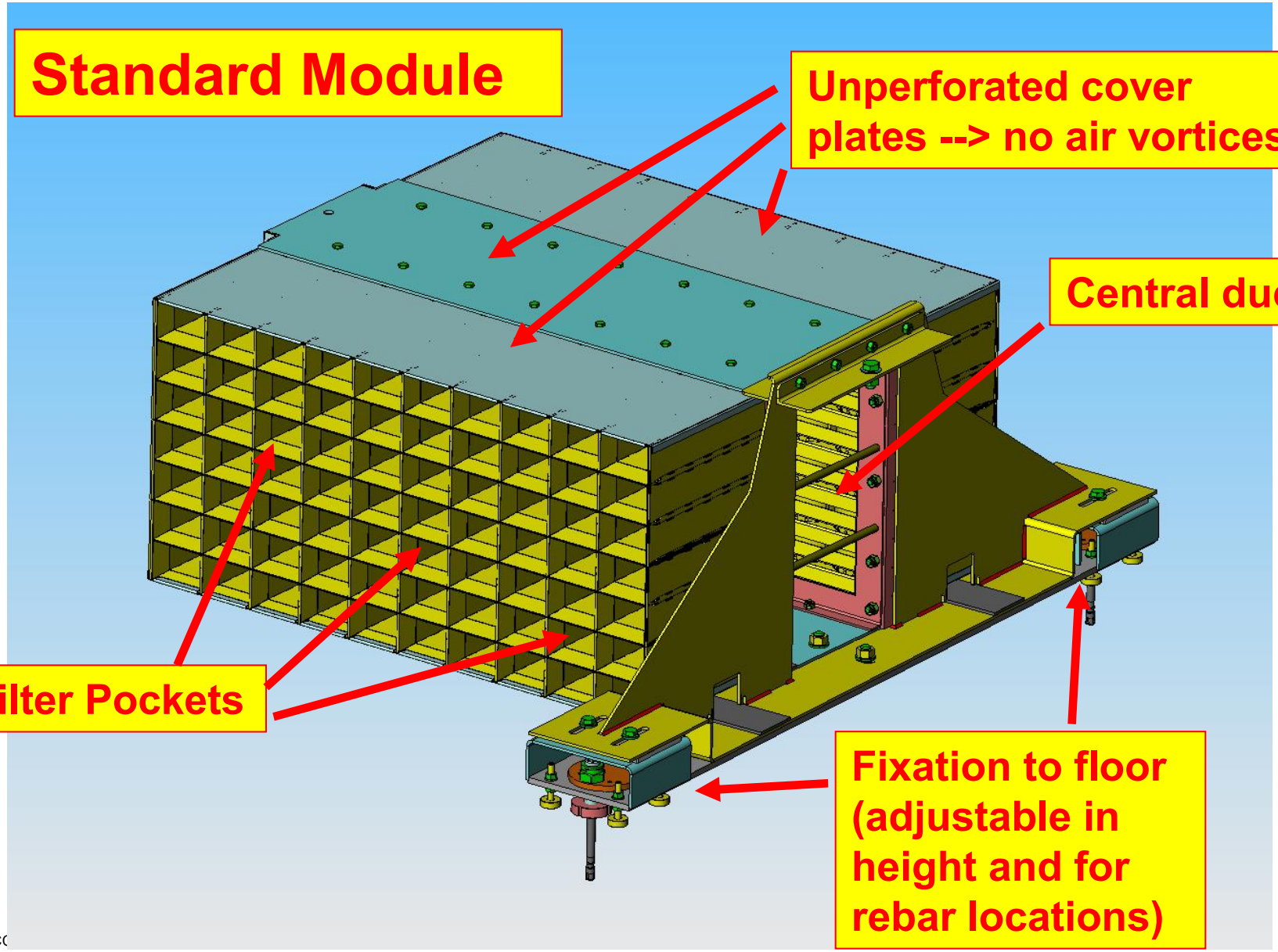
Byron/Braidwood Strainer Installation



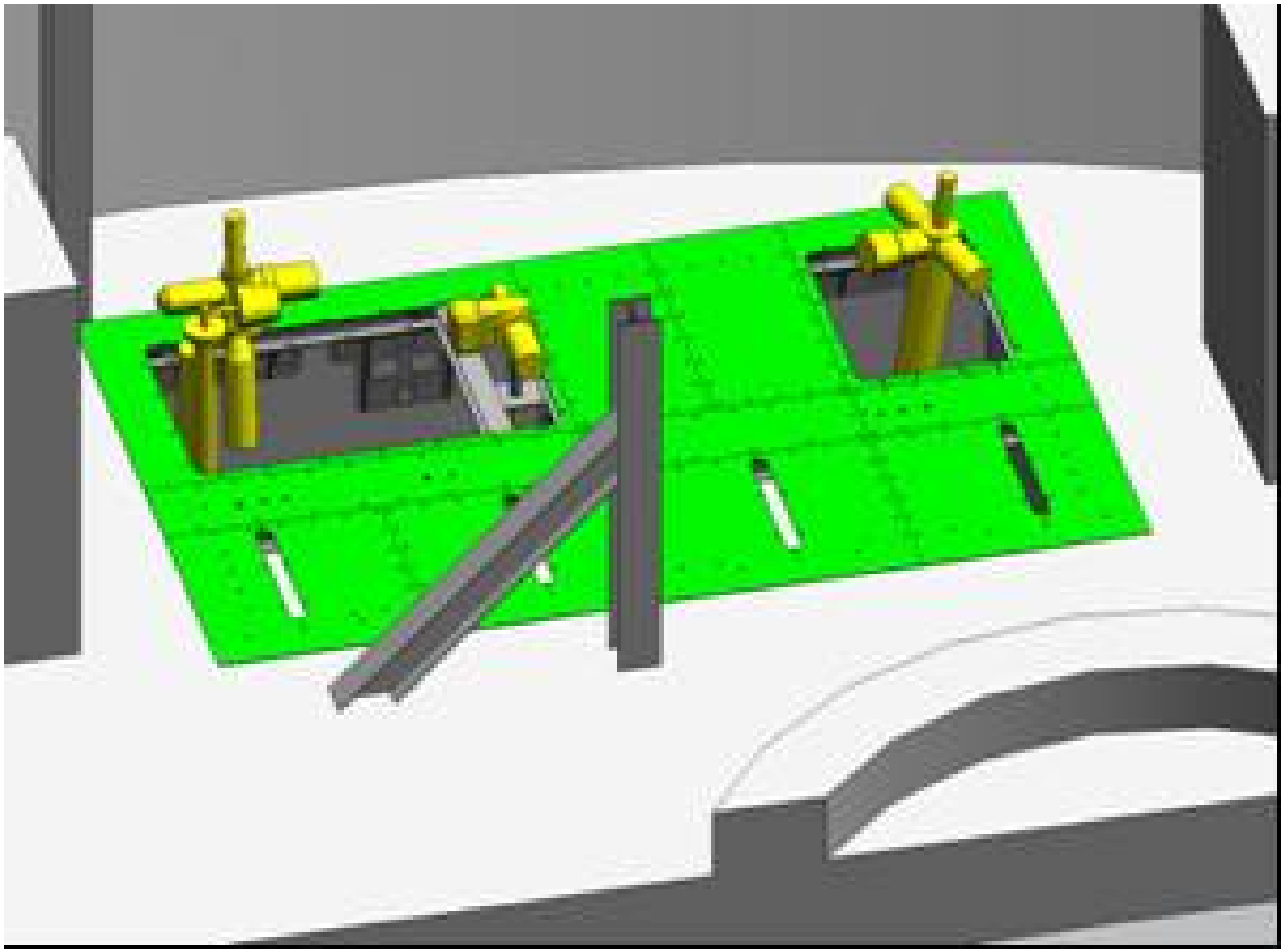
Byron/Braidwood Strainer Installation



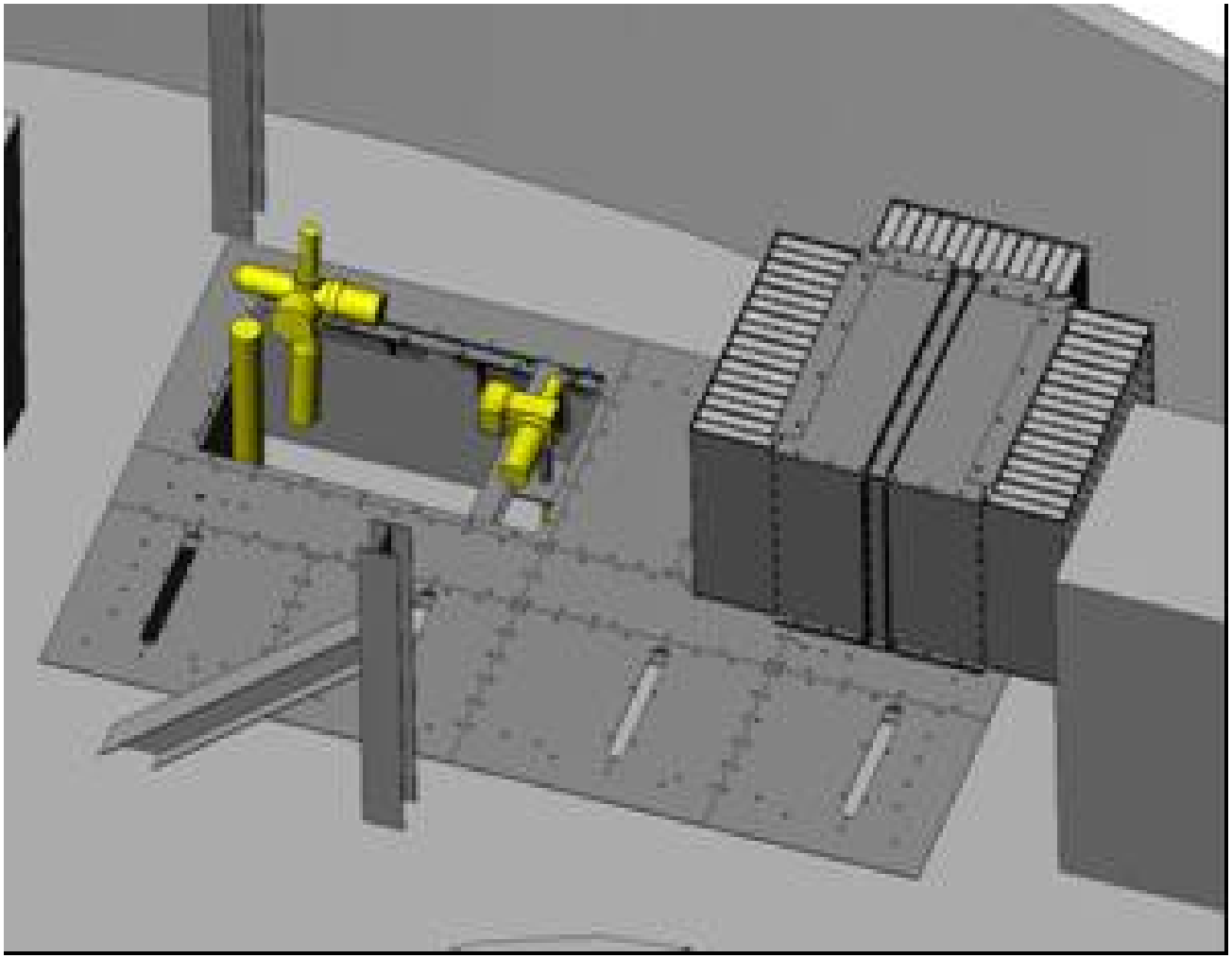

Standard Modules
Z shaped Duct
Suction Box
Salem Unit 1
Layout


Standard Module
Unperforated cover plates --> no air vortices
Central duct
Filter Pockets
Fixation to floor (adjustable in height and for rebar locations)

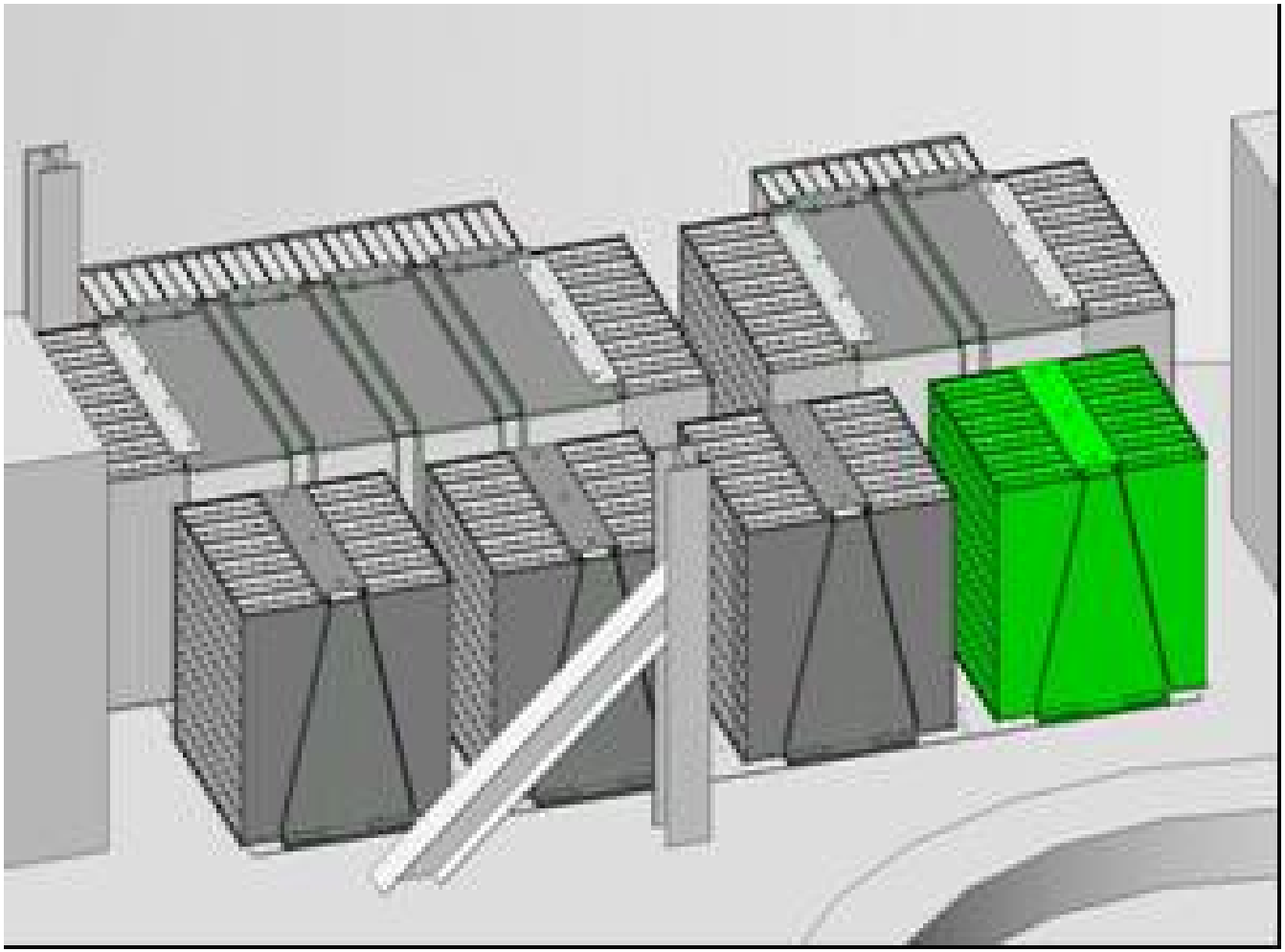
ANO sump



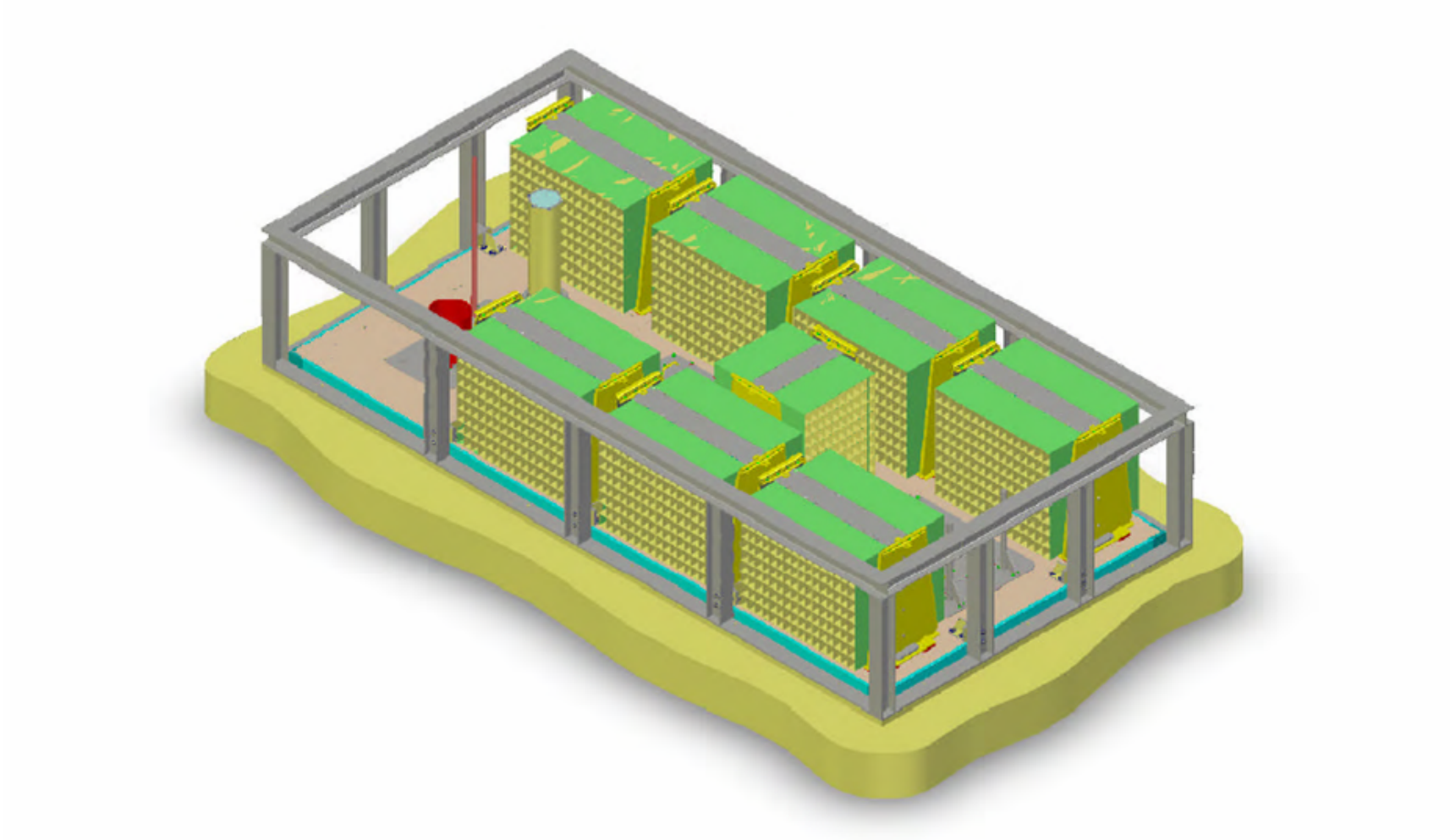
ANO Installation first Module



ANO Installation of last module



Palo Verde Installation



Chemical testing highlights

- Chemistry according ICET # 1, 2 and 4 (3 to follow soon for foreign plant)
- Room temperature
- Total Precipitate amounts set by WCAP methodology and filtering surface scaling
- Use of test loop as particle generator
  - avoiding analyzing one step more (for separate part.gen.)
  - precipitate concentration in loop closer to real plant
  - direct control/check of loop chemistry by sampling
- Pre-analyses by lab bench top testing
  - chemistry (effects of tap water and other debris)
  - filterability
  - settling rate
  - viscosity
  - precipitate size distribution

Chemistry testing steps for head loss

- Establishment of boric acid concentration
- Start of head loss testing with all other debris
- Slow addition of Sodium Aluminate rises pH
- Immediate precipitation of Aluminum Hydroxide in required quantity for filtering surface scaling
- Similar steps by adding calcium chloride and sodium silicate
- Buffering additionally to reach wanted pH with Sodium Hydroxide, if required
- Continuation of head loss testing up to a predefined termination criteria
- Sampling of loop water at regular intervals for lab analysis
- Integration of chemical head loss results in final plant head loss report

Basic layout of MFT loop

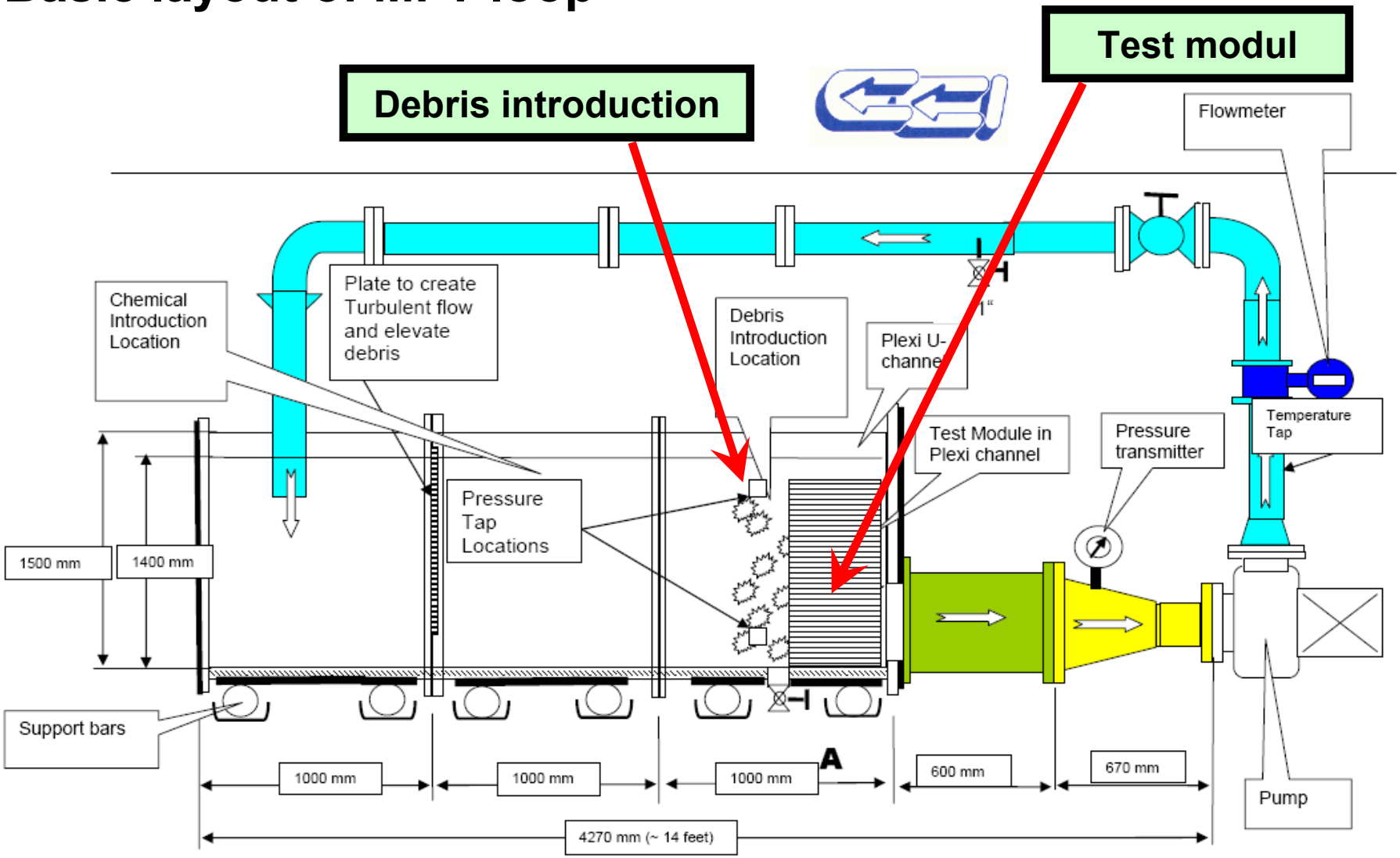
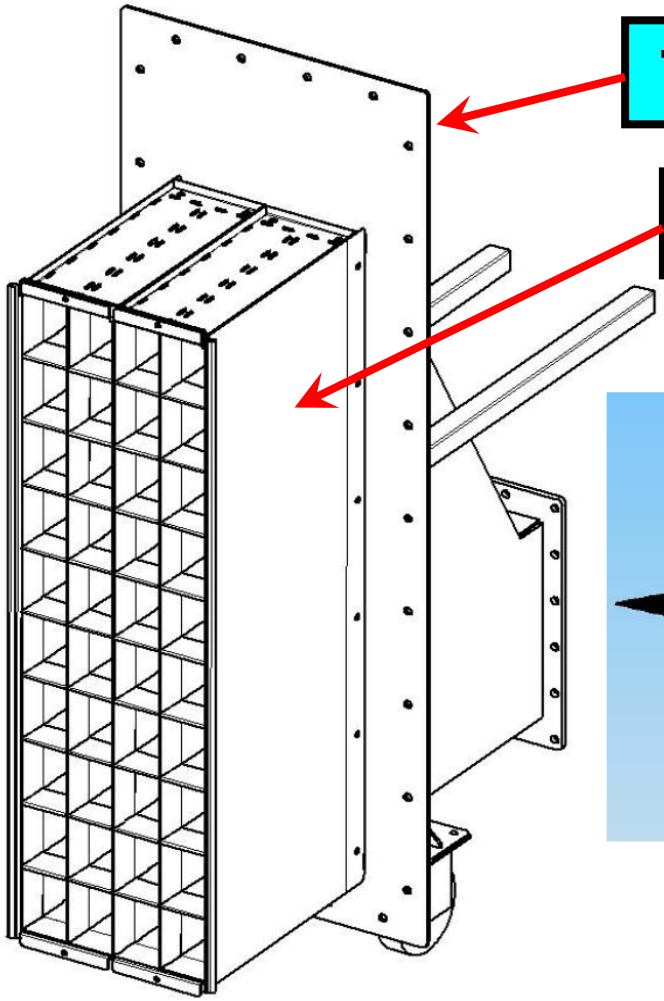
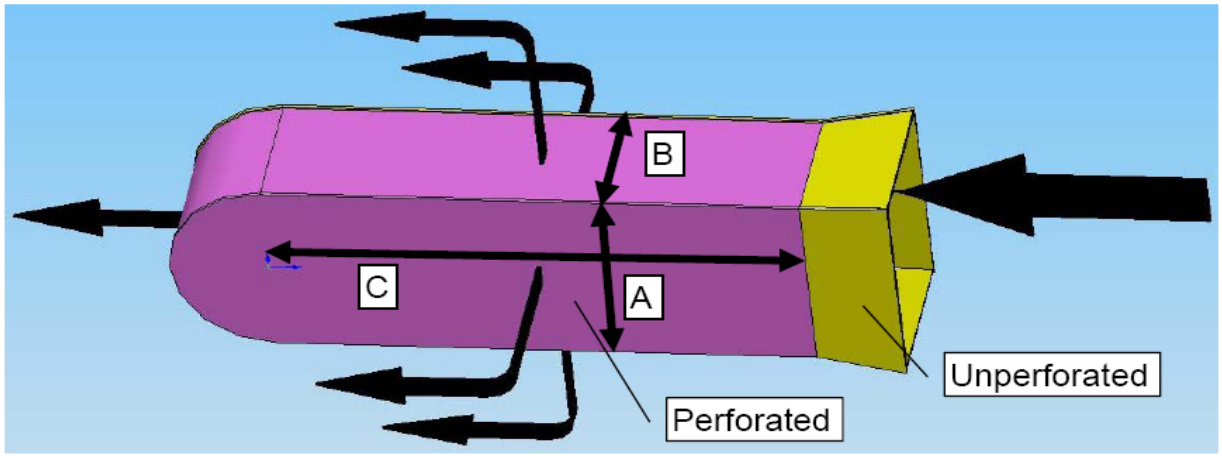


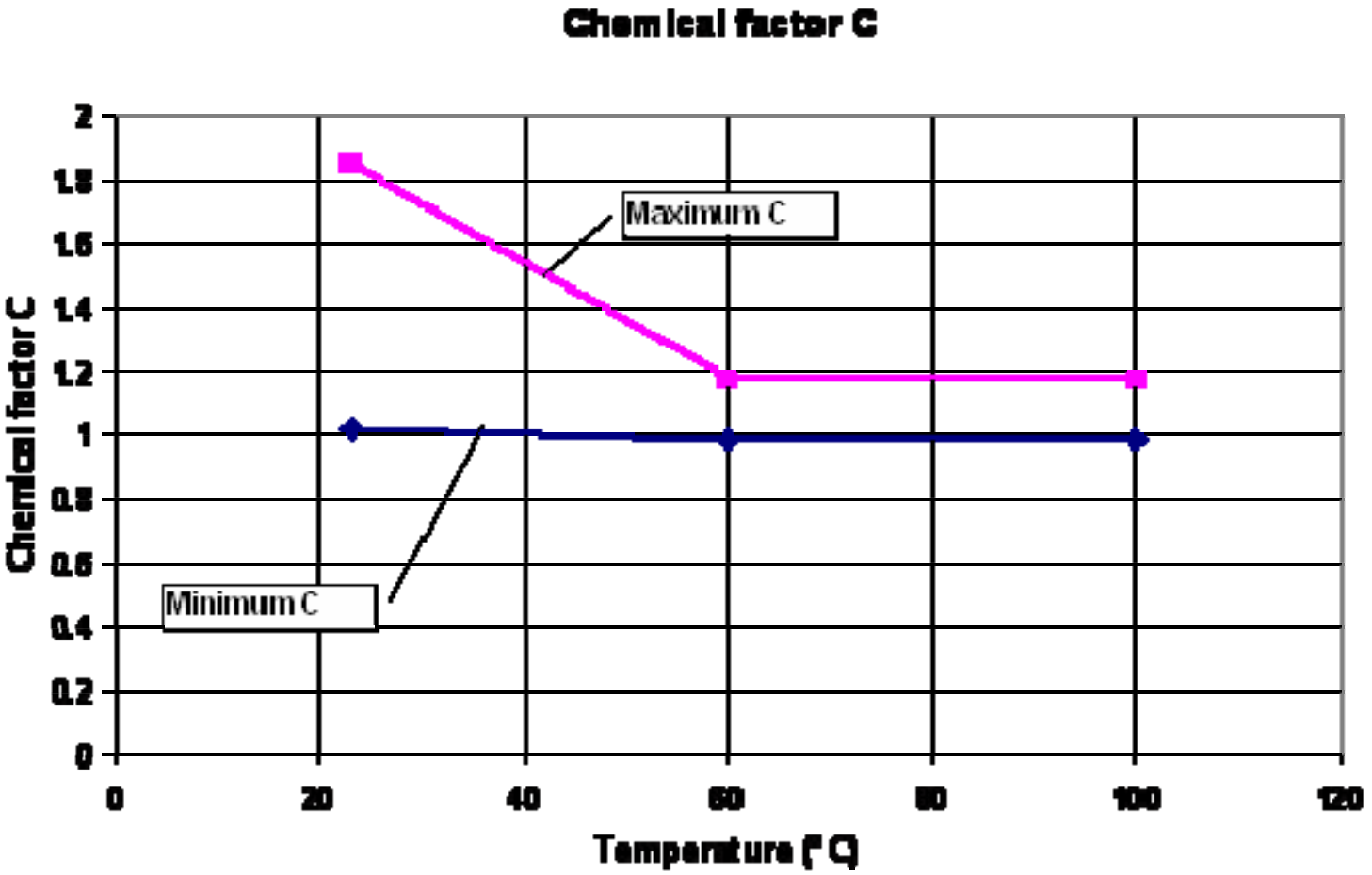
Figure 1: CCI Strainer Test Loop

CCI pocket strainer design

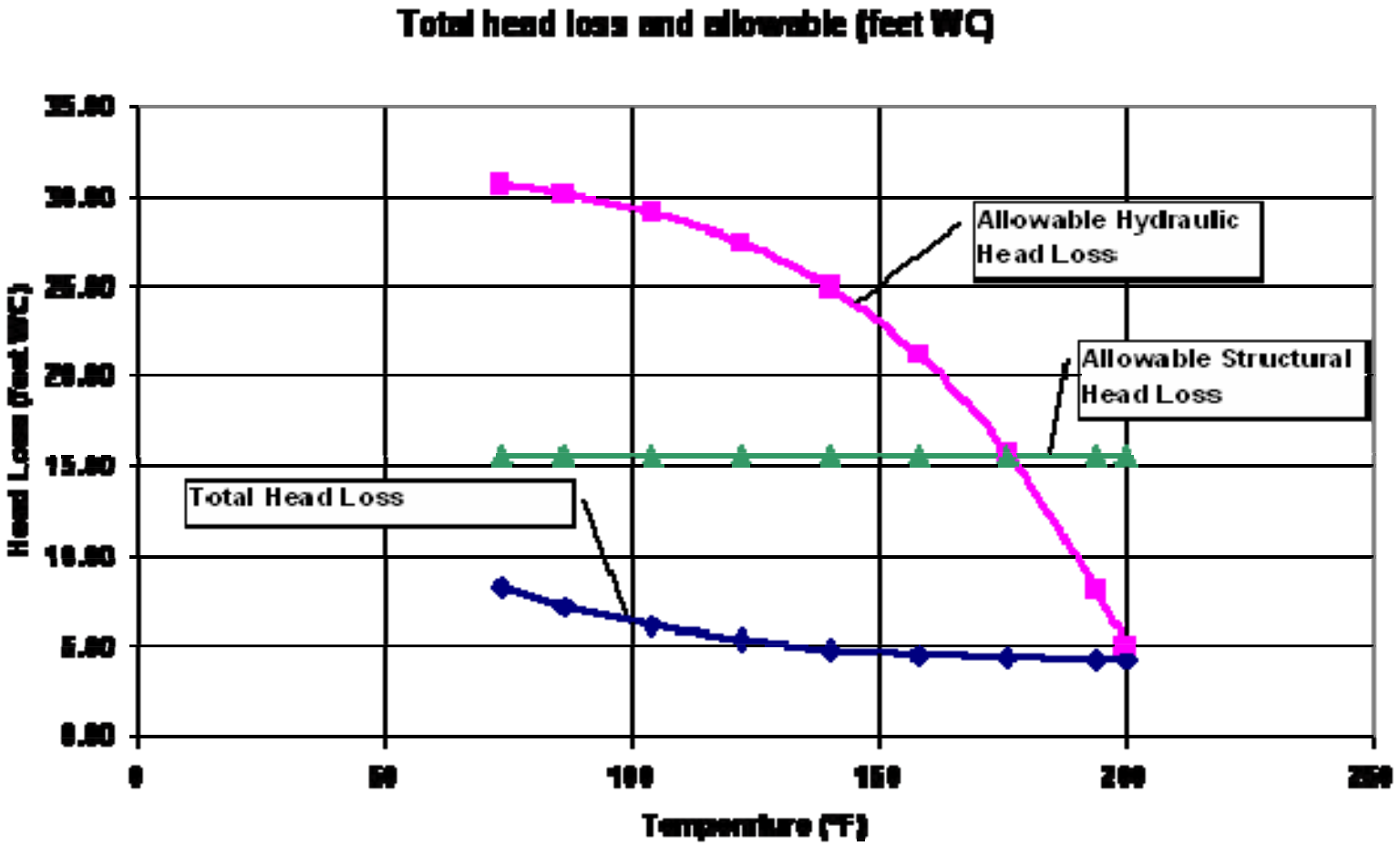




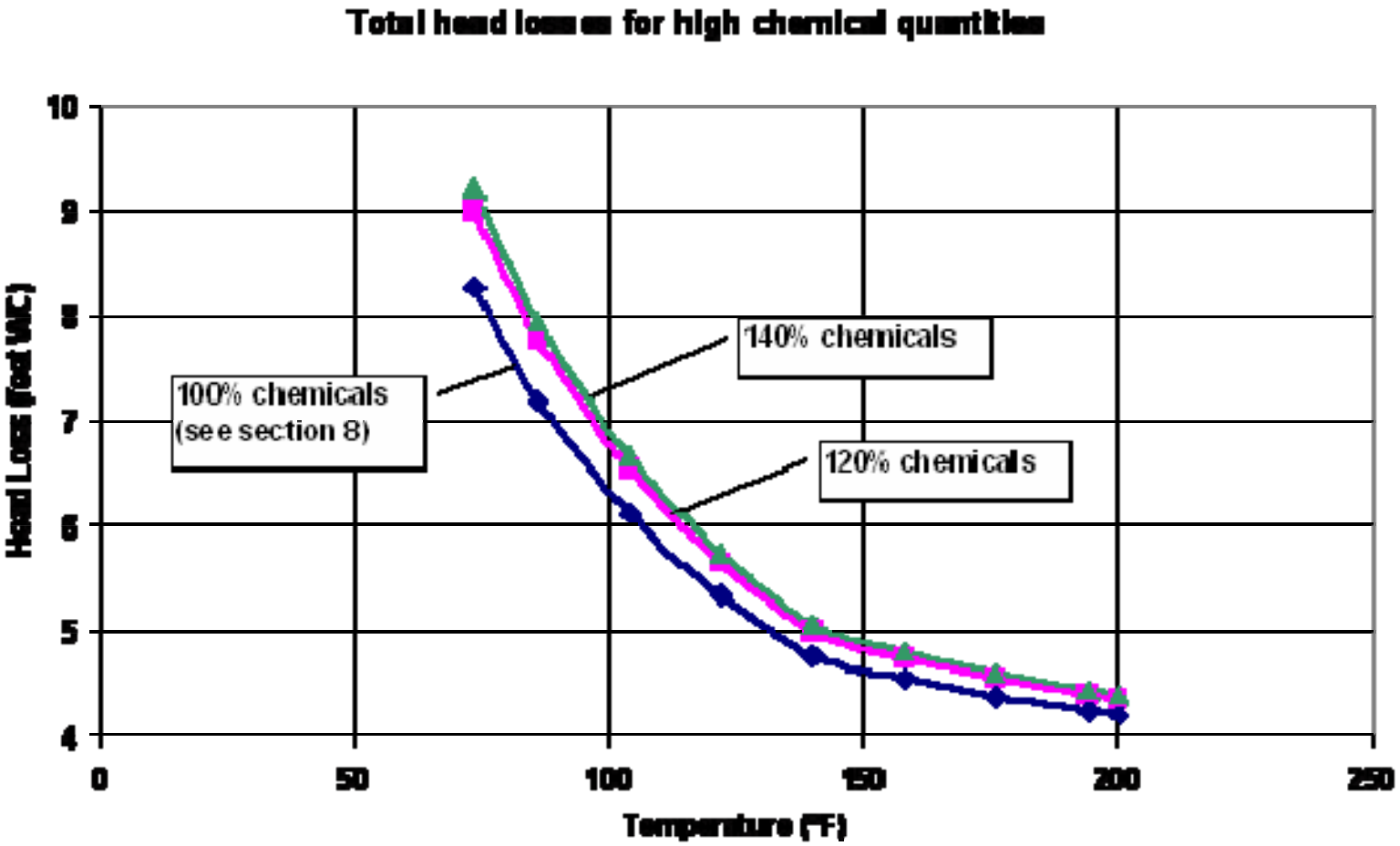
Influence of chemistry on Viscosity (derived from ICET tests at high flow shear rates)



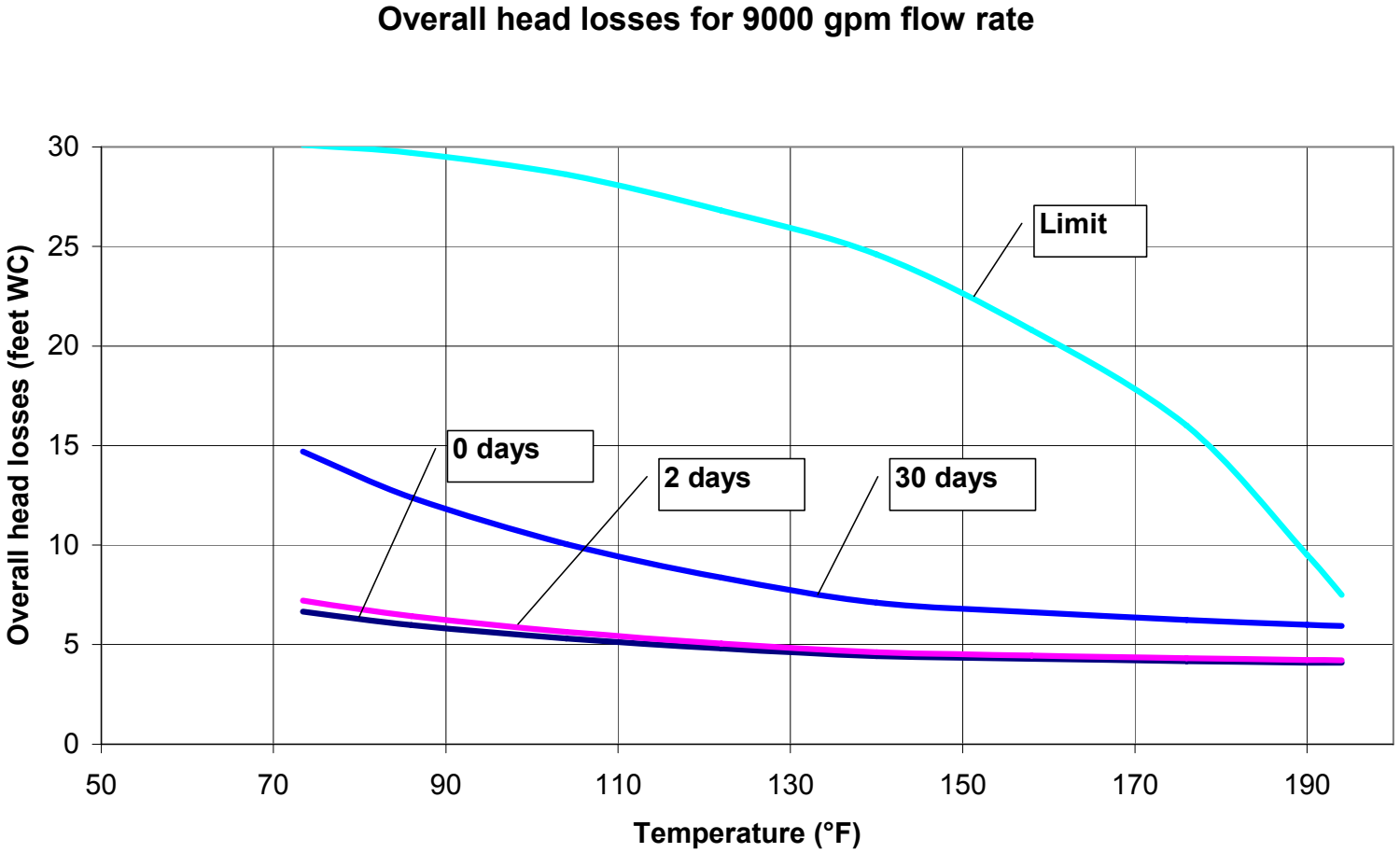
Final overall head losses for Byron/Braidwood



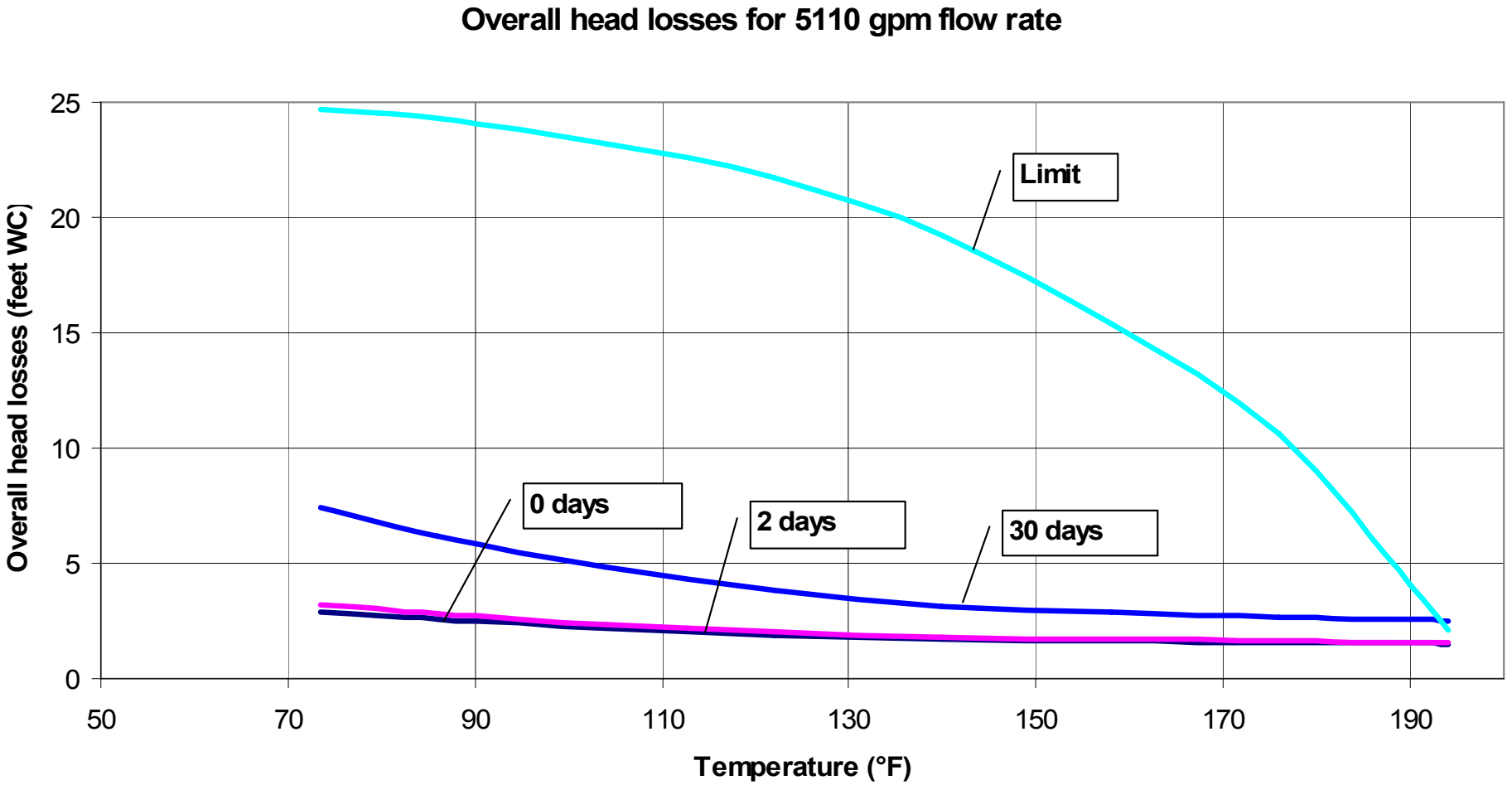
Byron/Braidwood : Influence of chemicals



Salem overall head losses for high flow rate



Salem overall head losses for low flow rate



Foreseen chemical testing (2nd half 2007)

- DC Cook
- Salem
- Calvert Cliffs
- Beaver Valley
- Ginna
- Foreign plant (with ICET #3 chemistry)

- → NRC comments (and concerns, if any) welcome ahead of this chemical testing scenario