RBOF DEINVENTORY PROJECT

HEAVY WATER COMPONENTS TEST REACTOR [HWCTR] OVERSIZED CAN DISPOSITION

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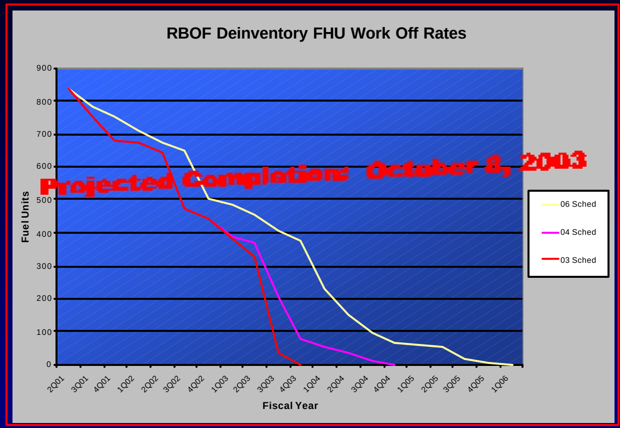
The following posters were presented at RERTR-2003

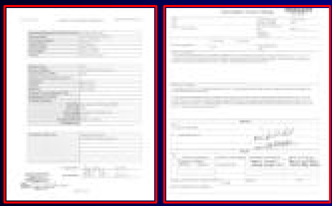
savannah river site

Receiving Basin for Offsite Fuels

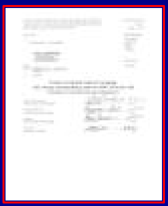


L-Area

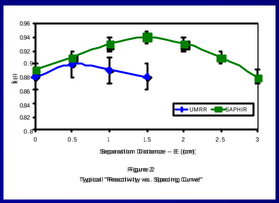
Engineering Preparations



Appendix A Development

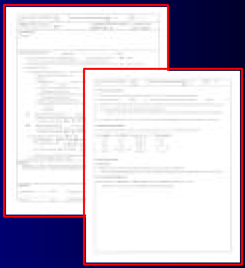


Nuclear Criticality Safety Evaluation



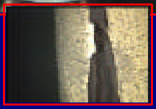
Uniform Fuel Evaluation Methodology

- New vs. Bounding fuel comparison
- k_{eff} + 2s<k_{safe}
- Codes to calculate k_{eff}
  - SCALE (4.4)
  - MCNP 4B
  - CASE
- Safe Number
- Dropped fuel analysis

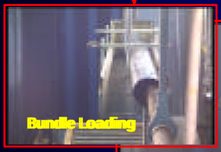


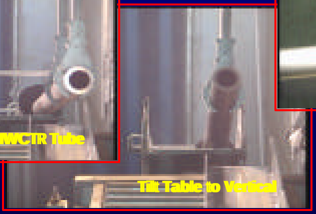
Nuclear Safety Data Sheets

Underwater Inspections

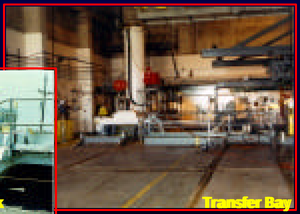


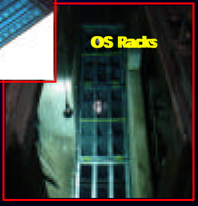
Fuel Packaging





Fuel Transfer





Rbof de-inventory project

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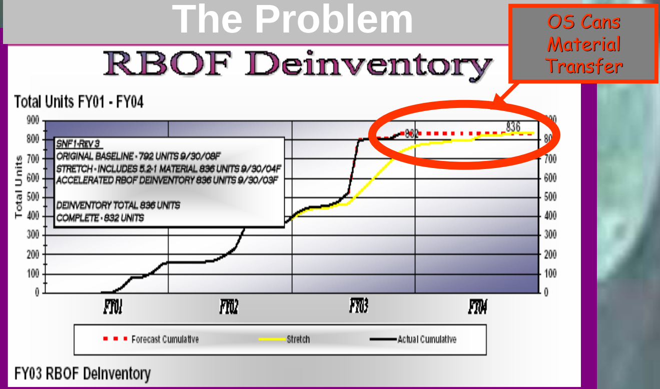
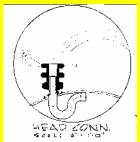
RBOF Deinventory Project
Heavy Water Components Test Reactor [HWCTR]
Oversized Can Disposition

The Problem



- Repackage and ship 9 Oversized HWCTR Cans from RBOF to L-Basin
- Areas of concern:
  - size and weight of containers [14" dia x 14' l / up to ~1000 lbs]
  - scattered historical information
    - >30 fuel assembly types
    - mostly cut pieces from post irradiation inspections
    - large amount of HWCTR
  - potential for increased basin activity
    - Not opened for flushed for >30 years
    - Gas venting evident
- 1 year estimated time to repackage and ship supporting a RBOF Deinventory in 2006
  - Management challenged to Accelerated RBOF deinventory to 2004
- Must be compatible with new 'versatile' OS cans and Saxton fuels
- HWCTR MUST be repackaged
  - HWCTR OS containers too large to unload and transfer to a storage location in L-disassembly
  - $1,000,000 question – "What's Inside?"

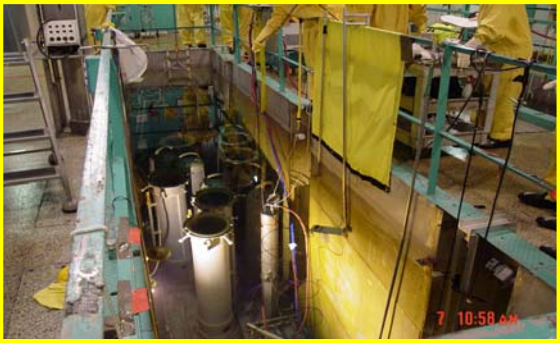


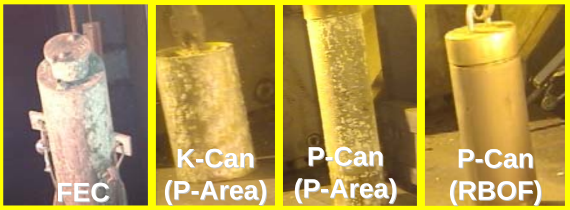
History of Fuel

- R Production Reactor
  - Irradiated test assemblies for Power Reactor Program
  - Prototype fuel for HWCTR
  - Disassembly Basin - Isolation Tank
    - Cut assemblies and sent to High Level Caves for examination
    - Cans were returned for storage
- Transferred to P-Basin after R shutdown in 1964
- P-Disassembly Basin
  - Water chemistry limits maintained for short storage times only (<1 yr)
  - Vented cans led to increased basin activity
  - Many cans were placed in 5" D x 12' long aluminum failed element containers [FECs]
  - FECs were vented and activity continued to increase
- Decision was made to ship to RBOF
  - Shipments made in 1969 and 1970

Fuel Characterization

- HWCTR Fuel Description
  - Irradiated between 1957 and 1963
  - U_{metal}, UO_2, U-Zr, and U-Mo cores
  - Zircaloy cladding (some Al)
  - Natural enrichment
- 2 Intact Assemblies and 145 smaller aluminum cans
  - Cans contain sections/pieces of cut assemblies
  - Unknown geometries (lack of detailed cutting reports)
  - 1 year effort to characterize > 300 cans of HWCTR fuel in Bucket Storage and OS cans





RBOF Deinventory Project
Heavy Water Components Test Reactor [HWCTR]
Oversized Can Disposition

How to Attack?

- Primary concern: saturated activity in stagnant water inside cans
- Characterize cans
- Measure dose on cans with RO7
  - 60 mR/hr to >200 R/hr practices
- Sampled
  - 5 of 9 cans
  - 0.1 Mr/HR [S1] TO 34 r/HR [A5]
  - 2.4 x 104 dmp/ml to 3.5 x 10^8 dpm/ml
  - OS can A5 released 65 Curies of ^{137}Cs during movement
- Evaluate Filter-Deionizer (FD) and capacity basin water activity impacts to facility operations

Initial Steps

- Estimate the isotopic contents of the HWCTR OS cans
- Engineering calculated up to 620 Curies of 137 Cs remaining in HWCTR OS cans
- Evaluated the RBOF allowable basin water Curie inventory (FD system capacity)
- Resin processing procedures revised to maximize decontamination of resin
- Alternative evaluation performed to define methodology of handling Cans and minimizing impact of activity on the facility

Alternative Solutions

- Open and Flush using FD system
  - Pros
    - Uses existing building processes
  - Cons
    - Large quantities of waste generated
    - Processing interruptions and major schedule delays
    - Maximum of 10 regenerations required
    - Elevated dose rates above the resin and waste cells
    - Difficultities with restart of NO_2 system
- Flush Directly to EP38
  - Pros
    - Minimal modifications or fabrication required
    - Generates small amounts of liquid waste compared to utilizing FD system
    - Quick removal of activity
  - Cons
    - Liquid waste generated (6000 gallons)
    - Elevated dose rates from EP38
    - Poor control and regulation of the operation
    - Criticality concerns with fuel fines in piping systems
    - WAC compliance concern, alpha activity in EP38

Alternative Solutions (cont'd)

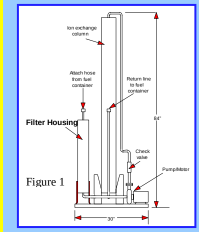
- Submersible Metal Ion Filtration System
  - Pros
    - Generates no liquid waste
    - Uses existing basin water shielding for good ALARA practices
    - Lower dose rates on facility roof
    - Quick and controlled removal of activity
  - Cons
    - Procurement schedule uncertainty
    - Criticality concerns with fuel fines in piping systems
    - Occupies fuel storage position in L-Basin
    - Additional 70-ton cask shipment

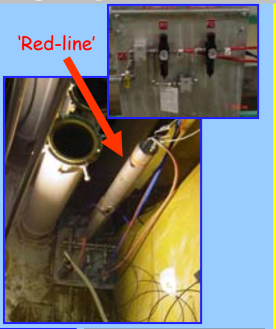
Selected Path

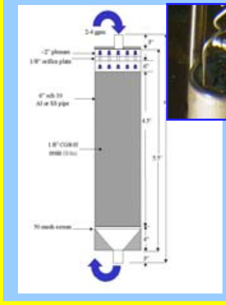
Submersible Metal Ion Filtration System

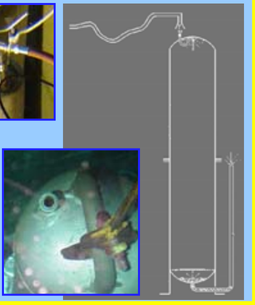
- Design
  - Underwater mobile skid (30-inch square footprint)
  - 2 pumps (one is redundant)
  - Quick connecting filter and resin column for easy replacement
  - Pre-filter for protection of pumps, resin column and basin water from damage/contamination from debris and fuel fines
  - Resin column and pre-filter fit into 8" OS can for disposal
  - Ion exchanged bed capacity of 1000 Ci 137Cs
    - 620 Ci estimated in HWCTR + 236 Ci estimated in Saxton Cans
    - Design arbitrarily doubled so actual capacity = 2000 Curies
  - ~$250,000 Design/Fabrication

Flushing Rig Operation









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Operations - Results

- S1, S3, A4 were opened without flushing
  - S1 2 intact SPR and TWT assemblies
  - S3 & A4 1 FEC each + 2 K-cans
  - Condition
    - FEC's
      - Surface corrosion, gas venting evident
      - Cables and vent hoses attached
    - Intact Assemblies
      - Minor corrosion
      - Structurally sound
    - K-cans
      - Minor corrosion, some discoloration
      - Structurally sound
      - Evaluated after discovered
  - No increase in basin activity observed
- Flushed A3, A1, A2, A6, A7 and A5 Cans

Can Number	RO7 Initial Reading	RO7 Final Reading	Duration of Flush	Contents
A3	14 mR/hr	1 mR/hr	1 hour	1 FEC
A1	29 mR/hr	1 mR/hr	1 hour	1 FEC
A2	410 mR/hr	2 mR/hr	1.5 hours	1 FEC
A6	323 mR/hr	4 mR/hr	1.5 hours	2 FECs
A7	290 mR/hr	2 mR/hr	2 hours	2 'Z' cans 1 4" can
A5	2.4 R/hr	10 mR/hr	3 hours	4 'Z' cans

- Basin water activity increased as expected after each opening but was quickly removed by the FD system

U_{metal} Oxidation

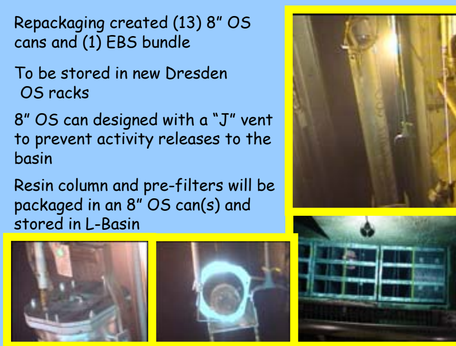
RBOF Basin Water Chemistry

Post flushing conditions:

- Whole body dose rate above FD system decon cell was 2.5 mrem/hr
- FD resin Curie loading approximately 8 Curies
- Dose rate at 'red line' of resin column is 6300 R/hr
- Resin column Curie loading approximately 250 Curies

L-Basin Storage

- Repackaging created (13) 8" OS cans and (1) EBS bundle
- To be stored in new Dresden OS racks
- 8" OS can designed with a "J" vent to prevent activity releases to the basin
- Resin column and pre-filters will be packaged in an 8" OS can(s) and stored in L-Basin



Failed 'Z' Cans

- A7 and A5 contained ruptured 'Z' cans
  - Each Z can contained sections of cut assemblies
  - Particulates, suspected to be U_{metal} oxidation, found in bottom of cans
  - Cans ruptured due to swelling of the fuel tubes caused by gases formed from corrosion

Concerns

- Rad rates from 8" OS cans and resin column
  - Maximum rate from OS can is 53 mR/hr @ 2 ft
  - Rate from resin column is 110 mR/hr @46" above 'red line'
- Disposition of Umetal Oxidation in A5, A7 and on basin
  - Weighing on Z cans (for MC&A purposes)
  - Vacuum and place in 8" OS can
  - More in-depth sampling plan

Conclusion

- HWCTR OS cans repackaging a SUCCESS
  - Design/Operation/Flushing of Submersible Metal Ion Filtration System
  - 8" OS can – versatile design
  - No operating limits challenged
  - Quick response and resolution of extra K-cans
  - Minimal waste generation
  - Schedule acceleration
- FUTURE USES
  - Saxon (if flushing is required)
  - L-Basin repackaging