Introduction to Aluminum Clad Research Reactor Spent Nuclear Fuel

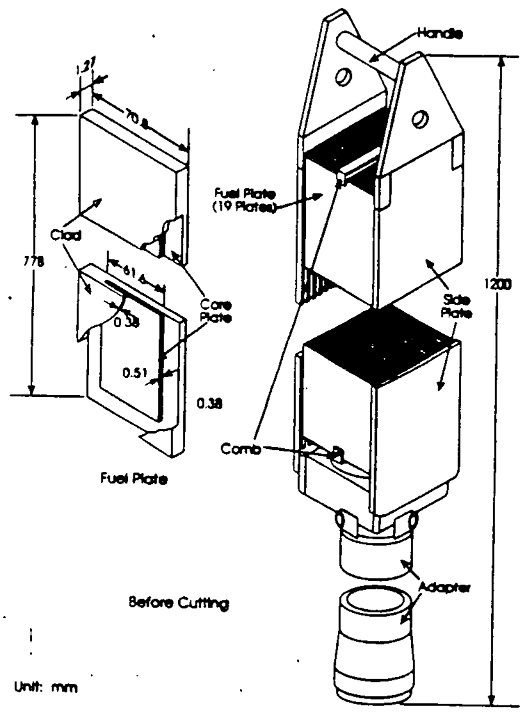
Presentation to
Nuclear Waste Technical Review Board
December 17, 1997

Mark W. Barlow, Manager
Alternate Technology Program
Westinghouse Savannah River Co.

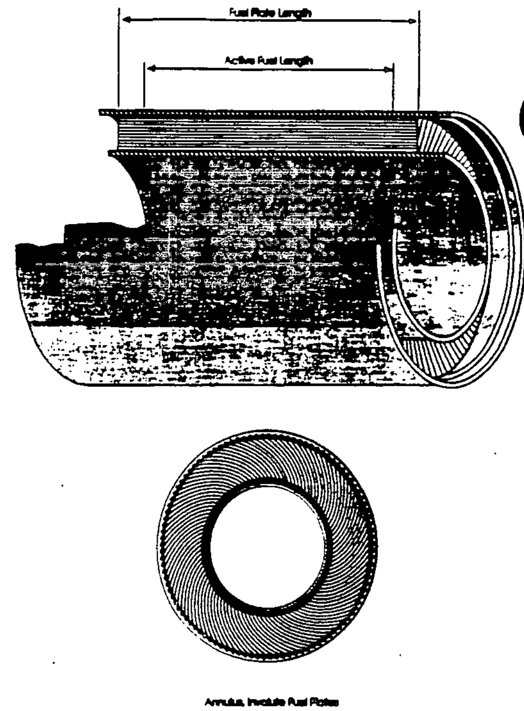
Al-SNF Characteristics

- Core Materials:
  - Uranium-aluminum, Uranium oxide-aluminum, Uranium silicide-aluminum alloys
  - Typical core thickness: 0.50 mm
  - 12 - 25 plates per assembly
- Cladding
  - Aluminum
  - Typical cladding thickness: 0.385 mm
- Operational Parameters
  - Enrichment: <20% - 93%
  - Burnup: 5% - 55% (5,000 - 9,000 MWD/MTU)
  - Heat Generation: 4-70 watts

AL-SNF Characteristics



Box

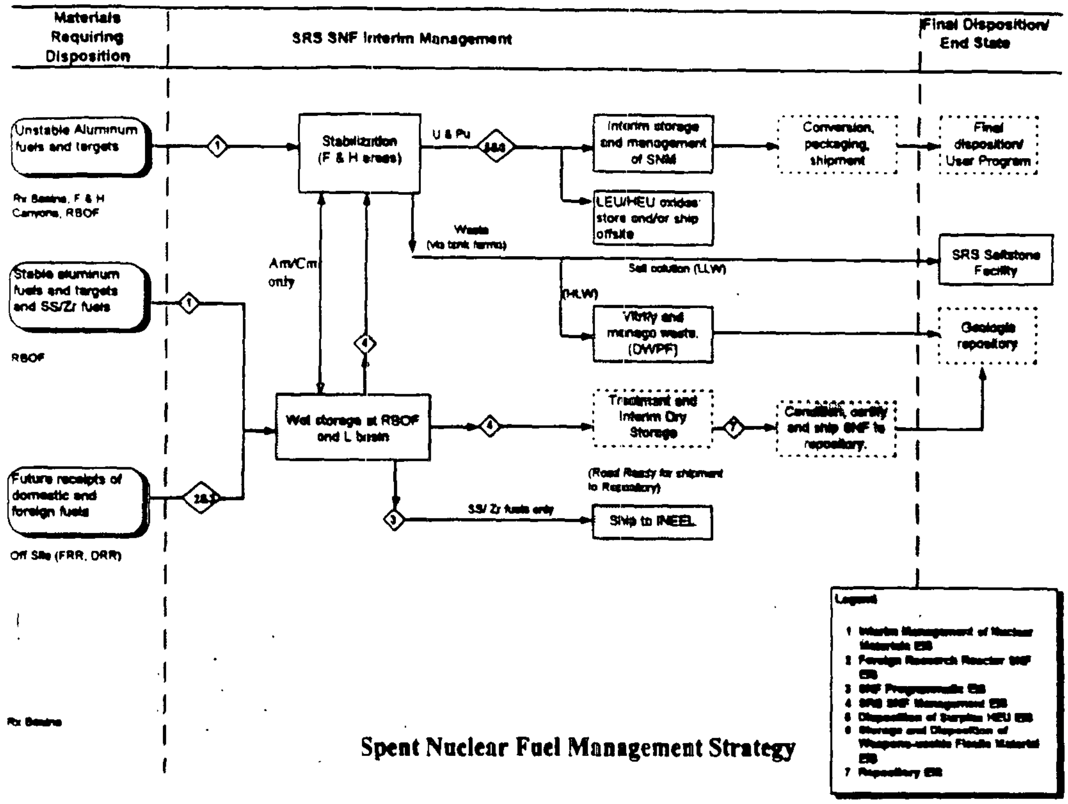


Involute

Typical Al-SNF Assembly

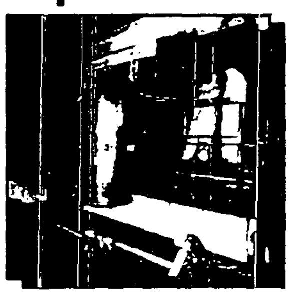
Al-SNF Corrosion Characteristics

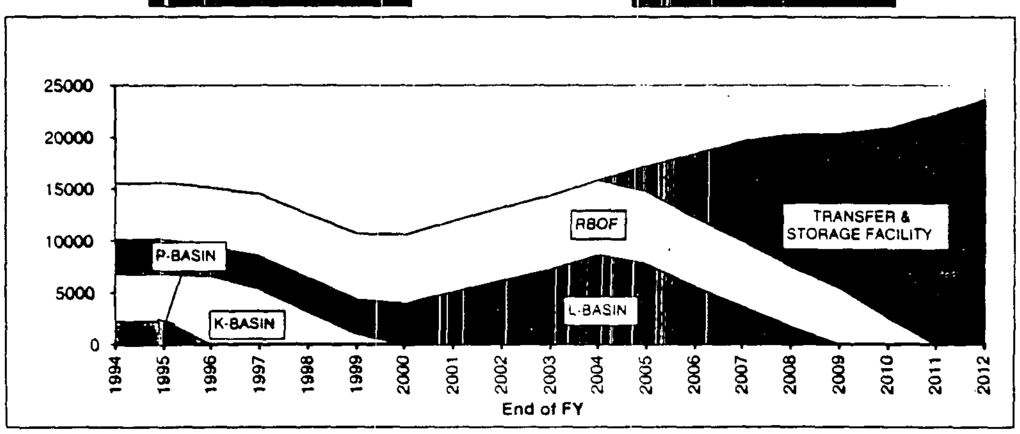
- Fuel cladding & core corrodes similar to standard aluminum
- Function of storage environment
- Function of oxide layer
- Low fission product release rates
  - Breached cladding effects are different than for commercial SNF



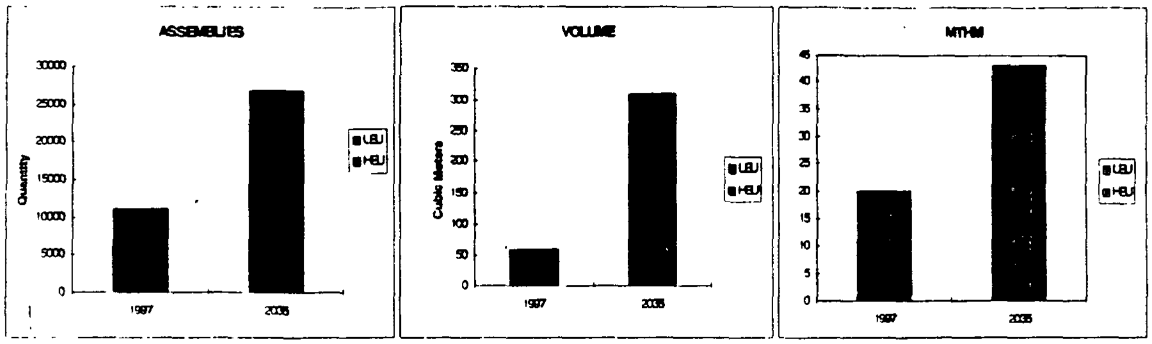
Spent Nuclear Fuel Management Strategy

Spent Fuels Basins





Inventory of Al-SNF (Research Reactor)



1. Includes Al-SNF currently in INEEL (7000 assemblies)

2. Includes SFO, SRE, and EBR-II which are candidates for reprocessing (1000 assemblies, 19 MTHM)

Research Reactor SNF Task Team

- Established by DOE in November 1995
- Charter: Develop a technical strategy for safe and economical handling, treatment and disposal.
- Groundrules:
  - Technical focus
  - Explore alternatives to processing.
  - Recommend path forward to a committed, demonstrated SNF disposal approach before 2000.
- Process:
  - Interaction with technology champions.
  - Qualitative, consensus-based recommendations.

RRTT Alternative Technologies

- **Direct Disposal** - The SNF would be placed into small waste packages, ready for direct disposal, with fuel quantities limited to satisfy repository criticality requirements.
- **Direct Co-Disposal** - The SNF canisters be disposed by placement in repository waste packages which contain HLW glass logs. Fuel quantities may be limited to satisfy repository criticality requirements.
- **Press and Dilute/Poison** - To minimize volume, the SNF would be mechanically compressed and either diluted with depleted uranium or mixed with a neutron poison.
- **Melt and Dilute** - The SNF would be melted and diluted with depleted uranium.
- **Plasma Arc Treatment** - The SNF would be placed directly into a plasma centrifugal furnace with depleted uranium and neutron absorbers, where it would be melted and converted into a HLW ceramic waste form.

RRTT Alternative Technologies, contd.

- **Plasma Arc Treatment** - The SNF would be placed directly into a plasma centrifugal furnace with depleted uranium and neutron absorbers, where it would be melted and converted into a HLW ceramic waste form.
- **Glass Material Oxidation and Dissolution System** - The SNF would be placed in a glass melt furnace where it is oxidized by lead dioxide and converted into a HLW glass waste form.
- **Dissolve and Vitrify** - The SNF would be dissolved and mixed with depleted uranium to dilute the HEU to LEU. The mixture is then fed into a vitrification plant for conversion to a HLW glass waste form.
- **Electrometallurgical Treatment** - The SNF would be melted with silicon and electrolytically removed for disposal as low-level waste; the residual aluminum, actinides, and fission products would be vitrified. Pure Uranium would be recovered.

RRTT Evaluation Criteria

- Confidence in Success
  - Overall potential to implement the concept within established cost, schedule and performance parameters.
- Cost
  - Near term and life cycle
- Technical Suitability
  - Technical Complexity (system and operations)
- Timeliness

RRTT Evaluation Results

Technology	Confidence in Success (30%)	Cost (30%)	Technical Suitability (20%)	Timeliness (20%)	Overall Scored
Direct Disposal	5	7	4	8	60
Direct Co-Disposal	6	10	5	8	74
Press & Dilute (20%)	6	7	7	6	63
Press & Dilute (2%)	7	5	6	6	62
Melt & Dilute	6	8	7	6	66
Plasma Arc	1	2	6	1	23
GMODS	1	2	7	1	25
Dissolve and Vitrify	4	1	7	1	31
Electrometallurgical	3	5	8	3	46

RRTT Evaluation Conclusions

- The simpler options (those in the direct disposal and dilution categories) are generally preferable to the advanced ones.
- Direct Disposal, in Co-Disposal Packages, is the most promising single option.
- Both dilution options have strong merit; further development is warranted.
- Electrometallurgical treatment has merit as a backup.

Alternate Technology Program - Goals

- Conduct Waste Form Qualification Studies
- Develop Technical Basis
- Support Transfer and Storage Services Project

Alternate Technology Program - Progress

Direct/Co-Disposal
- Drying Criteria for Interim Storage
- SNF Performance Analysis
  - -Thermal Analysis
  - -Degradation Analysis
  - -Criticality (intact canister)
- Instrumented Test Canister for Validation

Melt/Dilute
- Process Development
  - -Bench Scale
  - -Small Scale (full scale MTR)
- By Product Analysis
  - -Off Gas
  - -Secondary Waste

Alternate Technology Program - FY'98

Direct/Co-Disposal
- SNF Performance
  - -Criticality (degraded canister)
  - -Corrosion, etc. (WAC)
  - -Thermal

Melt/Dilute
- Process Development
  - -Induction Furnace
- Waste Form Performance
  - -Ternary Effects
  - -WAC

U.S. Nuclear Regulatory Commission Review

- Memorandum of Understanding signed between DOE-SR and NRC-Office of Nuclear Material Safety and Safeguards/Division of Waste Management - August 1997
- NRC to provide technical assistance to DOE in identification of potential issues related to geologic repository disposal requirements.
- DOE has provided the NRC with documents describing topics related to disposition of Al-based SNF.

National Research Council Review

(National Research Council/Board on Radioactive Waste Management)

Purpose: Review DOE's Al-based SNF dispositioned technologies, including:

- Identification of other alternatives.
- Evaluate methods to meet waste acceptance criteria.
- Assess cost and timing for implementation

Schedule:

- Information Meeting, December 2-3, 1997
- Issue a report by March 1998

Principal Investigator: Milt Levenson

Study Director: Kevin Crowley