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

JAN 2 3 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: Alternative Technology Program Overview Document

Provided for your convenience is the overview document of the Alternative Technology Program requested by members of your staff.

Please contact me at (803) 952-2497 or Charlie Anderson of my staff at (803) 557-3828 if you have any questions.

Sincerely,

Charles E. Anderson

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

RSFD:JMR:ddc

UE-98-0075

Enclosure

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

I. Purpose

The purpose of this document is to describe the Department of Energy (DOE) program for the development and selection 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 (Al-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 will be necessary.

Approximately two-thirds of the Al-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.

In 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. The four main elements of the ATP are:

- ***Development of Technologies for Direct/Codisposal of Aluminum Spent Nuclear Fuel*** - In Direct-Codisposal, the SNF would be packaged in a road ready SNF canister. The SNF will be packaged with neutron poisons, when necessary, to satisfy repository criticality requirements. The SNF canister would be placed into waste packages, with high level waste (HLW) glass logs, ready for disposal in a repository..

- ***Development of Dilution Technologies for Aluminum Spent Nuclear Fuel*** - The Melt-Dilute option for treatment of Al SNF consists of melting and diluting the Al-SNF with depleted uranium. The resulting diluted aluminum SNF form would then be packaged in a road ready SNF canister and co-disposed in the waste package with HLW glass logs.

- ***Characterization of DOE Aluminum Spent Nuclear Fuel*** - This program element consists of identifying the characterization requirements, assimilating the existing characterization data and identifying further characterization needs and techniques for both Direct/Codisposal and Melt-Dilute Al SNF forms.

- ***Development of Test Protocol for Metallic Aluminum Alloy Spent Nuclear Fuel Forms*** - This program is developing standardized test methods for the evaluation of performance of an aluminum SNF waste form in a repository. The test methods will be used to qualify Al-SNF forms for repository disposal.

Disposition of the aluminum-based spent nuclear fuel assemblies involves transfer and processing of wet-stored assemblies into an Al-SNF form (direct or melt-diluted) in a sealed, road ready canister. The canisters would 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 must select a technology that ensures the Al-SNF form will meet requirements for both the interim dry storage system and the Mined Geologic Disposal System.

III. Alternative Technology Program Activities:

1) Direct/Codisposal SNF Form Technology Development

The direct/codisposal technology activities include development of methodologies and analyses to support qualification of DOE-owned aluminum-based spent nuclear fuel assemblies for interim dry storage and ultimate repository disposal. The activities in the direct/codisposal technology program are:

- development of interim storage criteria for road ready package;
- development of an instrumented, shielded test canister system for validation of drying and storage criteria for interim dry storage systems;
- thermal analysis of storage and disposal configurations;
- analyses of degradation and radionuclide release rates of Al-SNF in storage environments and application to repository performance assessment;
- criticality analyses of materials configurations;
- materials data input for a total system performance assessment; and
- preparation of technical information base to meet regulations and requirements for repository disposal.

2) Melt Dilute SNF Form Technology Development

The dilution of the U235 in the HEU research reactor Al-SNF is being evaluated as an option to direct/codisposal of Al-SNF. The primary means of achieving the dilution is by the addition of depleted uranium or uranium oxide during a melting process. Benefits accrued from the melt-dilute process include the potential for significant volume reduction, reduced criticality potential, and potential for enhanced SNF form characteristics. The activities in the melt-dilute technology program are:

- definition of waste form composition;
- development of melting process parameters;
- evaluation of casting techniques;
- assessment of process conditions on waste form;
- volume reduction calculations;
- studies on role of ternary elements effects on waste form;
- evaluation of in-process characterization techniques;
- radionuclide discharge analysis for offgas design;
- analyses of degradation and radionuclide release rates of Al-SNF in storage environments and application to repository performance assessment; and
- small scale melting demonstrations.

IV. Alternate SNF Form Technology Selection

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:

6/98 - identify preferred technology for draft EIS
7/98 - start conceptual design
10/98 - issue EIS Record of Decision
4/99 - validate project baseline (technical, cost, schedule)
10/99 - start detailed design

A multi-attribute decision analysis is underway to support the June, 1998 preferred technology selection milestone. Results of the ATP technology program will be used to evaluate the performance of the two candidate SNF forms against each of the decision attributes, e.g. criticality safety, technical maturity, cost. NRC comments regarding technology performance are key inputs to the decision analysis. Comments from the NRC must be received by May, 1998 in order to support the project schedule.

Shortly after the preferred technology is selected, the 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 any other stakeholder will be considered in the writing of the EIS Record of Decision that is scheduled to be issued in the fall of 1998.

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 Al-based SNF. In August, 1997 the DOE and NRC signed a Memorandum of Understanding that describes the NRC agreement to review the activities of the DOE Aluminum SNF Alternate Technology Program and provide comments that will assist DOE in selecting the preferred disposition technology.

The results of the ATP evaluations and analyses have been documented in several reports (See Attachment II). These reports have been provided to the NRC for their review in the context of interim storage and repository disposal requirements. Though other topics may be identified by the NRC in the course of their review, the DOE is particularly interested in NRC comments pertinent to the two candidate SNF forms performance including criticality safety, thermal behavior, dissolution and volatile release rates and characterization. Most of the information needed for the NRC review is contained in four reports:

- "Evaluation of Codisposal Viability for Al-Clad DOE Owned Spent Fuel: Phase 1, Intact Codisposal Canister," (June 1997).
- "Evaluation of Codisposal Viability for DOE Aluminum Clad Spent Fuel: Phase 2 - Degraded Codisposal Waste Package Internal Criticality" (to be issued February 1998)
- "Alternate Aluminum SNF Treatment Technology Development Status Report" (October 1997)
- "Alternate Aluminum SNF Treatment Technology Development Status Report" (April 1997)

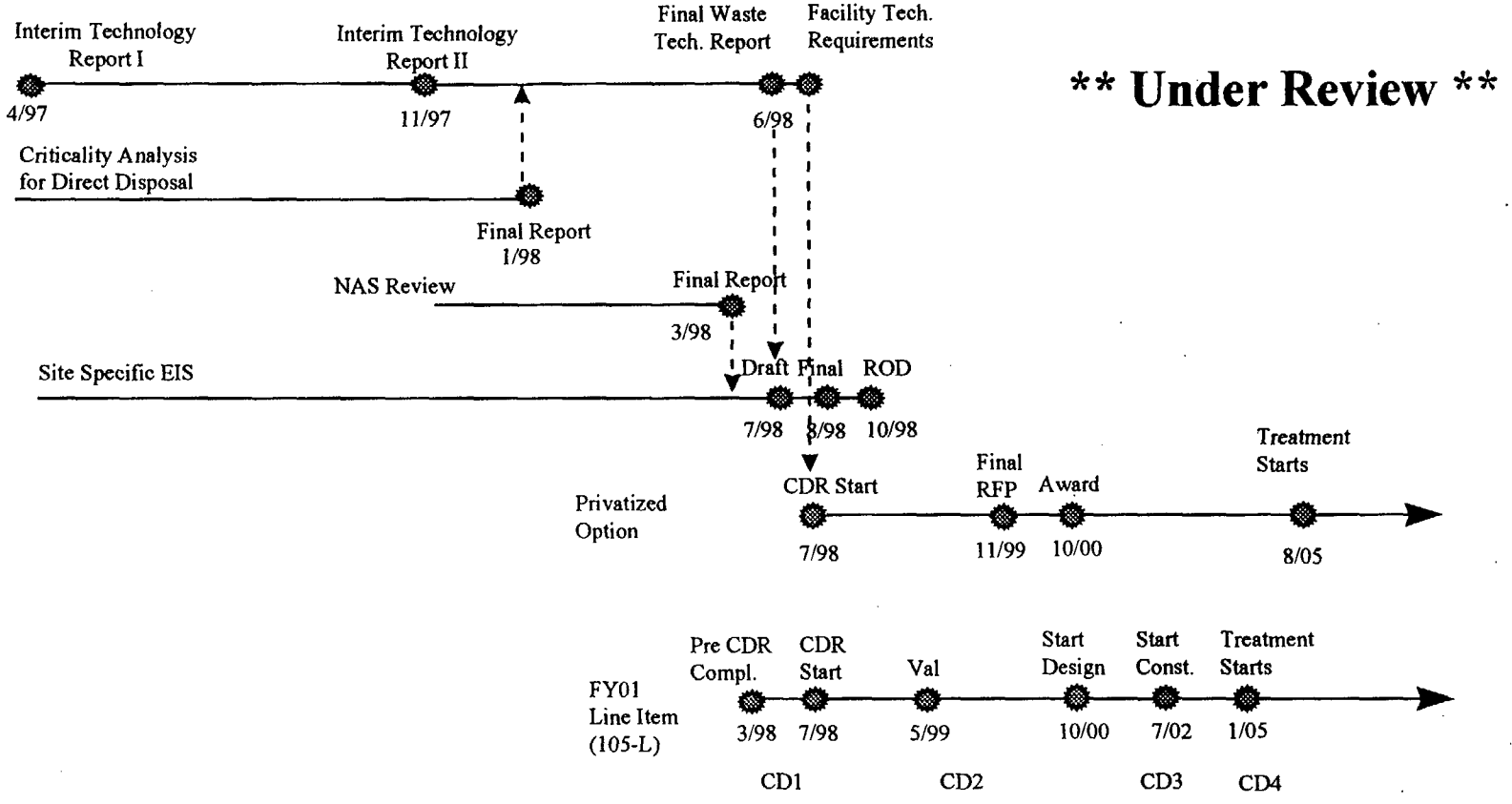
These reports, including reports referenced therein, and the others listed in Attachment II have been or will be provided to the NRC for their review.

VI. Organization

A listing of the DOE and WSRC contacts for the Alternate Technology Program is shown in Attachment III.

Attachment 1

Alternative Technology / Transfer and Storage Schedule



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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 have been provided to the NRC for their use in the review. The last 10 documents will be provided by the end of FY'98.

Title	Relationship to SRS ATP
Evaluation of Codisposal Viability for Al-Clad DOE Owned Spent Fuel: Phase 1, Intact Codisposal Canister	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. 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.
Alternate Aluminum SNF Treatment Technology Development Status Report (WSRC-TR-97-00345, October 1997)	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.
Acceptance Criteria for Interim Dry Storage of Al Alloy Clad SNF	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.
Evaluation of Corrosion of Al-Based Reactor Fuel Cladding Materials During Dry Storage	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.
Vapor Corrosion of Aluminum Cladding Alloys and Aluminum-Uranium Fuel Materials in Storage Environments	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.
Plan for Development of Technologies for Direct Disposal of Al SNF	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.
Task Plan for Development of Dilution Technologies for Al Based SNF	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.

Title	Relationship to SRS ATP
Task Plan for Characterization of DOE Al SNF	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 Protocal Development Program in FY98.
Task Plan for Engineering Test Protocol for Metallic Alloy Waste Forms	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.
Material Issues in Interim Storage & Direct Disposal of Al Clad SNF	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 Al 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.
Creep Analysis for Materials Test Reactor (MTR) Fuel Assemblies in Dry Storage	This is a technical report providing part of the technical bases for interim dry storage of Al 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).

The following documents will be completed in 1998. The scheduled dates of availability of the reports for NRC review are provided. A summary of its relationship to the ATP will be provided as each document is submitted.

- Evaluation of Codisposal Viability for DOE Aluminum Clad Spent Fuel: Phase 2 - Degraded Codisposal Waste Package Internal Criticality (February)
- Evaluation of Criticality for Melt/Dilute Waste Form: Phase 1, Intact Codisposal Canister (March)
- Thermal Analysis of Aluminum Based Spent Fuel in Codisposal Waste Package (May)
- Aluminum Spent Fuel Alternate Technology Assessment (July)
- Technical Basis for Direct/Codisposal and Melt/Dilute Process Requirements (August)
- Characterization Requirements for Disposal of Aluminum Spent Fuel (August)
- ASTM Standard Guide for Testing of Aluminum Based Spent Nuclear Fuel (August)
- Preliminary Evaluation of Melt/Dilute Ternary Constituents (September)
- Preliminary Evaluation of Aluminum Spent Fuel Dissolution (September)
- Aluminum Spent Fuel Corrosion and Radionuclide Release Rate (October)

ATTACHMENT III

Department of Energy

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