Lessons Learned

WTP Prototypic Mixing and Sampling System

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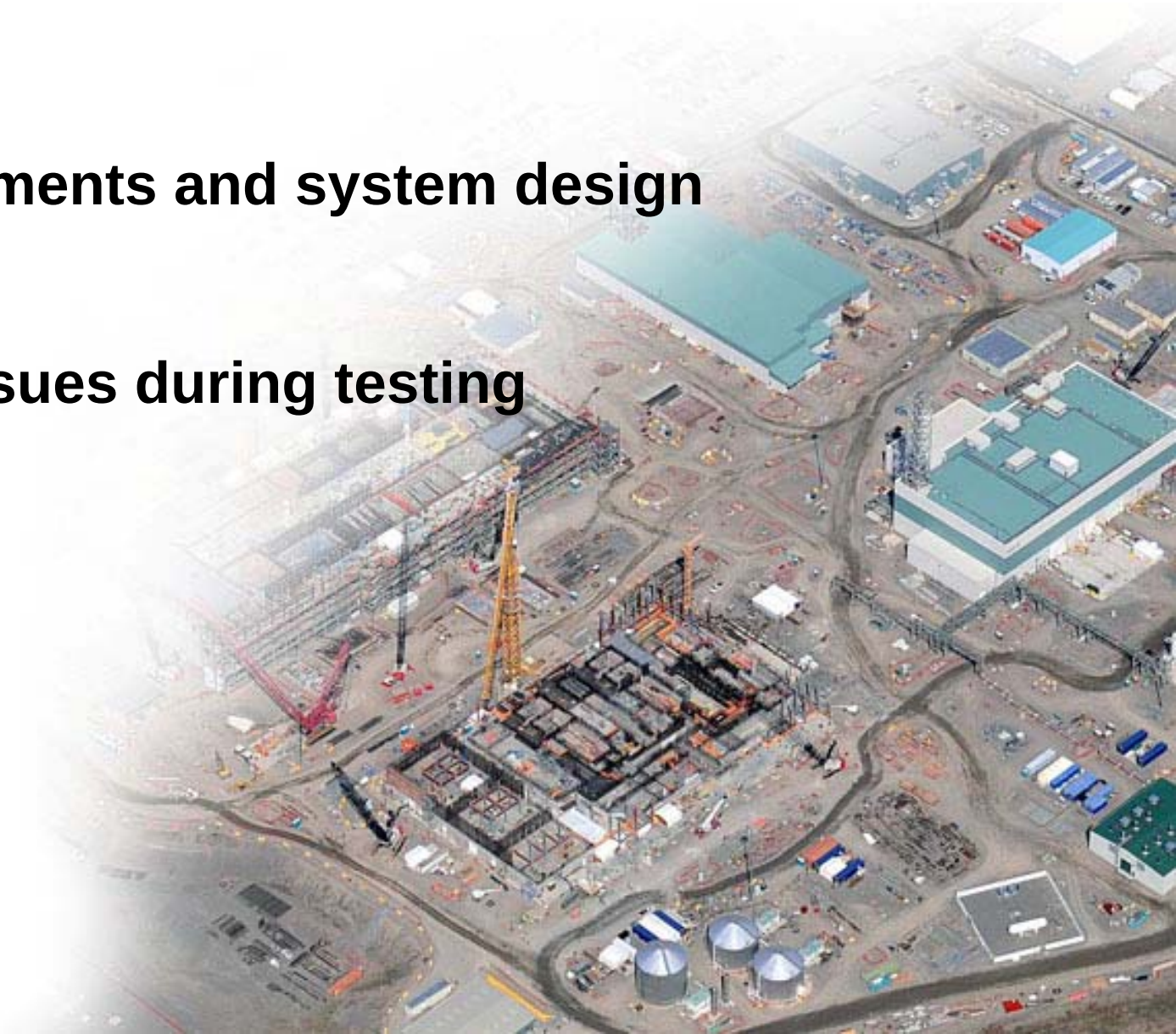
Waste Treatment & Immobilization Plant Project

Outline

- Background
- Test requirements and system design
- Test status
- Technical issues during testing
- Test results
- Summary



Highlights

- Testing system is prototypic
- Major technical and design issues resolved
- LAW report (3 simulants) – issued
- HLW & LAW tests – complete
- Data analyses – 08/09
- Reports – 12/09

Background

- **Compliance to waste specifications is critical to the success of WTP vitrification operations:**
  - **Mixing and sampling of waste and melter feed is an integral part**

- **Successful operations require:**
  - **Mixing system to homogenize the contents of the tanks**
  - **Pumps to uniformly transfer the contents to sampler**
  - **Sampler system to obtain a representative sample**
  - **Level measurements to accurately measure the level**
  - **Glass former system to accurately deliver the amounts of GFCs**
  - **Pumps to uniformly transfer the contents to another tank**

Test Requirements

- **Prototypic mixing and sampling system**
  - **Sized and configured appropriately to meet Project requirements**
    - **Components ranged from full to ½ scale**
  - **Simulants cover bounding range of rheological properties for waste and melter feed (waste plus glass formers)**

Mixing & Sampling System – Pedigree

- 8 feet diameter Stainless Steel tank to represent 3 WTP tank configurations (1/2 – 3/4 scale) – same L/D ratio
- Prototypic baffles, changeable and moveable to support different tank configuration
- Transfer line (~80 feet) – prototypical layout around sampler
- Prototypic, full-scale transfer pump
- Scaled prototypic agitator (blades adjusted or replaced to represent tanks)

Mixing & Sampling System – Pedigree (cont)

- Prototypic, full-scale auto sampler
- Prototypic, full-scale bubbler level detector
- Prototypic, full-scale radar level detector including wave guide
- Scaled air spargers
- Glass Formers unloading equipment to meet scaled prototypic addition rate

Test Components

Prototypic Mixing and Sampling System

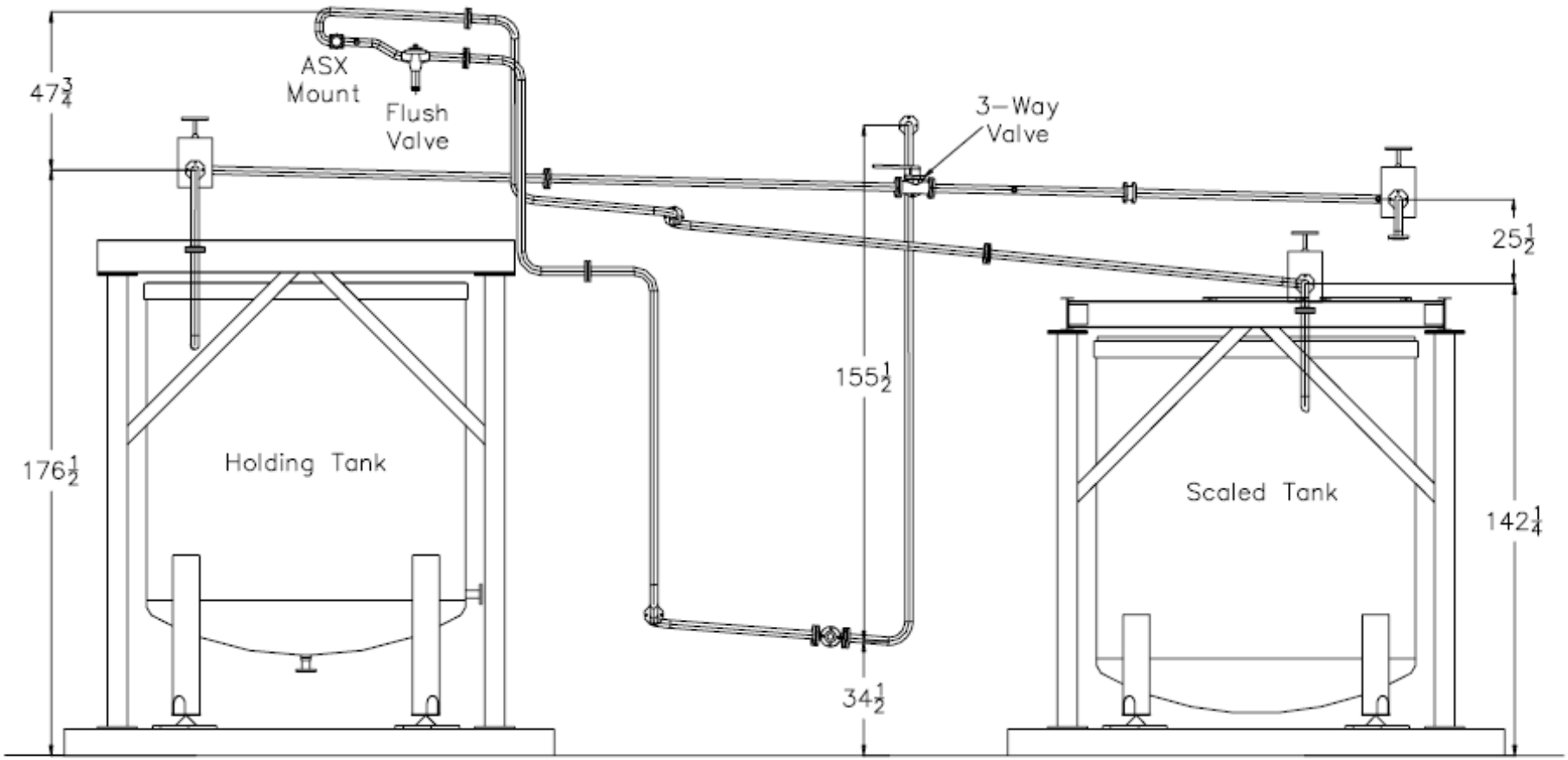


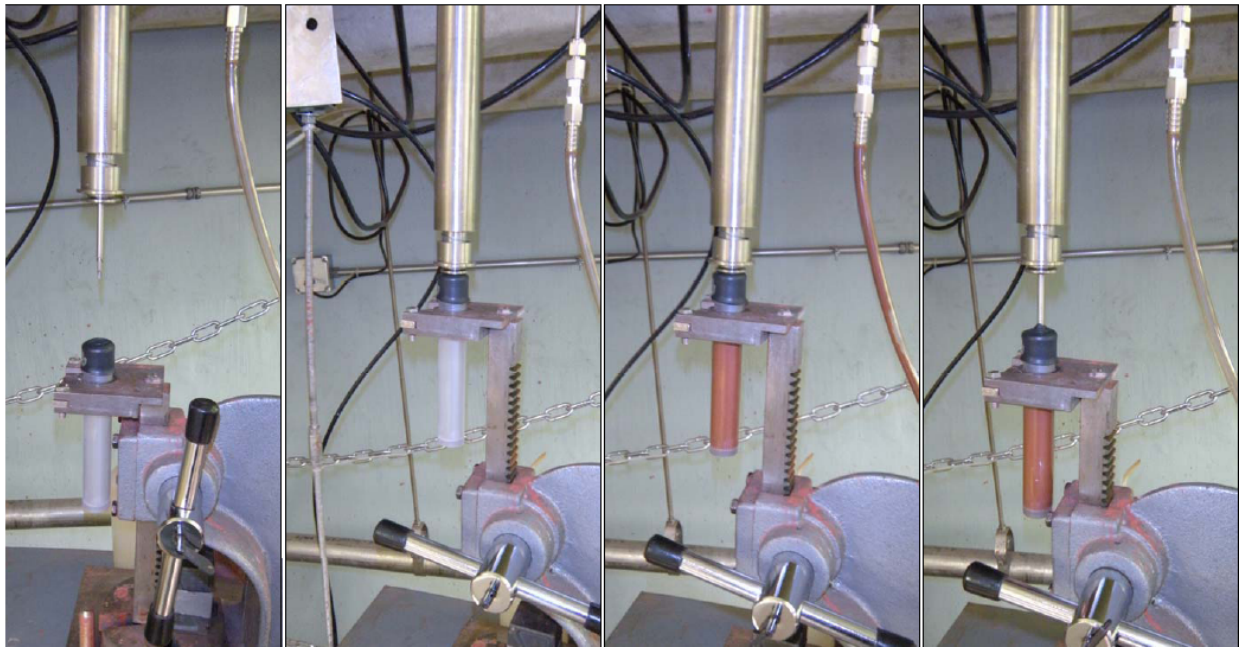
Figure 2.31. Elevation view of the transfer piping between the scale and holding tanks (tank equipment not shown for clarity). All measurements are in inches.

Feed Tank and Sampler Internals

Photo 3 Isolok sampler piston A annulus post flushing

Figure 2.4. View of the radar horn in the scale tank. Note: the pipe to the left of the radar horn is the GFC addition port.

ASX Sampler Filling Sequence



Test Status

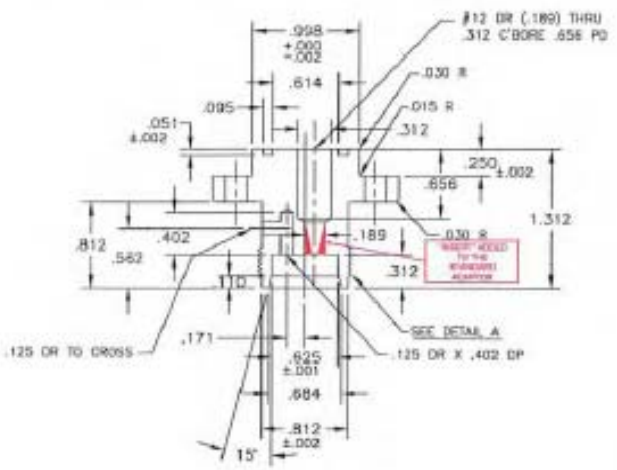
	Simulant/Rheology	Status	Comments
LAW	High Bound LAW Concentrate	Tests complete; Report Issued (08/29/08)	Needle size increased to avoid frequent plugging
	Low Bound LAW Melter Feed		
	Low Bound LAW Concentrate with heel		
	High Bound LAW Melter Feed	Test complete – May 2009	Initial test in 2008 stopped due to simulant gel formation due to xanthum gum degradation. New simulant developed and retest complete in May 2009
HLW	Low Bound Pretreated HLW	Tests complete (04/08/09); chemical analyses and statistical analyses in progress.	Tests stopped to redesign needle and septum system (11/07). Functional verification of the redesigned system successful (09/08). Developed flushing procedure for removing deposits on back end of the Isolok piston (03/09)
	Low Bound HLW Melter Feed		
	High Bound Pretreated HLW		
	High Bound HLW Melter Feed		

ASX Sampler

Liquid ISOLOKÂ® MSE.swf

Frequent Plugging of Needle Assembly

- **Cause: accumulation of solids in the flow path**
- **Resolution: Redesigned needle assembly to taper all sharp reductions in pipe diameters and eliminated right angle transitions in the flow path. Developed back flushing. Changed concentric needle from 16/13 to 9/6 gauge**
- **Results: Functionality of the redesigned needle assembly verified during HLW melter feed testing. No plugging during sampling.**



Leakage in Double Septum

- **Cause: Inadequate closure of septum upon needle retrieval (inability to hold flush water in septum). Potential dilution of sample.**
- **Resolution: Redesigned double septum to triple septum. Flushing in upper cavity of the septum.**
- **Results: Functionality of the redesigned septum verified during HLW melter feed testing. No leakage observed during sampling.**

Photo 2 Loctite 435 Bonded Richland Septum

Collection of Simulant Behind Isolok Piston Assembly

- **Cause: Dripping of simulant collected in the purge line during sampling behind the piston**
- **Resolution: Developed a flushing procedure to clean the simulant collected behind the piston**
- **Results: Functionality of the cleaning procedure verified and optimized during HLW melter feed testing (awaiting confirmation by analytical results)**

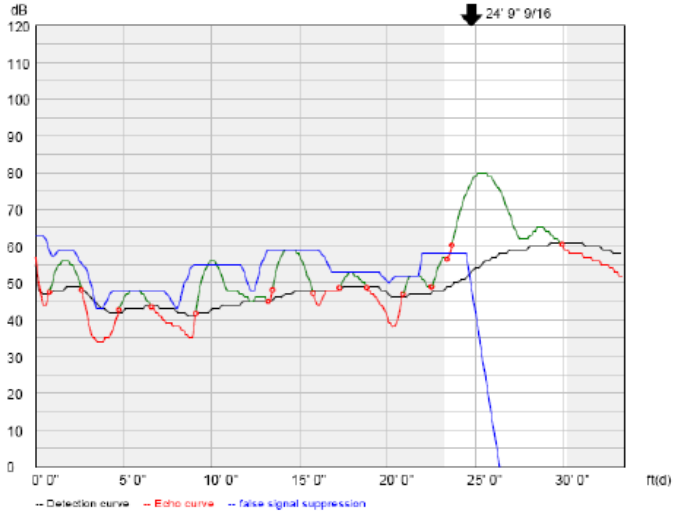
Photo 2 Picture of the Isolok plunger after collecting 15 30 mL samples (or 30 WTP HLW samples)

Photo 3 Isolok sampler piston A annulus post flushing

Radar Level Detection System Failure to Read Liquid Level in the Presence of Foam

- **Cause: Inability of radar signal to penetrate foam bubbles. PEP also experienced this.**
- **Resolution: Combination of radar level detection system and bubblers proposed for WTP. Protocol under development. Add anti foam agent, if needed.**
- **Results: Combination of both radar level and bubblers is successfully used at VSL for level control**

Figure 2.4.



Rheology Outside Processing Envelope

- **Cause: High bound rheology extremely sensitive to percent total solids. SRS also experienced this.**
- **Resolution: Addition of 2 weight percent water reduced the consistency to normal level**
- **Results: Rheology measurements on prequalification sample will be used to determine acceptable dilution**

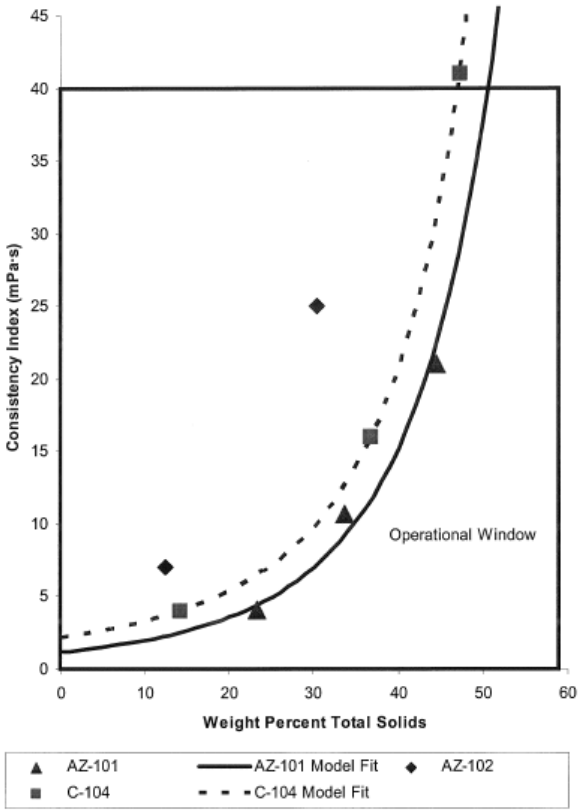


Figure 4.15. Bingham Consistency Index as a Function of Weight-Percent Total Solids for HLW Melter Feed at 25°C

Plugging of Pumps

- **Cause: Suction line plugged and clogged priming line due to high bound rheology**
- **Resolution: High pressure purge to clear clogged lines**
- **Results: WTP operations plan to add a trickle flow through priming line to avoid clogging**

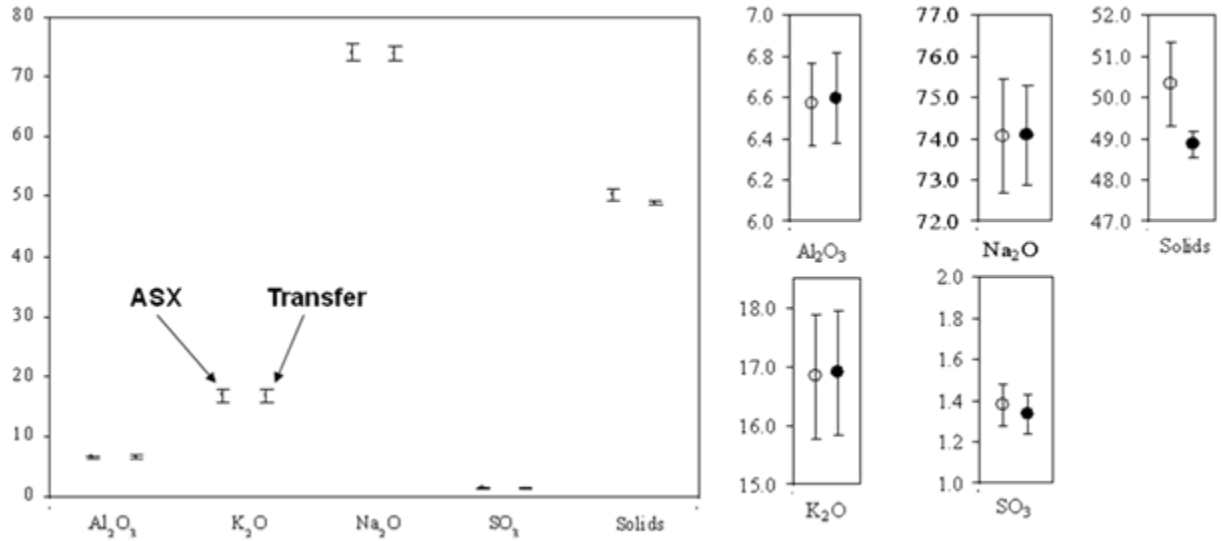
High Bound Rheology Simulant Gelled

- **Cause: Degradation of additive xanthum gum caused simulant to gel and become very fluid. Both scaling and aging issue.**
- **Resolution: Developed new simulant**
- **Results: During WTP operations, such additives will be avoided**

Air Entrapment in Pumps

- **Cause: High bound rheology simulant slowed upward movement of sparge bubbles causing them to be driven into pump suction line**
- **Resolution: Reduce /stop air flow through spargers close to the pump suction line**
- **Results: During WTP operations, rheology measurement on prequalification sample will be used to determine acceptable dilution**

Use of LAW Results – An Example



- **Mixing and sampling uncertainties evaluated for application to waste form qualification**
  - **No statistical significant bias between the composition of the ASX samples and the mean composition of the tank at 5% level**
  - **Uncertainty between tank samples (after transfer) and ASX samples appears to be component independent**
  - **Relative standard deviation was 1.23%**

Summary

- **Resolved significant design issues with Isolok sampler during testing**
- **Verified functionality of the redesigned Isolok during testing**
- **Preliminary data shows tanks are homogeneous and sampler provides representative samples**
- **Final reports will be issued 12/2009**