

**Department of Energy**  
Savannah River Operations Office  
P.O. Box A  
Aiken, South Carolina 29802

**AUG 27 1998**

Dr. Carl J. Paperiello, Director  
Office of Nuclear Material Safety and Safeguards  
U.S. Nuclear Regulatory Commission  
Washington, DC 20555

Dear Mr. Paperiello:

**SUBJECT: Updated Overview Document of the Alternative Technology Program**

Provided for your convenience is the updated overview document of the Alternative Technology Program requested by Richard Weller of your staff. The document outlines the technical assistance requested from the Nuclear Regulatory Commission over the next few months as well as the projected reviews for 1999.

Please contact me at (803) 952-2497 or Jean Ridley of my staff at (803) 557-3758 if you have any questions.

Sincerely,

A handwritten signature in black ink, appearing to read "John E. Anderson", is written over the typed name.

John E. Anderson  
Acting Assistant Manager for Material  
and Facility Stabilization

RSFD:JMR:gis

UE-98-0203

Enclosure  
Updated Overview Document of the  
Alternative Technology Program

cc w/ encl:

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**Alternate Technology Program  
for  
Aluminum-Based Research Spent Nuclear Fuel**

**I. Purpose**

The purpose of this document is to describe the Department of Energy (DOE) program for the development; selection and validation of technologies for disposition of aluminum-based research reactor spent nuclear fuel. This document will address the major activities in the DOE Alternate Technology Program and the role of the U.S. Nuclear Regulatory Commission (NRC) in providing technical assistance to DOE.

**II. Background**

The United States Department of Energy has selected the Savannah River Site (SRS) as the location to consolidate and store U.S. origin aluminum-based spent nuclear fuel (AI-SNF) from foreign and domestic research reactors (FRR and DRR, respectively). These SNF are currently being irradiated in the research reactors, or are being stored in water basins or dry storage at their sites, or have been transferred to SRS and stored in water basins. Since the fuel receipts would continue for several decades beyond projected SRS canyon operations, alternative disposition technologies to chemical reprocessing would be necessary.

Approximately two-thirds of the AI-SNF contains HEU with up to 93% enrichment. The Materials Test Reactor type of assembly, comprised of fuel elements or plates of aluminum-clad, aluminum-uranium alloy fuel, is the dominant design (approximately 80% of total) for research reactors. In addition, some reactor fuel assemblies were fabricated from aluminum-uranium silicide alloys or aluminum-uranium oxides. The fuel elements are clad with one of three aluminum alloys; 1100, 5052, or 6061 or their foreign equivalents.

The 1995 the Research Reactor Spent Nuclear Fuel Task Team was appointed by the Office of Spent Fuel Management of DOE to evaluate the effectiveness, relative merits, costs, and difficulties in implementation of alternative technologies and waste forms for the treatment, packaging, and disposal of aluminum-based SNF (Reference 1). The DOE implemented the recommendations of the Task Team through an aggressive program for the parallel development of direct disposal and melt and dilute SNF form options. This program is referred to as the Alternate Technology Program (ATP).

Technical activities of the ATP are being conducted by the Savannah River Technology Center (SRTC). SRTC is supported by scientists and engineers from Argonne National Laboratory (ANL), Pacific Northwest National Laboratory (PNNL), and the DOE-RW Management and Operating (M&O) contractor. It is also being coordinated with the DOE-EM National Spent Nuclear Fuel Program.

Disposition of the aluminum-based spent nuclear fuel assemblies involves transfer and treatment of wet-stored assemblies into an AI-SNF form (direct or melt-diluted) in a sealed, road-ready canister. The canisters will be managed in interim dry storage awaiting repository availability. Subsequently, the canisters would be transported to the repository and placed into waste packages containing HLW glass logs disposal. To proceed on this path, DOE will implement a technology that ensures the AI-SNF form will meet requirements for both the interim dry storage system and the Mined Geologic Disposal System.

**III. Alternate Technology Program Activities**

An assessment was recently completed on the relative merits of the direct, co-disposal and melt/dilute technologies. Based upon the recommendation made to implement the melt and dilute technology, the Alternate Technology Program is currently focused on validation of melt and dilute treatment and waste form performance.

**1) Melt Dilute Treatment Validation:**

The validation of the melt-dilute treatment technology entails process development activities using full-scale surrogate fuel elements and irradiated fuel samples. The focus of the activities will be the evaluation of the synergistic effects of the fuel and melt parameters on the fission product/gases evolution and off gas system efficiencies. This evaluation will guide the refinement of the off gas system design. Further, an experimental test facility capable of melting full-scale irradiated research reactor associated SNF assemblies are being installed. This test apparatus will be used to characterize and validate the melt-dilute process and the associated off gas and waste streams. These studies will also help validate integration of the secondary waste streams with the existing SRS high level and low level waste flow sheets.

**2) Aluminum SNF Form Performance:**

Studies are being conducted on the evaluation of SNF form degradation and criticality performance. These conducted on the evaluation of SNF form degradation and criticality performance. These studies include the development of data inputs, namely dissolution rate data, for the performance assessment. An ASTM standard guide for aluminum SNF test protocols will also be balloted. Further, the necessary analysis to ensure conformance of the aluminum SNF form with the Disposability Interface Specification (DIS) will also be conducted and updated.

**IV. Alternate SNF Form Technology Implementation**

In the Record of Decision for the Foreign Research Reactor EIS the DOE committed to implementing an alternate technology by the year 2000, if possible. Implementation of an alternate technology implies project execution is underway for new facilities and/or systems. Attachment I provides the schedule for the project. The key near term milestones for the project execution schedules are as follows:

- 7/98 - start conceptual design
- 4/99 - validate project baseline (technical, cost, schedule)
- 10/99 - start detailed design

DOE will be issuing a draft and then final EIS. All comments received from the public, National Academy of Sciences, Nuclear Waste Technical Review Board, U.S. NRC and an other stakeholder will be considered in the writing of the EIS Record of Decision that is scheduled to be issued in late or early 1999.

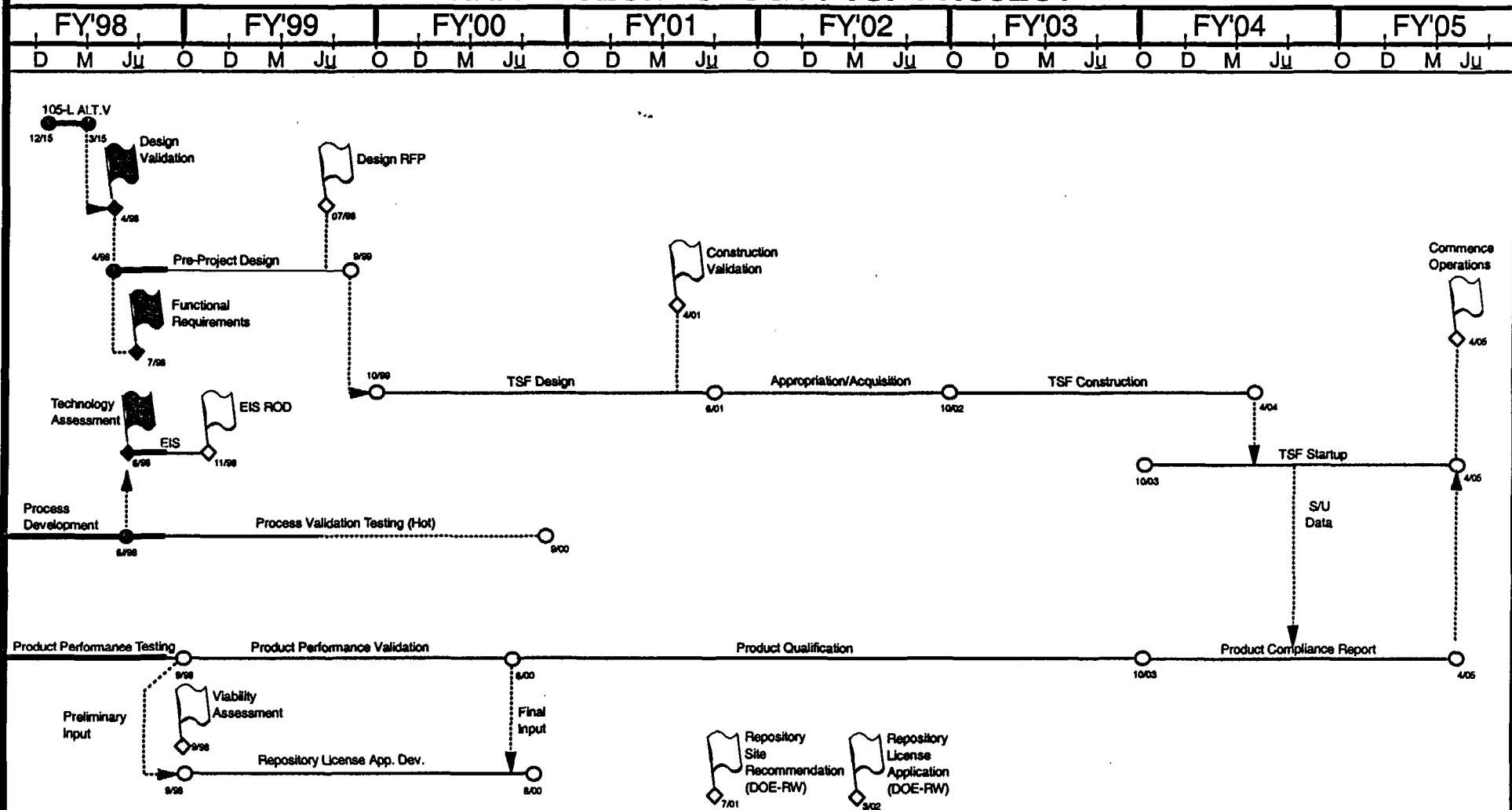
**V. NRC Technical Assistance**

The DOE and NRC have established a framework for the NRC to provide technical assistance to DOE in identifying issues related to disposal of AI-based SNF. In August 1997 the DOE NRC signed a Memorandum of Understanding that describes the NRC agreement to review the activities of the DOE Aluminum SNF Alternate Technology Program.

The results of the ATP evaluations and analyses completed to date have been documented in several reports (See Attachment II). These reports were provided to the NRC for their review in the context of repository disposal requirements. In June 1998 the NRC issued a report with several comments regarding the analyses documented in the reports they received. Also enclosed is a schedule of the ATP program as currently approved. (See Attachment 1)

Listed in Attachment III are additional reports that will be provided to the NRC for future review. The reports are listed in an appropriate order or priority, though many are interrelated and should be reviewed concurrently. The expectation is the NRC will review the documents for technical issues or concerns related to repository disposal requirements.

# ALTERNATE TECHNOLOGY / TSF PROJECT



Approved:

DOE

WSRC

SCHEDULER: D. FURTICK  
CONTACT: M. BARLOW  
DATE: 08/11/98 Rev. 1

ALTTS1.PRE

## Attachment II

### DOCUMENTS FROM THE ALTERNATE TECHNOLOGY PROGRAM

The following table provides information regarding the relationship of several technical documents to the Savannah River Site Alternate Technology Program. The first 11 documents were provided to the NRC for their use in the review and were evaluated in the NRC's report to DOE dated June 5, 1998.

Title	Relationship to SRS ATP
<b>Evaluation of Codisposal Viability for Al-Clad DOE Owned Spent Fuel: Phase 1, Intact Codisposal Canister</b>	<p>This is a technical report to evaluate the reactivity of the direct-disposed Al SNF form within an intact (non-degraded) DOE SNF co-disposal canister. The purpose was to demonstrate that the 10CFR60 requirements for criticality are met for this disposal configuration.</p> <p>Structural integrity analysis of the canister against drop loads and thermal analysis of the co-disposal configuration were also part of the report. Additional criticality analyses are in progress and include degradation and its impact of the direct-disposed Al SNF form within a waste package and similar analyses for the melt-dilute form. Additional thermal analyses of disposal configurations of the direct-disposed and melt-dilute Al SNF forms in the WP are in progress.</p>
<b>Alternate Aluminum SNF Treatment Technology Development Status Report (WSRC-TR-97-00345, October 1997)</b>	<p>This is the second and latest technical report to provide the status of the development activities under the ATP technical programs. The four main task technical programs are: 1) Direct/Co-Disposal Technology Development.; 2) Melt-Dilute Technology Development.; 3) Test Protocol Technology Development; and 4) Characterization Technology Development. Task technical programs 3 and 4 have been combined in FY98.</p>
<b>Acceptance Criteria for Interim Dry Storage of Al Alloy Clad SNF</b>	<p>This is a technical report prepared prior to the ATP and provides the requirements, with technical bases, for the dry storage of Al-clad SNF. The SRS-developed requirements are an expansion of those 10CFR72 requirements for maintaining fuel integrity throughout handling and storage. These requirements were adopted in the ATP as part of the preliminary requirements for road-ready storage which were listed in the above status report.</p>
<b>Evaluation of Corrosion of Al-Based Reactor Fuel Cladding Materials During Dry Storage</b>	<p>This is a technical report providing part of the technical bases for safe interim dry storage of Al SNF. It describes tests and initial development of models for vapor corrosion degradation of Al SNF materials in pure water vapors. The results and conclusions have been updated in the following report.</p>
<b>Vapor Corrosion of Aluminum Cladding Alloys and Aluminum-Uranium Fuel Materials in Storage Environments</b>	<p>This is a technical report containing part of the bases for safe interim dry storage of Al SNF. It updates the data and models of the corrosion response of Al cladding and Al-based fuel materials to repair/water vapor/radiation environments. Additional testing is in progress to investigate the effects of J-13 water chemistries on cladding and fuel materials and on the melt-dilute forms in air/water vapor/radiation environments.</p>
<b>Plan for Development of Technologies for Direct Disposal of Al SNF</b>	<p>This document contains the Task Technical and Task Quality Assurance Plans for the activities under the Direct/Co-Disposal Technology Development Program. The plan is revised/superseded at least annually to reflect changes in the program.</p>
<b>Task Plan for Development of Dilution Technologies for Al Based SNF</b>	<p>This document contains the Task Technical and Task Quality Assurance Plans for the activities under the Melt-Dilute Technology Development Program. The plan is revised at least annually to reflect changes in the program.</p>

Title	Relationship to SRS ATP
<b>Task Plan for Characterization of DOE AI SNF</b>	This document contains the Task Technical and Task Quality Assurance Plans for the activities under the Characterization Program in FY97. The Characterization Program has been combined with the Test Protocol Development Program in FY98.
<b>Task Plan for Engineering Test Protocol for Metallic Alloy Waste Forms</b>	This document contains the Task Technical and Task Quality Assurance Plans for the activities under the Test Protocol Development Program. The plan is revised at least annually to reflect changes in the program. A revised plan combining the Test Protocol Development Program with the Characterization Program for FY98 has been issued.
<b>Material Issues in Interim Storage &amp; Direct Disposal of AI Clad SNF</b>	This is a technical report preceding the development of the Acceptance Criteria for Interim Dry Storage (WSRC-TR-95-0347) and the ATP. It identified several of the degradation processes that effect AI SNF in storage and disposal environments. The results and conclusions from this report, providing technical bases for storage and disposal, have been updated in the development of the dry storage acceptance criteria and in the testing and analysis activities under the ATP.
<b>Creep Analysis for Materials Test Reactor (MTR) Fuel Assemblies in Dry Storage</b>	This is a technical report providing part of the technical bases for interim dry storage of AI SNF. It describes the analytical model and data input to predict thermally-induced deformation and slump of the MTR fuel design for temperatures up to 250°C and times up to 50 years. The creep model is being improved and range of time/temperature parameters is being extended to allow prediction fuel deformation under short-term repository disposal conditions (pre-environmental intrusion).

### Attachment III

#### DOCUMENTS FROM THE ALTERNATE TECHNOLOGY PROGRAM

The following table provides information regarding the relationship of several technical documents to the Savannah River Site Alternate Technology Program. These documents will be supplied to the NRC during late FY98 and FY99..

<b>Title</b>	<b>Relationship to SRS ATP</b>	<b>Date Available</b>
<b>Evaluation of Codisposal Viability for Al-Clad DOE Owned Spent Fuel: Phase II</b>	This is a technical report to evaluate the reactivity of the direct-disposed Al SNF form in degraded condition in a co-disposal waste package. The purpose was to demonstrate that the 10CFR60 requirements for criticality are met for this disposal configuration. The study considers the use of poisons in the SNF canisters. The study also identifies potential poisons that will be required to meet the criticality requirements.	Sent to Rick Weller on 31 Jul 98
<b>Criticality Evaluation of DOE SNF Codisposal Canister with Melt-Dilute Form</b>	This is a technical report to evaluate the reactivity of the melt-dilute Al SNF form within an intact (non-degraded) DOE SNF co-disposal canister. The purpose was to demonstrate that the 10CFR60 requirements for criticality are met for this disposal configuration. The study has been conducted parametrically to provide guidance with respect enrichment, and fill volume for a selected melt-dilute form composition.	Sent to Rick Weller on 31 Jul 98
<b>Thermal Analysis of Repository Codisposal Waste Package Containing Aluminum SNF</b>	This technical report details the development of the finite element thermal model of the co-disposal waste package. A parametric analysis was conducted considering decay time, bounding and nominal heat source for the various heat transfer modes. The temperature limits predicted by the models were reconciled with the repository disposability interface specification (DIS).	Sent to Rick Weller on 31 Jul 98
<b>Disposability Assessment of Aluminum SNF Forms</b>	This is a summary of the aluminum SNF form assessment. The report shows the conformance of the direct/co-disposal form and the melt-dilute form to the attributes of the Disposability Interface Specification (DIS). It either provides the technical bases for the assessment or provides the appropriate technical reference. It also identifies the DIS attributes for which additional clarification may be required and/or work may have to be performed to show conformance.	9/98
<b>Technical Bases for the Functional Performance Requirements for the Treatment and Storage Facility</b>	This report details the technical bases for the functional performance requirements for the TSF facility. It also serves as a summary/update of the technology development effort since the October '97 status report. The report summarizes the bench scale testing of the off-gas system and the waste stream disposition options.	9/98

<b>Title</b>	<b>Relationship to SRS ATP</b>	<b>Date Available</b>
<b>Preliminary Report on Dissolution Rates of Al SNF</b>	This technical report provides preliminary data on dissolution rate for aluminum SNF. The dissolution rates were measured using a flow through dissolution rate tests. It also discusses the performance of aluminum SNF materials under various test conditions and uses this information to develop a mechanistic understanding of the dissolution rate process for the heterogeneous microstructures typical in aluminum SNF.	10/98
<b>Effect of Ternary Constituents on Melt-Dilute Process and Product Form (October '98)</b>	This report documents the analysis of the effect of ternary constituents present in irradiated SNF. It details the effect the ternary constituents have on the melt-dilute process parameters and also the interaction of these constituents and the resultant compound formation.	10/98
<b>Analysis of Creep Deformation of Aluminum SNF</b>	This technical report details a parametric analysis of creep deformation using the finite element modeling approach for the direct/codisposal configuration. The report considers creep for a range of temperatures, grain sizes for extended storage periods.	8/98
<b>ASTM Standard Guide for Testing of Aluminum Based Spent Nuclear Fuel (Draft)</b>	This draft document has been submitted to the ASTM C26.10 and will be presented to the committee for ballot in late 1998. The document presents the approach to the evaluation of aluminum SNF form performance in repository environments.	9/98

The following documents will be completed in FY99. The scheduled dates of availability of the reports for NRC review are provided.

- Thermal Analysis of Melt/Dilute SNF Form in Codisposal Package(January '99)
- Thermal Analysis of Melt/Dilute SNF Form with Hydrogeological Media Surrounding Waste Package (April '99)
- Preliminary report on corrosion performance of melt-dilute SNF form in interim storage. (August '99)
- Evaluation of Criticality for Melt/Dilute SNF Form: Phase2, Degraded Canister in Waste Package (August '99)
- Aluminum SNF Form Disposability assessment report (October '99)