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Spent Nuclear Fuel Storage in L Basin

Extended Storage Surveillance & Maintenance

David B. Rose
Spent Fuel Project Engineering

Presentation to Nuclear Waste Technical Review Board

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Outline

- Extended Safe Storage Overview
- Basin Chemistry & Corrosion Control
  - Water Quality
  - Corrosion Monitoring; Results & Actions
  - Microbial Monitoring; Results & Actions
  - Augmented Monitoring and Condition Assessment Program (AMCAP) Status
- Basin Structural Integrity
  - SRNL Report of 2008
  - Structural Integrity Program; Results & Actions
  - AMCAP Status
- Summary

Extended Safe Storage of Used Fuel

- Surveillance & Maintenance Programs for Fuel Storage
  - Basin water chemistry control program
    - *Stringent controls on water purity; minimize corrosion of fuel and storage fixtures*
  - Corrosion surveillance programs
    - *Corrosion coupon surveillance; predict corrosion rates of fuel and fixture materials*
    - *Microbial monitoring program*
  - Structural integrity program
    - *Periodic visual examination of basin floor, ceiling & walls and accessible exterior walls*
- Augmented Monitoring and Condition Assessment Program (AMCAP)
  - Implement three additional programs to assess long term viability of:
    1. Al-based fuels in standard storage configurations
    2. Isolation cans containing degraded/damaged fuels
    3. Basin structural integrity
  - Adjust existing programs to incorporate new information

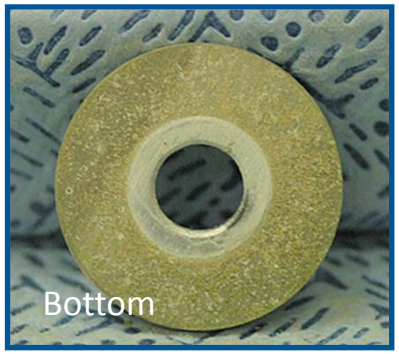
Basin Water Chemistry Control

- Sand Filter system removes particulates
- Deionizer system removes cesium and other water soluble ions
- No active heat removal system
- Water quality sampling

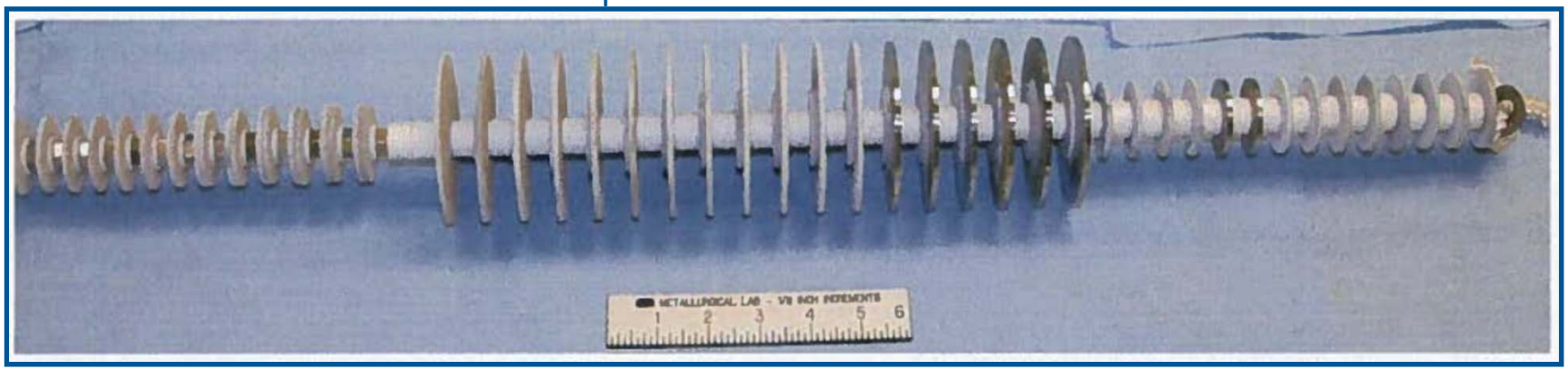
Parameter	Normal Value	Operating Limit
Conductivity, micro Siemens/cm	<1.5	<10
pH	6.1	5.5 – 8.5
Chloride, ppm	<0.05	<0.1
Mercury, ppm	<0.014	<0.014
Copper, ppm	<0.05	<0.1
Cs-137 activity, dpm/ml	20 - 60	<500
Alpha activity, dpm/ml	<1	<3
Temperature, degrees C	18 - 26	<40

Fuel Corrosion Monitoring

- Corrosion Coupons
  - Designed to include crevices and galvanic couples
  - Pulled periodically for analysis by SRNL
  - Results after 11 years in basin (Pulled May 2010)
    - *General corrosion rate – 0.03 mils per year*
    - *Crevice pits – average 2.5 mils deep*
    - *Galvanic corrosion pits – average 20 mils deep*
    - *More pitting on top surfaces; attributed to particulates*

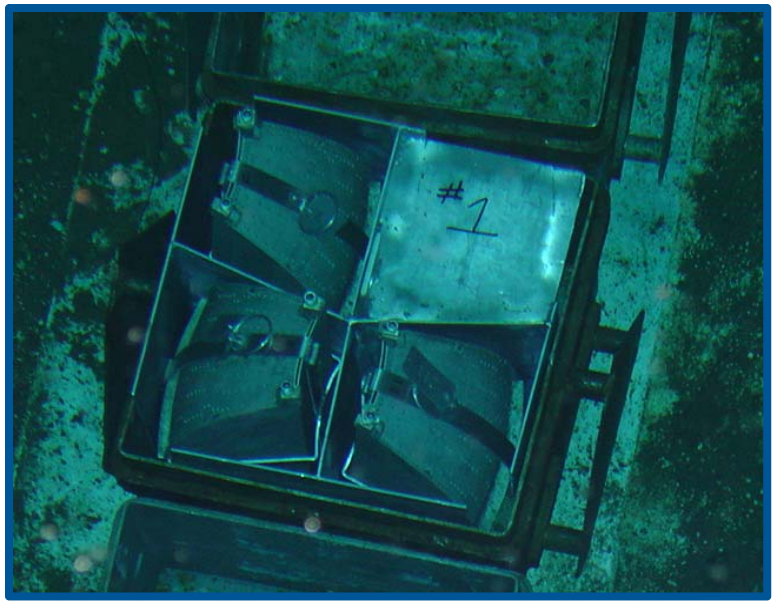


Research Reactor Fuel Corrosion Coupons



Fuel Corrosion Monitoring – Near Term Actions

- Galvanic Couples
  - Few instances of aluminum clad fuel not compatible with aluminum rack storage systems due to size & shape
  - Stored in stainless steel containers in bucket storage lanes
  - Currently designing and installing insulator material to eliminate galvanic couples
- Particulates on Fuels
  - Few instances of odd-shaped fuels not in covered containers
  - Conceptual design for covers

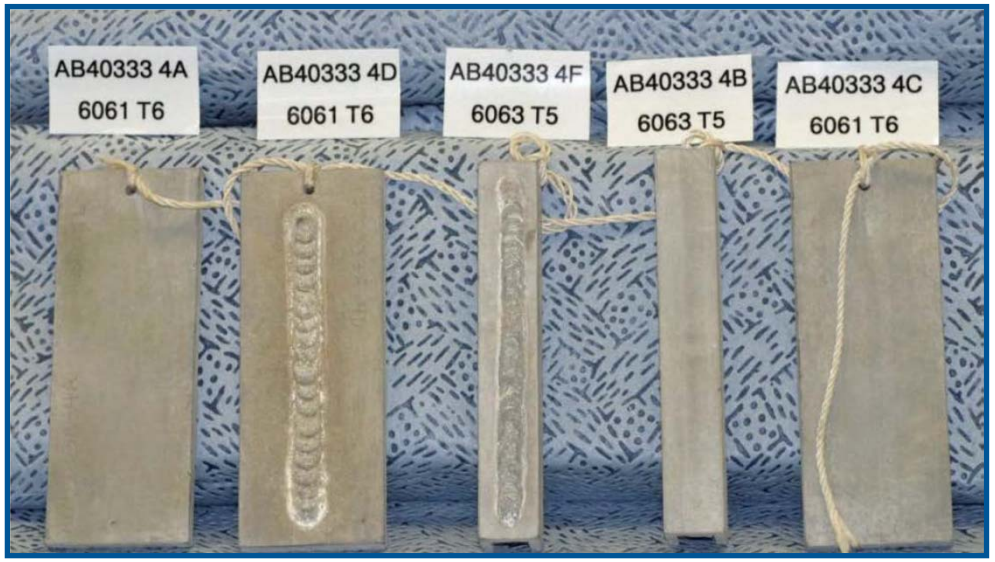


Tower Shield Reactor Sections in Open-Topped Container

Fuel Rack Corrosion Monitoring

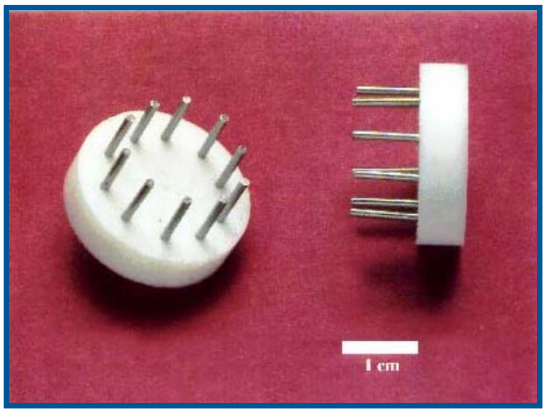
- Corrosion Coupons
  - Designed to include welds
  - Pulled periodically for analysis by SRNL
  - Results after 16 years in basin (pulled July 2011)
    - *Pits form early, grow slowly*
    - *Base metal pits – 1-2 mils deep*
    - *Heat affected zone pits – average 4 mils deep*
    - *Weld pits – average 3 mils deep*
- Sample from actual rack
  - Cut from rack being removed (2009)
  - Included welds & crevices
  - 14 years in basin
  - Similar results

Fuel Rack Coupons



Microbe Monitoring

- Coupons
  - Pulled annually for biofilm analysis & pitting
  - No trends
- Water Samples
  - Analyzed every six months
    - *Microbes, inorganic carbon, organic carbon*
  - No trends



Specimens - stainless steel & aluminum in Teflon disc

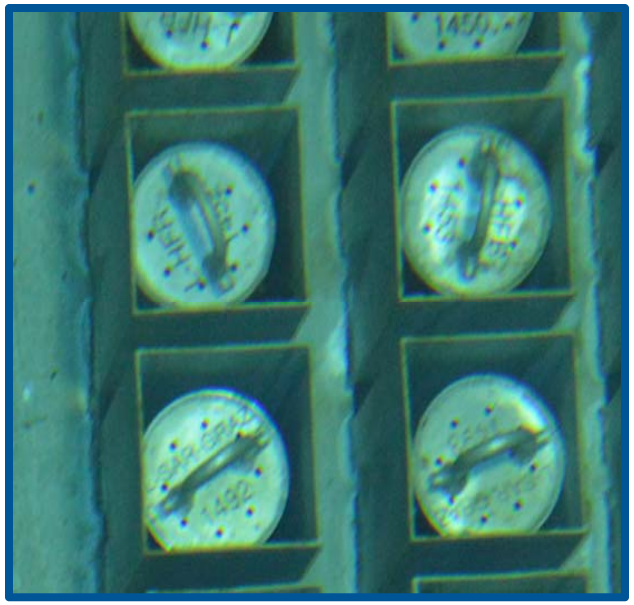
"Cobwebs" – String-like bacterial growth

- Routine monitoring did not predict or detect the appearance of the "cobwebs" which:
  - Did not attach to the coupons
  - Were not freely floating in water; thus not captured in routine samples
- Extensive sampling and analysis of distribution densities did not reveal source or environmental conditions favoring growth

Microbe Monitoring – Near Term Actions

- Completed vacuuming of “cobwebs”
- Conduct periodic visual surveys for their return

Before vacuuming

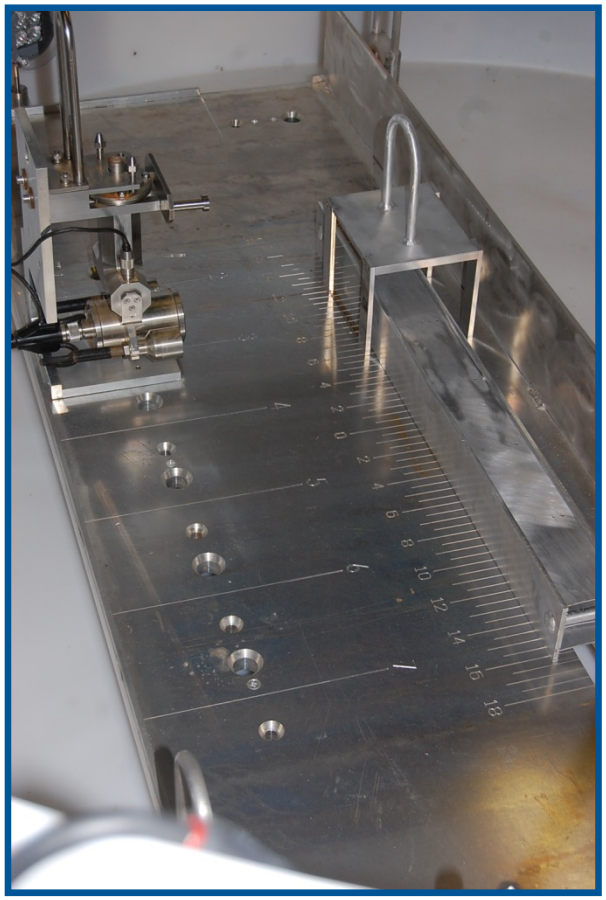


After vacuuming

AMCAP Status – Aluminum-Based MTR Fuels

- Establish in-service inspection program for bundled Material Test Reactor (MTR) fuel
  - Selection of fuels for inspection (complete)
    - *Fuels with known defects; various burnups; one with high cobweb density*
  - Develop inspection equipment & procedure (complete)
    - *Defined regions of interest for each assembly*
    - *Underwater cameras with reproducible geometry & lighting*
  - Sample water inside fuel bundle tubes before disturbing (complete; no anomalies)
    - *Conductivity, pH, alpha, beta/gamma, chlorides, metals, microbes*
  - Perform baseline visual inspections; evaluate results
  - Periodic reexamination; trend changes

Fuel Inspection Table



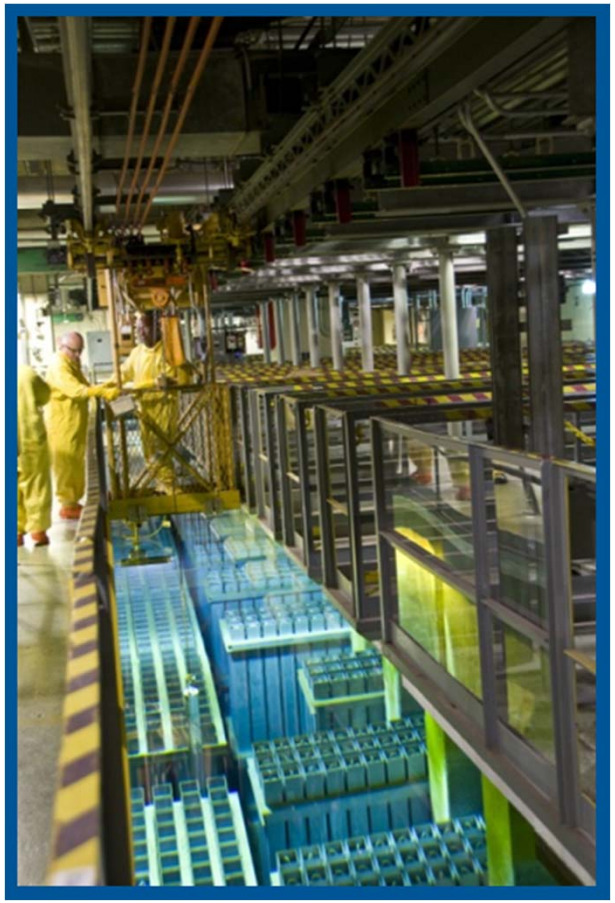
AMCAP Status – Fuel in Isolation Containers

- In-situ examination of L Basin oversized cans
  - Visual and ultrasonic examination of cans (complete; no anomalies)
- Degradation evaluation of Isolation Can configurations
  - Compile details & history of isolation containers and contents (complete)
  - Evaluate configurations for degradation susceptibility (complete)
  - Perform risk ranking to identify configurations for further study (complete)
    - *Continuing oxidation of degraded fuels*
    - *Type & integrity of containment, levels of containment*
  - Evaluate fuel isotope characteristics & alteration products
  - Develop and deploy indirect characterization methods, if needed

Beyond AMCAP
Shipped Sodium Reactor Experiment (SRE) fuel to H Canyon for processing

L Basin Structure

- Steel reinforced concrete basin
  - Walls 2.5’ to 7’ thick
  - Floors 5’ to 7’ thick, except 2’ in Transfer Pool
- Approximately 3.4 million gallons
  - Working areas 17’ and 30’ deep
- Placed in service in 1954
- Epoxy coating reapplied in early 1980s
  - No longer performs protective function



L Basin Life Expectancy Report – SRNL 2008

- Concluded basin expected to maintain structural stability for an additional 50 years based on:
  - No harsh service environment
  - Structural analyses for similar structures
  - Condition surveys; no extensive cracking or degradation
  - Literature survey confirming appropriateness of material considerations & monitoring
  - Continuing inspections per Structural Integrity Program and taking appropriate maintenance actions where indicated by inspection results

L Basin Structural Integrity Program

- Visual inspection of accessible surfaces of basin walls & floors
- Visual inspection of exterior walls where exposed in reactor building
- Inspection frequency based on results; range from quarterly to five years
- Video recordings and photographs of inspections, archived for later comparison
- Interdisciplinary team performs each inspection, evaluates findings, and recommends actions
  - Design Authority Engineering, Structural Mechanics, SRNL Materials Science & Technology
- Summary reports
- TSR Level Safety Management Program – non-discretionary

L Basin Structural Integrity Program Results

- No structural vulnerabilities identified
- Vinyl coating degraded beyond its useful life
- Efflorescent sites in locations with recent or active weeping are monitored most frequently
  - Periodically stop or resume activity
  - No staining to indicate degradation of reinforcing steel
- Recent equipment modifications for receipt of longer fuels made additional wall temporarily accessible for inspection
  - Promptly inspected; no anomalies other than degraded vinyl coating

AMCAP Status - Basin Structural Integrity

- Test concrete of similar age and operating history
  - Obtain concrete core samples from below water line in C Basin wall (complete)
  - Analyze samples (complete)
    - *Compressive strength averaged 4148 psi; exceeds required value of 3500 psi (design strength of 2500 psi plus confidence factor of 1000 psi)*
    - *No significant leaching of concrete components*
    - *Insignificant ingress of carbonation or deleterious species*
    - *No evidence of alkali-silica reactions*
- No change in material property inputs for structural evaluations

SRS evaluating the newest seismic hazards analysis; additional work being done on ground motion models

Summary

- L Basin mission has been extended beyond 2030
- Spent fuel can continue to be safely stored in L Basin for fifty additional years and possibly beyond contingent upon:
  - Continuation of existing surveillance & maintenance programs
  - Performance of augmented program activities (AMCAP)