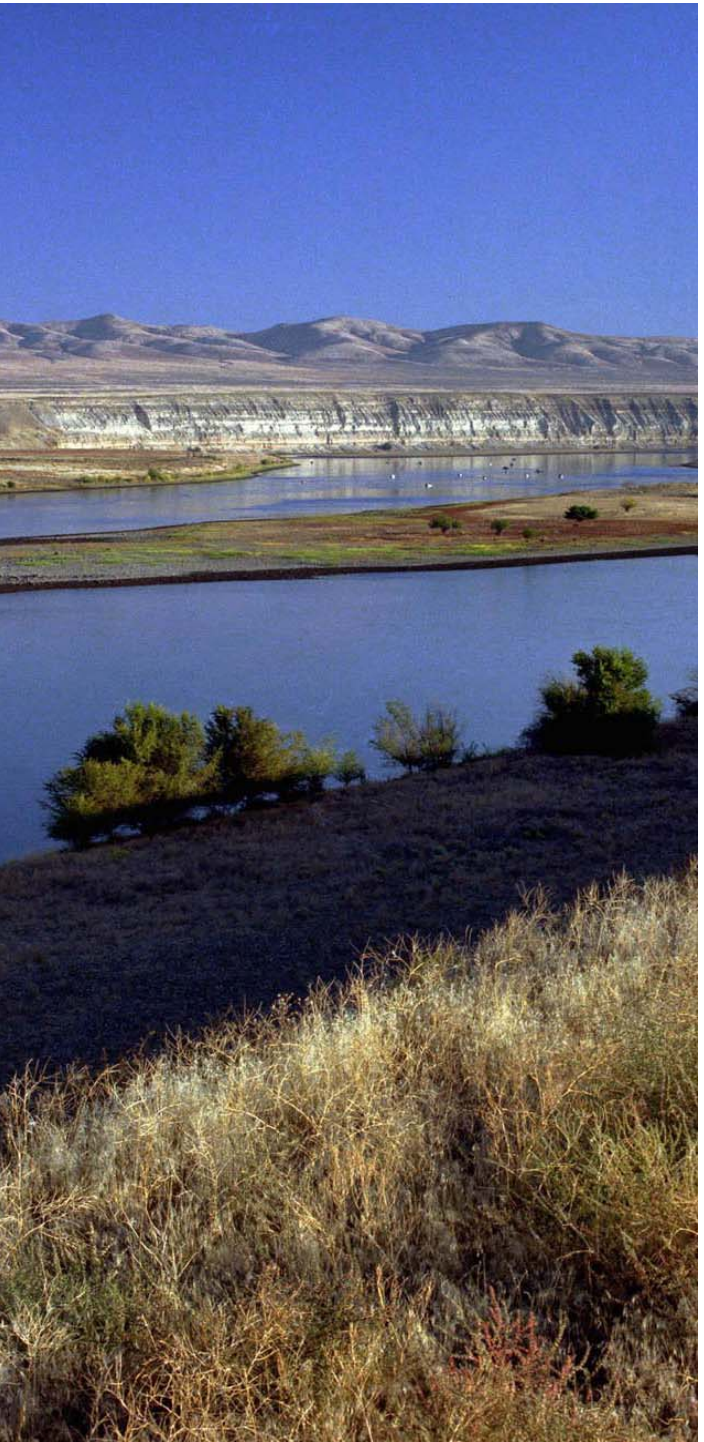

Caustic and Oxidative Leaching to Solubilize Aluminum and Chromium

Waste Treatment Plant River Protection Project

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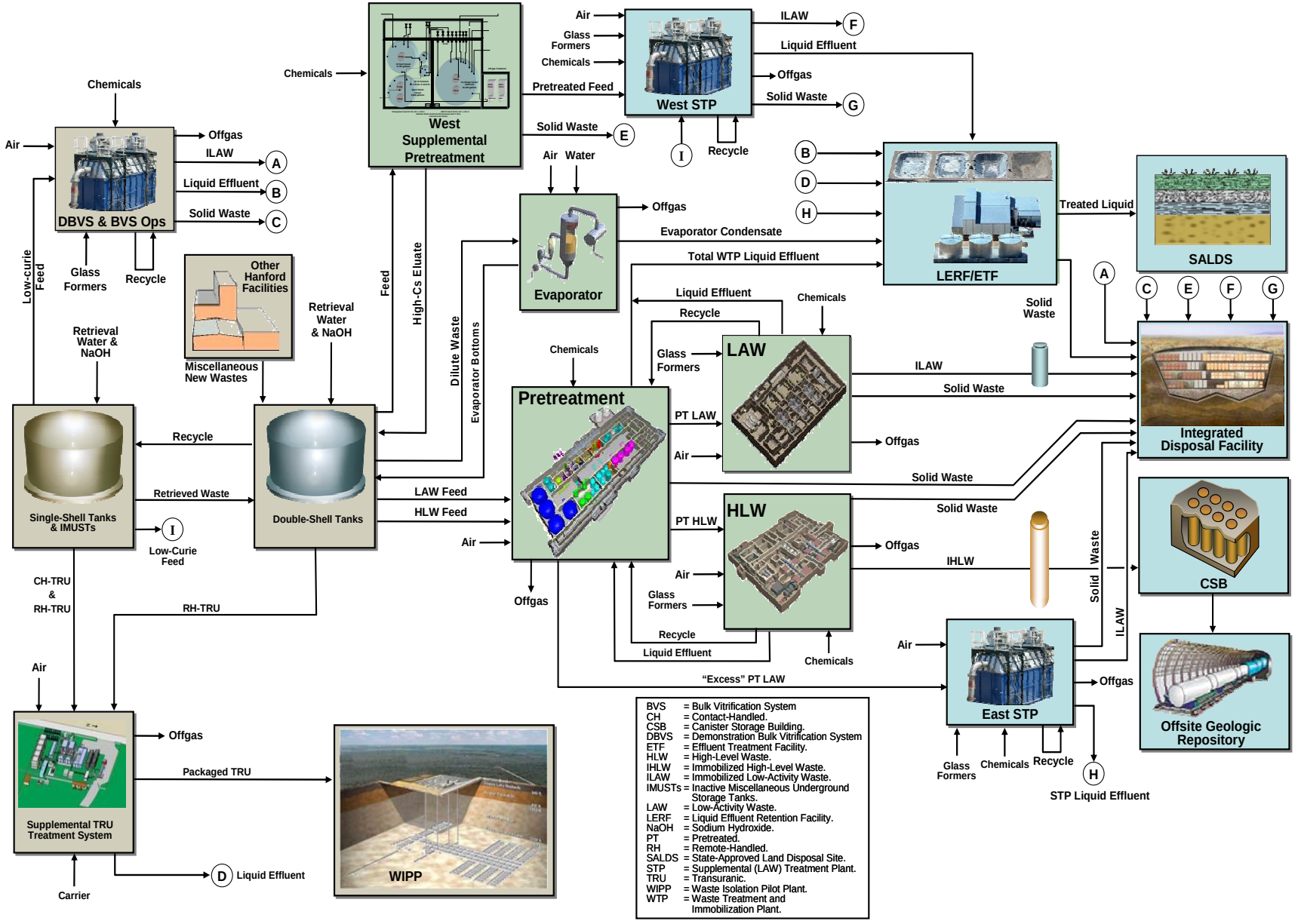
January 23, 2007

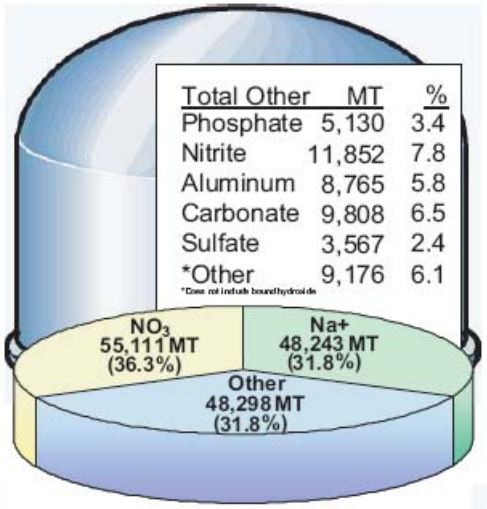
Department of Energy

Office of River Protection

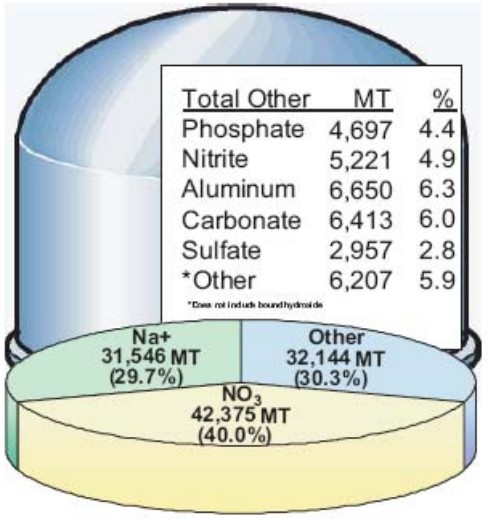
Simplified Schematic of the River Protection Project



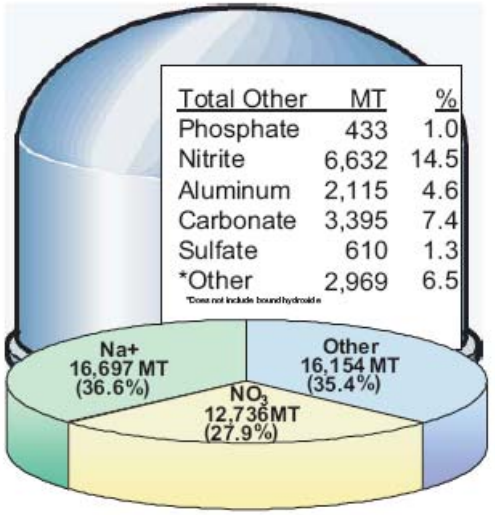
Hanford Tank Chemical Inventory



Total in All Tanks
151,653 Metric Tons



Single-Shell Tanks
106,065 Metric Tons



Double-Shell Tanks
45,587 Metric Tons

Inventory updated through FY06 Q3, data downloaded from http://twins.pnl.gov Best Basis Summary query on 8/24/06

HLW Glass Projections

- HLW glass canister projections range from 10,000 to 15,000 with:
  - an effective caustic leaching process to remove Al from HLW solids (>80% of batches)
  - an effective oxidative leaching process to remove Cr from HLW solids (>50% of batches)
- HLW glass canister projections without caustic and oxidative leaching approach 30,000 – 40,000 canisters.

(WTP produces 4.5m long canisters with ~3.2 metric tonnes glass)

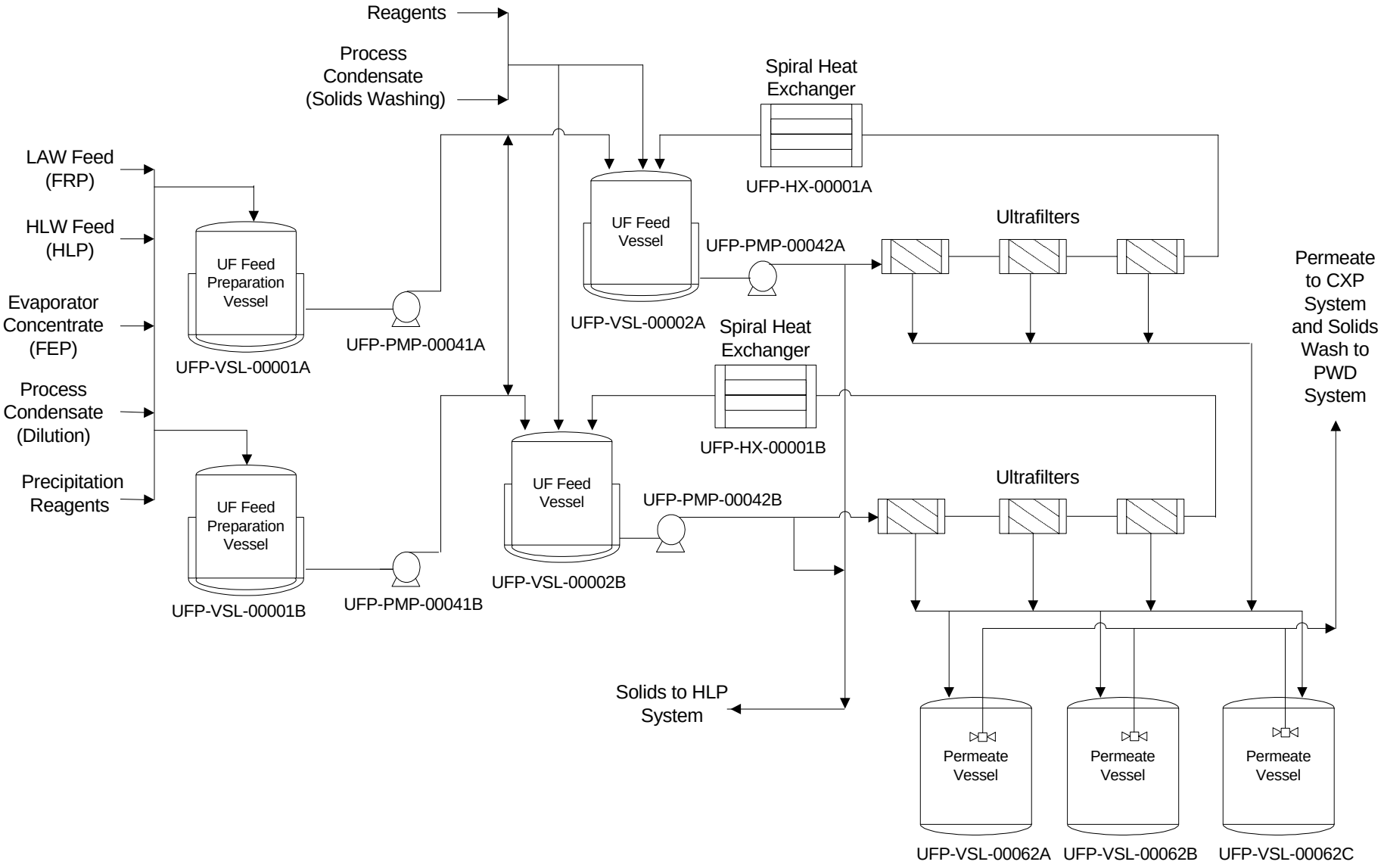
Caustic Leaching

- Caustic leaching performed to solubilize Al from HLW solids to allow increased glass waste loading.
- Caustic Leaching Process
  - Add caustic (19M NaOH)
  - Heat to ~90°C
  - Hold at temperature for 8 hours
  - Cool to ~25°C
  - Wash
- Most of the Gibbsite and a fraction of Boehmite is solubilized.

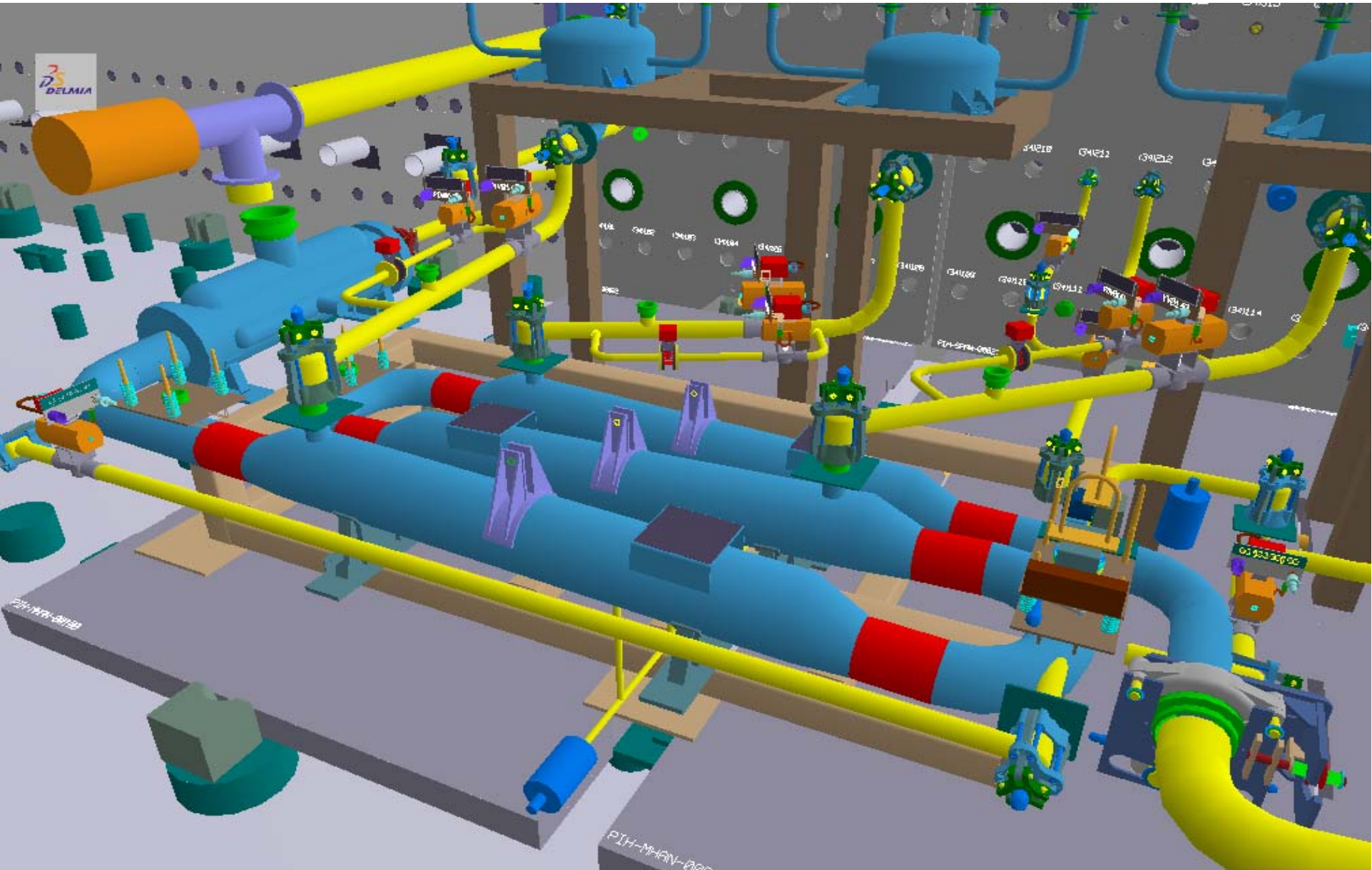
Oxidative Leaching

- Oxidative leaching performed to solubilize Cr from HLW solids to allow increased glass waste loading.
- Oxidative Leaching Process
  - Add sodium permanganate at a ratio of 1.1 part per part Cr
  - Hold for 6 hours
  - Wash
- Cr-3 is oxidized to Cr-6. Approximately 90% of Cr is soluble after treatment.

Simplified UFP Process Flow Diagram



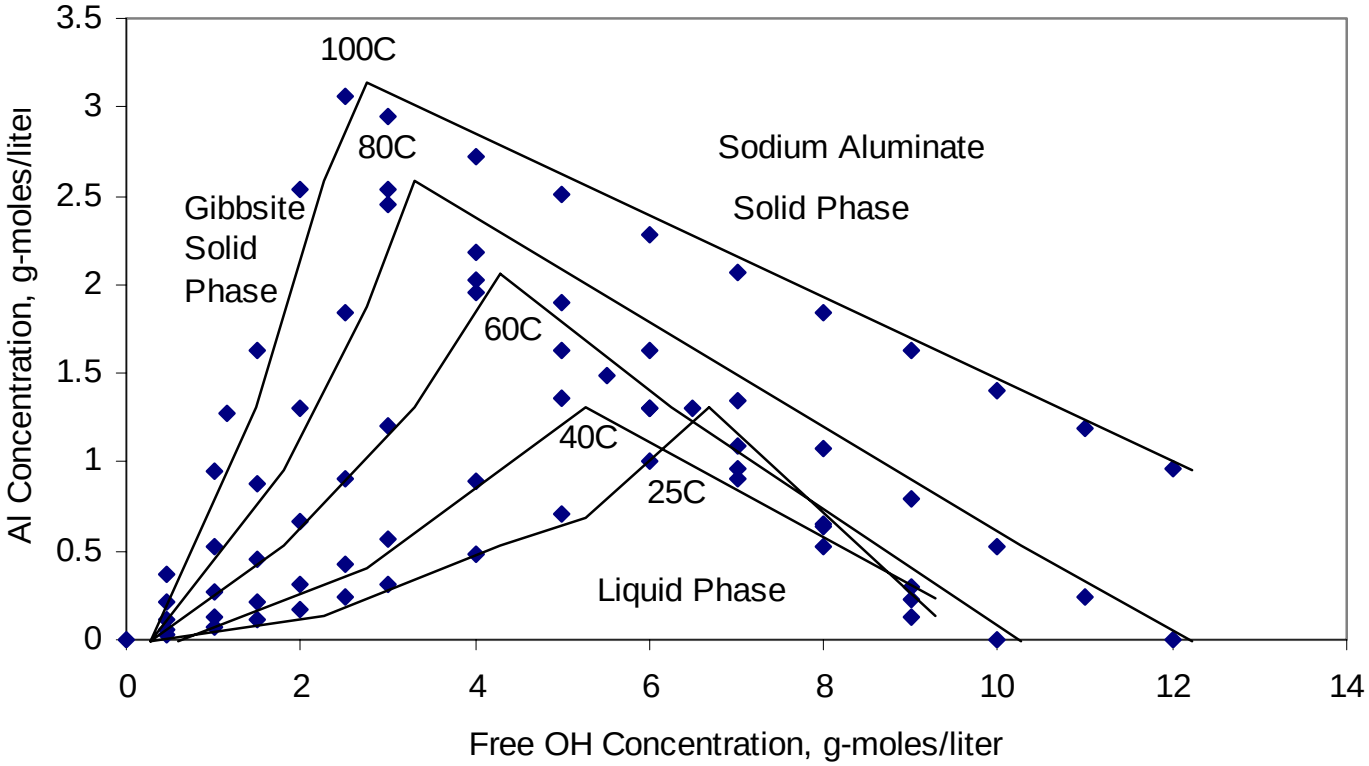
UFP Equipment in Hot Cell
Front/Right View



UFP System Design Issues

- Flowsheet chemistry must keep aluminum in solution
  - Must add adequate caustic to keep Al in solution following cooling and in Cs ion exchange
  - ~40,000 MT Na must be added to leach Al and keep Al in solution after cooling to 25°C. (increase of >30,000 MT Na from historical estimates)

Al Chemistry of Hanford Tank Wastes



UFP System Design Issues (cont)

- Baseline UFP flowsheet and equipment sizing cannot complete processing HLW solids in desired operational period.
  - Batch sizes too small
  - Cycle time too long

Response to Issues

- BNI and ORP are actively working to resolve Issues
  - Chemistry being analyzed to determine required caustic additions.
  - Engineering study performed to establish ultrafiltration system design to maximize available filter surface in WTP. ~92% increase in filter surface area achievable.
  - Modeling underway to identify enhanced ultrafiltration, washing, and leaching operating approaches.
  - Testing of flowsheet with tank waste samples and simulants at bench scale to confirm flowsheet chemistry.
  - Engineering scale testing of UFP system with full length filters and prototypic control schemes to confirm design.
- ORP will spend at least $40 million to address ultrafiltration, washing, and leaching issues.

Technology Needs

- HLW Glass Development Studies
  - Study HLW glass formulation to increase Al and Cr waste loading (Ongoing work – Jan 2012)
- Caustic Recovery from WTP Process Streams
  - Study caustic recycle to mitigate increase to LAW glass produced as a result of required increased caustic addition (Technology need, Sept 2008 – Sept 2010)
- HLW Slurry Concentration Equipment Development
  - Identify and develop approaches to concentrate HLW slurry after Pretreatment but before vitrification (Technology need, Sept 2008 – September 2009)

Technology Needs (cont.)

- Alternative reagents to optimize oxidative leaching process operations
  - (Ongoing work – Sept 2008)
- Expert Review of WTP Ultrafiltration System Design and Sludge Leaching Process
  - (Technical Assistance, June – Sept 2008)