



Liquid Waste Program
Prime Contractor



Evaluation and Impacts of Mercury in the Savannah River Site Liquid Waste System

(16121)

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Agenda

- **Background – Mercury in Liquid Waste System**
- **Mercury Program Team**
 - Assessment Approach
 - Phased Evaluations
- **Mercury Speciation**
- **Mercury Removal Challenge**
 - DWPF
 - Liquid Waste System Alternatives
- **Summary**

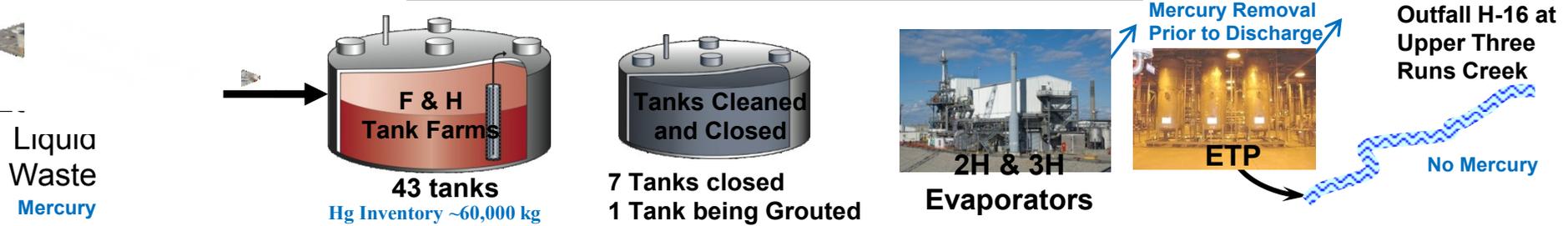


Mercury in Liquid Waste System (LWS)

- **Mercury has long been a consideration in the Savannah River Liquid Waste System, both from a hazard and a chemical processing perspective**
- **Originated from decades of canyon processing (used to aid reactor fuel dissolution)**
- **Is present throughout the liquid waste system (~60 metric tons)**
- **Is not a new issue**
 - Removed at Tank Farm evaporators
 - Designed to be steam stripped and removed at Defense Waste Processing Facility (DWPF)
 - Removed at Effluent Treatment Plant
 - Will need to remove about one 200 L / 55-gal drum of mercury from the Liquid Waste System every year for the remaining life of the program
- **But the issue is changing**
 - Higher mercury concentrations in H-area waste is being processed in DWPF (H-area Tank Farm contains ~96% of the mercury)
 - Intended LWS/ DWPF process to remove Mercury is not functioning per design
 - SRR evaluations identified that a significant amount of mercury (40-80%) is being recycled to the tank farms from DWPF
 - Chemical forms of mercury are changing
 - *Higher total soluble mercury and higher methyl mercury ion concentrations*
- **Poses several challenges to waste processing**
 - Equipment impacts
 - Saltstone grout performance (relative to mercury leaching)
 - DWPF Mercury Removal and Recovery Process
- **Mercury Program Team formed to Evaluate Mercury Behavior and Develop Action Plan**

Mercury in Liquid Waste System (LWS)

Tank Farm and ETP Processing Systems



Sludge Waste Processing

Contains the Bulk of the Mercury



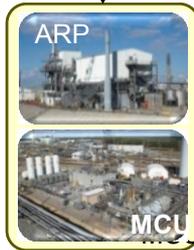
DWPF Mercury Purification
Mercury Removal & Purification

DWPF Mercury Removal & Purification

- Early Hg removal system operations successful
- Since 2008 timeframe, not functioning per design due to Chemistry & Equipment Issues
- Need to Remove 1 gallon Hg per week from LWS

Salt Waste Processing

Increasing Soluble Mercury Concentrations, Including MeHg



SWPF
(under construction)



<<1% radionuclides to saltstone
Trace Mercury

Radionuclides Removed from Salt

DWPF Recycle
Increasing Mercury Concentration



Most radionuclides to glass
No Mercury

Legend:	
ARP	Actinide Removal Process
DWPF	Defense Waste Processing Facility
MCU	Modular Caustic Side Solvent Extraction Unit
SWPF	Salt Waste Processing Facility
ETP	Effluent Treatment Plant

Liquid Waste Program Prime Contractor

Mercury Program Team

- **An integrated, system-wide evaluation of mercury behavior in the Liquid Waste System to identify**
 - The inventory and chemical form of mercury throughout the Liquid Waste System
 - The chemical processing behavior and accumulation of mercury in the liquid waste facilities
 - The impacts of mercury, including worker safety and equipment degradation
 - Mercury removal and disposal alternatives
- **Overall Goal:** Develop long-term action plan to address overall mercury management and removal
- **Two Phase Assessment Approach:**
 - Phase 1: Review Liquid Waste inventory and chemical processing behavior using a system by system review methodology
 - *Assess Current Knowledge*
 - *Identify Gaps & Info Needs*
 - *Identify and Execute Selected Near Term Action Recommendations*
 - Phase 2: Integrated Assessment
 - *Re-Assess Overall System Knowledge*
 - *Identify Critical Gaps & Info Needs – Rank and Prioritize Gaps / Actions*
 - *Assess Impacts and Removal / Disposal Options*
 - *Document Action Plan Needed to Resolve Overall Mercury Management and Removal*

Mercury Program Team

- **Established Mercury Expert Advisory Panel**
 - Panel Members:
 - *Dr. Lou Papouchado, Retired SRS/SRNL Chemistry Expertise*
 - *Dr. Eric Pierce, ORNL Mercury Expert*
 - *Mandi Richardson, AECOM Mercury Consultant*
 - *Dr. Eric Prestbo, Tekran Corp. Chief Scientist, Mercury Behavior & Speciation Expert*
- **Established AECOM Mercury Issue Coordination Team to integrate mercury related efforts between SRS and Oak Ridge (UCOR)**
 - Lead: SRR – Richard Edwards
 - Lead: UCOR – Harold Conner
 - *Charter Jointly Approved by SRR & UCOR Company Presidents*
 - *Both Companies Jointly Supported the DOE-EM “Addressing Mercury Challenges in DOE’s Waste Tanks and the Environment” Priority Technology Development Effort*
- **Participated on Mercury Technology Challenges Team chartered by EM-1**
 - Proposed DOE EM-21 FY 2016 Technology Development Request now includes SRR Mercury TD efforts

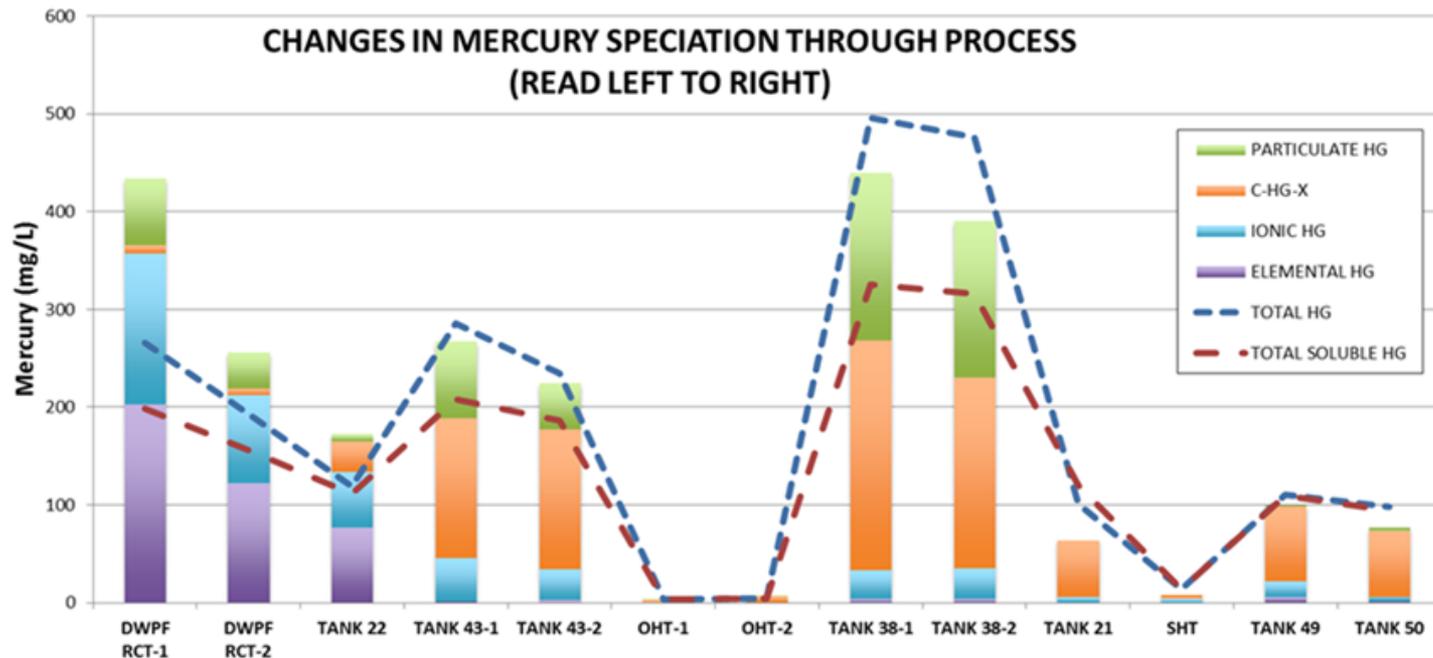
Mercury Program Team – Phased Evaluations

- **Mercury Assessment for Liquid Waste**

- Phase 1 Evaluations Completed (Phase 1 Report Issued July 1, 2015)
 - *Significant Effort to Determine Mercury Speciation throughout the Liquid Waste System*
 - **Over 40 Samples analyzed for Mercury Speciation by Commercial Laboratory**
 - **Remaining Samples, to complete Mercury Behavior understanding, under Phase 2 Evaluation**
 - **Significant mercury buildup around 2H (recycle) evaporator (~ 500 mg/l & ~40% is methylmercury)**
 - *In-depth DWPF Chemical Process Cell (CPC) sampling effort performed*
 - **Confirmed significant mercury returning to tank farm in DWPF recycle (> 40%)**
- Phase 2 Initiated (July 2015)
 - *DWPF operations resumed September 8, 2015*
 - **Supports remaining Sampling and Analysis efforts to further understand Mercury Behavior in the Chemical Processing Cell (CPC)**
 - *Condensate samples during CPC Processing*
 - *Partial Analysis of Mercury Balance Performed – Pending additional sample results to complete*
 - *Two Key System Engineering Evaluations (SEE) recommended from Phase 1 completed:*
 - **Re-Establish Mercury Removal Capability within DWPF**
 - **Determine Best Alternative Mercury Removal Location within Liquid Waste System**

Mercury Speciation in the Liquid Waste System

- Significant amount of soluble Hg present either as ionic mercury or Methyl Mercury
- Methyl Mercury is dominant in Tanks 43 and 38 which are feed/drop tanks for 2H Evaporator (used to evaporate DWPF Recycle)
- Majority of the Hg from DWPF recycle is either elemental or ionic with traces of Methyl Mercury
- Presence of Methyl Mercury in salt batch preparation Tank 21 is attributed to contributions from Tank 38 (2H recycle evaporator concentrate)



DWPF Mercury Removal Challenge

- **Primary Liquid Waste Mercury Removal Timeline**

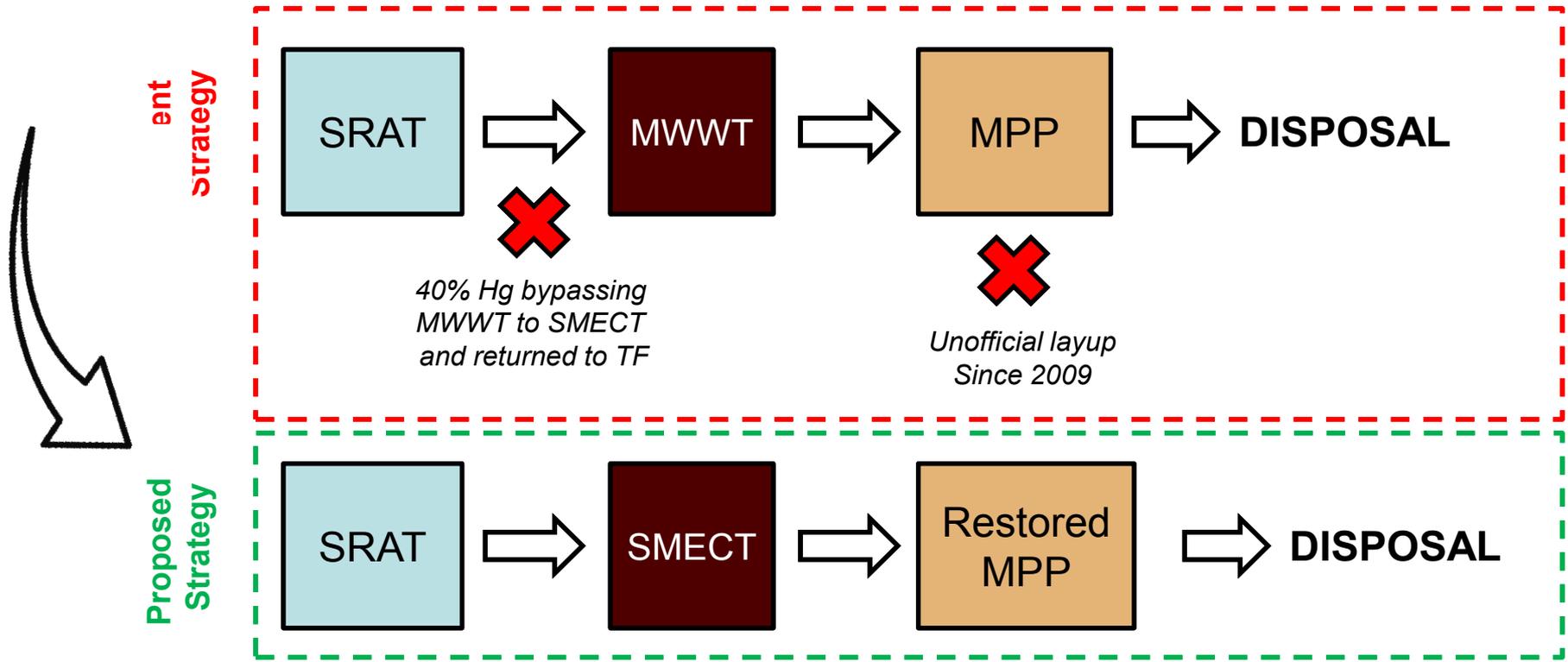
- Chemistry shift occurred in mid-2008 timeframe
- Multiple Mercury Purification System pluggage events / recovery attempts due to “Dirty Hg” (2009-2010)
- Comprehensive parametric SRNL simulant testing performed (2011-2012)
 - *Did not identify specific cause, multiple causes plausible*
- Multiple Independent Consultant Reviews (2013)
- Mercury Sampling and Characterization (2013/14)



Photographs of SMECT (A), SRAT (B), and MWWT (C) Samples

Phase 2 DWPF Mercury Removal - System Engineering Evaluation

- Conducted System Engineering Evaluation to evaluate best means to re-establish mercury removal capability in DWPF
 - Utilized systematic approach to develop alternate strategy
 - Prioritized contingency options should primary approach selected experience problems



Phase 2 Alternate Mercury Removal System Engineering Evaluation

- **Alternate Liquid Waste Mercury Removal System may be necessary**
 - System Engineering Evaluation Recommendations:
 1. *Target Process Vessels for mechanical removal of Hg (opportunistic)*
 2. *Removal of Ionic Mercury via reductant with a chemical additive to the Evaporator (2H) system to Enhance Current Mercury Collection*
 3. *Pursue removal of organic mercury via photoreaction (Tank 50) in parallel with enhanced retention of mercury in saltstone*
 - All will involve varying levels of technology development, deployment, and maturation
 - *Screening Testing of Recommended Alternatives necessary to verify feasibility*
 - *Input into the DOE-EM Research and Technology Development Plan for Mercury*

Phase 2 Remaining Activities

- **Complete Sampling and Speciation Activities to Understand Mercury Behavior (a small number of Tank Farm samples remain)**
 - Projected Completion is end of 1st Quarter CY2016
 - Use of Offsite Lab is time consuming (6-8 weeks for analysis)
 - *Critical Path for Schedule Execution*
- **Perform Overall Systems Review**
 - Sub-divided into three Major Systems
 - *Salt Processing (Completed)*
 - *Tank Farm Processing*
 - *DWPF Processing*
- **Advisory Team Review of Conclusions / Preliminary Action Plan**
- **Action Plan Finalization**
 - Expected Completion is end of 2nd Quarter CY2016

Summary

- **Mercury is pervasive throughout the Liquid Waste System**
- **Represents both a current and a long term challenge to liquid waste processing**
- **DWPF Mercury Removal System is a key technology challenge**
- **Long term action plan under development**
- **Long term actions may be significant**
 - *Process adjustments*
 - *Operational restrictions*
 - *Facility modifications*