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Role of Liquid Waste Pretreatment Technologies in Solving the DOE Clean-up Mission

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HLW Corporate Board, Phoenix, AZ

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Background

- **Separations is a fundamental business within DOE.**
- **The role of separations today is to expedite waste retrieval, processing and closure.**
  - Recognized as part of E&T Roadmap
  - Focus is moving to In- or At-tank technologies
- **Separation technologies are borne in fundamental discovery.**
  - Key aspect of “Scientific Opportunities to Reduce Risk in Nuclear Process Science”
- **Goal of paper was to convey “current state” of technologies and show applicability to an interim pretreatment facility at Hanford.**

Key Conclusions for HLW Pretreatment Technology Selection

- First, requirements for low activity waste evolved differently at the two sites.
- Second, the tank wastes originated from different processes so have different compositions.
  - Multiple processes used at Hanford while only one basically at SRS
- Third, the technologies continue to evolve whereas selections are made at specific point in time.
- Fourth, the magnitude of the removal of a key radionuclide may not originate from a regulatory requirement.
  - Specific facility design feature may drive the radionuclide DF

HLW Requirements Evolution

Hanford

- **Based on a determination prepared by the U.S. Nuclear Regulatory Commission (letter from Bernero, NRC, to Lytel, DOE, March 2, 1993)**
- **Establishes Class C limits for highly radioactive radionuclides**
  - Requires Cs removal
  - Very limited Sr/TRU removal required
- **Is concentration dependent and does not specify technology**
- **TriParty Agreement**

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- **Based on Waste Determination IAW Section 3116 of the 2005 National Defense Authorization Act**
- **3116 requires waste not exceed Class C limits**
- **Permit agreements limit waste to Class A values**
  - Requires Cs removal
  - Requires Sr/TRU removal from most if not all wastes
- **Specifies the technology as solvent extraction**
- **Federal Facility Agreement**

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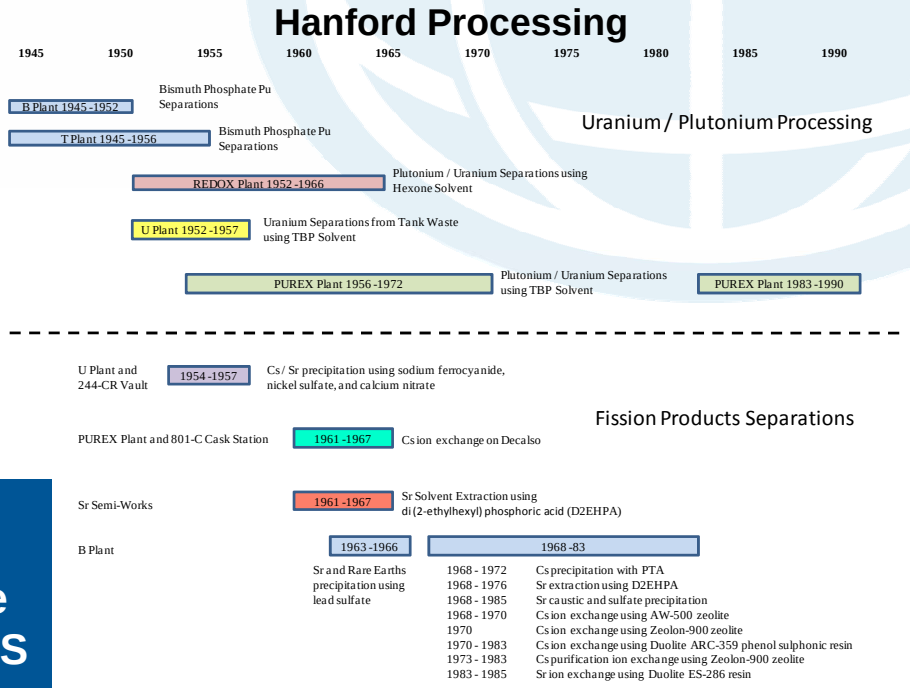
Impacts of Different Waste Compositions

- Bismuth phosphate process added large amounts of Bi, S (as sulfate), and discarded U to waste
- Redox used dichromate as an oxidant
- K added as permanganate salt to oxidize



Impacts

- **Presence of Cr in sludge calls for oxidative leaching in WTP Pretreatment and not at SRS**
- **Potassium eliminates CSSX as technology candidate**
  - ➢ ORNL data up to 41 stages of contactors will be needed to achieve DF and CF targets of respectively 5000 and 5
  - ➢ If the CF requirement to 15, the number of stages more than doubles to 74

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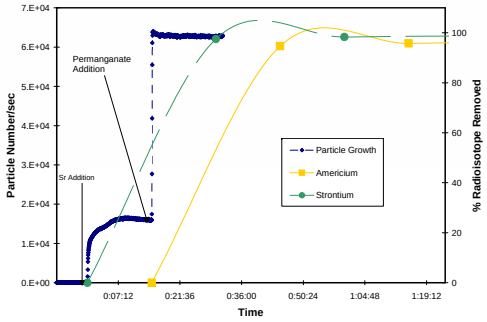
Impacts of Waste Composition – Alpha Removal



Hanford

- Class C limit (100 nCi/g)
- Only 2 tanks (AN-102, -107)
- Actinides (Am) complexed by sugars (gluconate) and Sr Complexed with EDTA used in Sr recovery operations
- MST does not work
- SRNL/PNNL developed isotopic dilution/permanganate treatment

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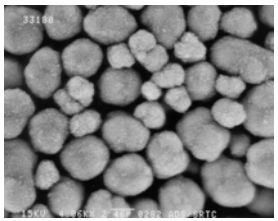
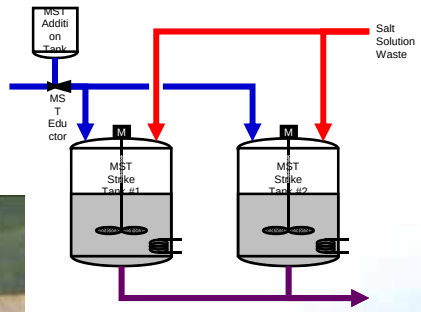
- Permit constrained to 18 nCi/g in SS feed solution
- Most tanks require processing
- Sorbent technology developed at SRNL using Monosodium Titanate
- EM-21 investing in modified MST to increase throughput





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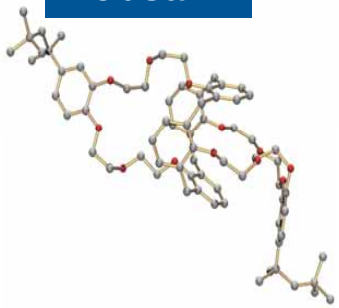
When a Point in Time Counts – Evolution of Technology

SWPF

BobCalix



Spherical RF

WTP

- **Selection of IX for WTP predates CSSX selection for SWPF**
  - IX was selected by BNFL as part of the competition phase
  - CSSX chosen based on systems engineering evaluation of over 144 technologies
- **Significant technical risk associated with resin maturity focused the SRS down selection to non-elutable IX (1998)**
- **Need established within WTP project for backup to SL644 (2002)**
- **Technical risks associated with sRF not fully resolved until 2007/8**

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Decontamination Factors (Regulatory vs. Operational)

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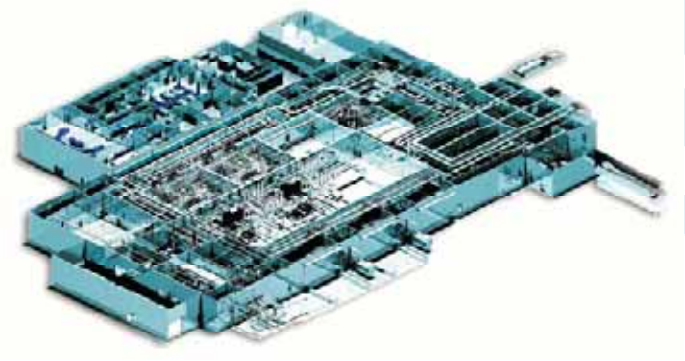
- Permit limit imposed by SC DHEC forms the decontamination factor requirement
  - DF's can be as high as 40,000 but average under 20,000
  - Interim processing allows higher Cs with constraints and allows lower DF's
- Saltstone in its original form was contact maintenance and still is today



Hanford

- NRC determination limited to less that Class C (4600 Ci/m^3) and waste would not require much (if any) Cs DF
- Contract limited Cs to 3 Ci/m^3
- ALARA limit for contact maintenance drops value to 0.3 Ci/m^3
- Cs DF's can be as high as 25,000 but average around 1,100
- IPS would need DF between 5 and 1000 depending on feed and immobilization method

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Summary

- **Next-generation pretreatment solutions will effect significant cost and risk reductions in the treatment and disposition of HLW.**
- **Pursuit of new technologies that offer multi-site benefit is desirable but not always practical.**
- **In some cases, development of innovative pretreatment processes tailored to differences in waste compositions and other conditions among sites is necessary.**
- **The choice of interim pretreatment process at Hanford is one such case.**

Evolution of Pretreatment Technologies