LA-UR-

Title:

Applying Modular Concepts to Process and Authorizations Basis Issues for Plutonium Residue Stabilization

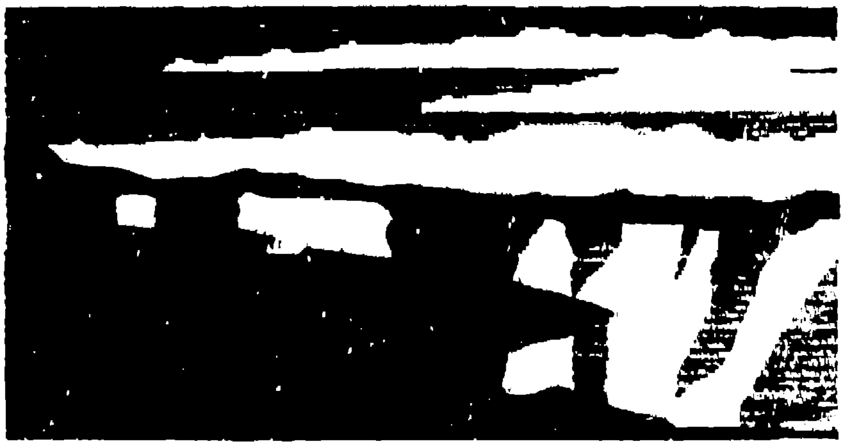
Author(s):

Richard A. Hildner, ESA-DE
Stanley J. Zygmunt, CST-18

RECEIVED
JUL 1 9 1996
OSTI

Submitted to:

American Glovebox Society, Annual Meeting
San Diego, CA
July 22-25, 1996



Los Alamos
NATIONAL LABORATORY

Richard A. Hildner
Engineering Sciences and Applications—Design Engineering
Los Alamos National Laboratory
Los Alamos, NM 87545

Stanley J. Zygmunt
Chemical Science and Technology
Los Alamos National Laboratory
Los Alamos, NM 87545

APPLYING MODULAR CONCEPTS TO PROCESS AND AUTHORIZATION BASIS ISSUES FOR PLUTONIUM RESIDUE STABILIZATION

Abstract: A recent study completed for the Rocky Flats Environmental Technology Site proved that it is feasible to use modular, skid-mounted processes for disposition of Category 1 quantities of nuclear materials. This would allow personnel to assemble, test, and authorize the processes outside of the nuclear material management area. Besides having cost and schedule advantages, this technology reduces the uncertainty and risk in applications involving disposition of materials and facilities. This paper explains the previous research into modular skid-mounted processes and suggests various future applications of the technology.

BACKGROUND

Los Alamos National Laboratory (LANL) has developed a strategy to stabilize legacy residues that can be independent of local facilities. The key element of this strategy is to develop modular processes and authorization bases that are stand alone. Figure 1 depicts the technological aspects of three levels of containment for Category 1 materials and the influencing (and often less technical) elements of the authorization basis. The process and authorization basis interfaces must be carefully documented to precisely dovetail with elements of the host facility that can be operated under the existing site's authorization basis. The "Feasibility Study on the Modular Treatment System for Plutonium Residue Stabilization" (LA-CP-95-296) proved that it was feasible to treat Category 1 quantities of legacy residues with modular systems. The study team was composed of Rocky Flats Environmental Treatment Site (RFETS), Savannah River Site (SRS), and LANL personnel.

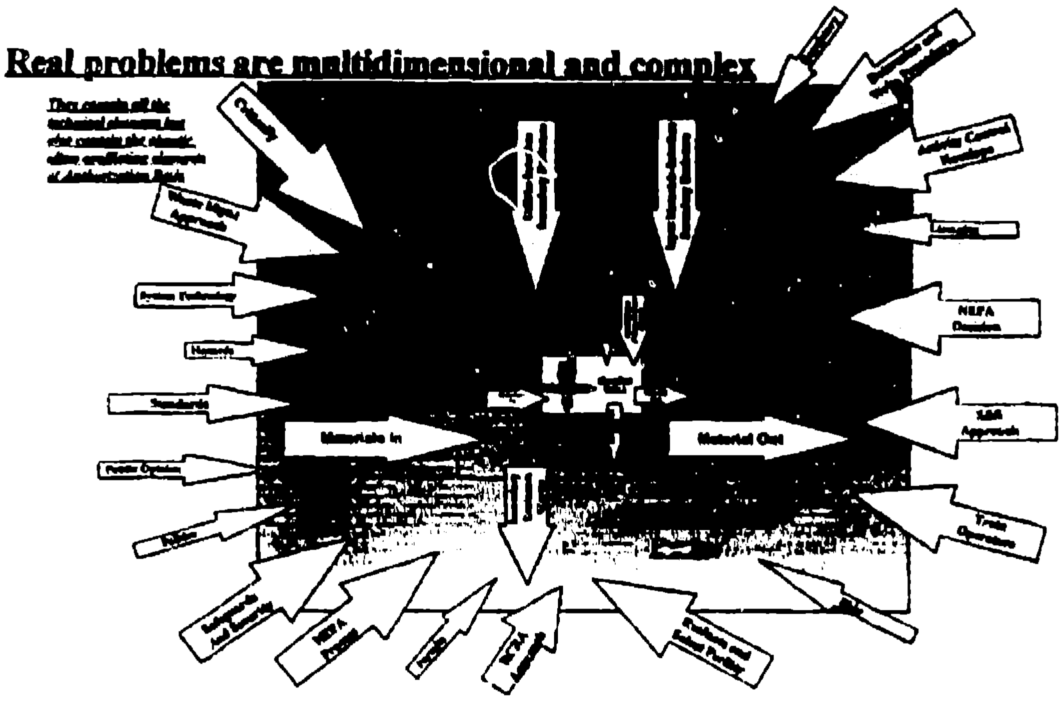


FIGURE 1
TECHNOLOGICAL ASPECTS OF THREE LEVELS OF CONTAINMENT FOR CATEGORY 1 MATERIALS

Decommissioning Category I nuclear facilities such as RFETS is complex. The regulatory environment requires that materials be removed below Category I levels, but the regulation environment and stabilization and decommissioning requirements conflict. As a result, materials can not be disposed of. The site lacks suitable staging areas because potential locations are being used to store legacy materials. Total resumption of facilities scheduled for decommissioning and disposal is not economical.

Previous storage standards were less specific as to stabilization and types of materials that could be packaged together. Legacy residues are stored with other materials in 55-gal. drums. Many of the containers have ruptured due to aging and chemical and radiological effects. Figures 2a and 2b show two examples of failed packages of legacy residues. Processing technologies must identify the broken internal packages before the drums are opened for sorting.

FIGURE 2a
FAILED PACKAGE OF LEGACY RESIDUES

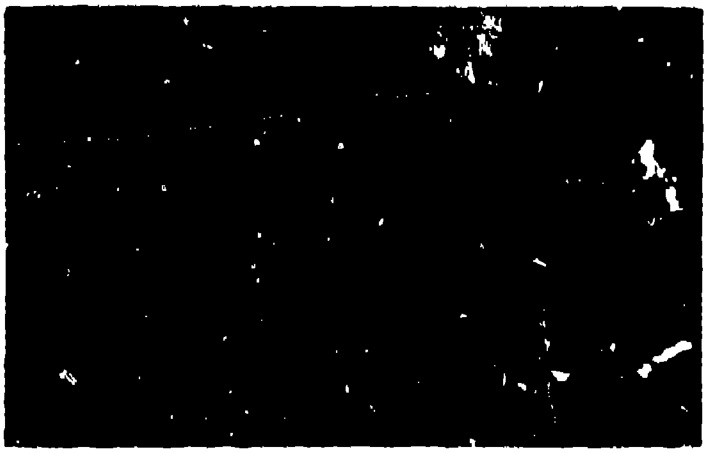


FIGURE 2b
FAILED PACKAGE OF LEGACY RESIDUES

At RFETS, stabilization of legacy residues and facility decommissioning are supposed to occur approximately at the same time. There exists an enormous potential for programmatic gridlock. The technologies that are currently used to stabilize process residues may not be satisfactory for stabilizing legacy residues. Conflict exists between facility resumption and facility removal. In addition, there is the inherent inflexibility of contracting procedures and performance-based incentives to schedule milestones. These technological, legal, regulatory, and economic dimensions are causing the baseline design to move forward using some very optimistic assumptions that include packaging for interim storage standards, shipping to WIPP, and not recovering any plutonium.

Industry uses temporary, flexible, portable, or modular processing systems due to economics. LANL has built transportable, temporary facilities for our customers. Figures 3a and 3b show a portable incinerator developed by the Laboratory to burn excess flares and smokes for the Navy.

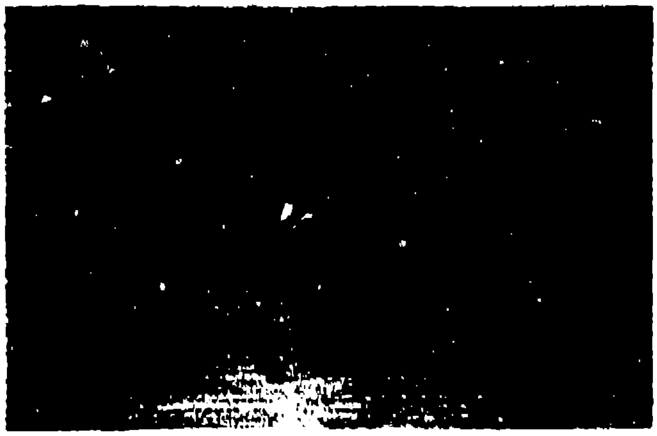


FIGURE 3a
A PORTABLE INCINERATOR DEVELOPED BY LANL (IN TRANSPORT)

FIGURE 3b
A PORTABLE INCINERATOR DEVELOPED BY LANL

The Laboratory has also built portable equipment to measure and process various radioactive materials. Figure 4 shows a portable skid used to stabilize uranium chips. Figures 5a and 5b show a stand-alone module of the glovebox process in a skid and a stand-alone module of the glovebox process in a transportainer, respectively.

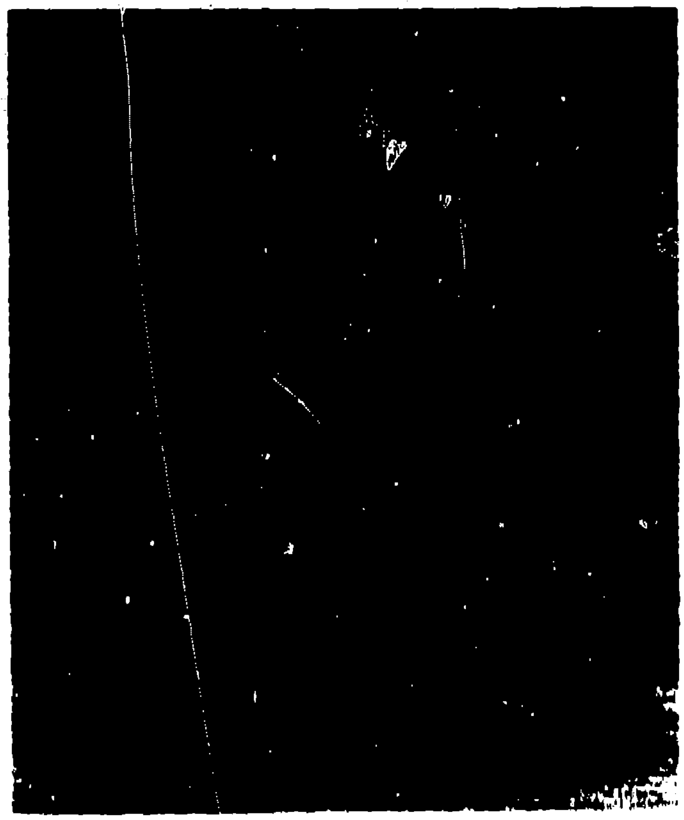
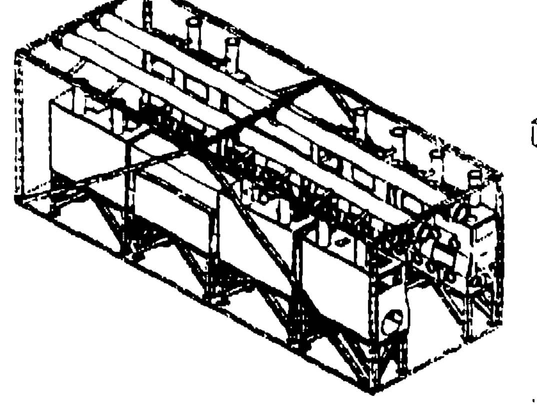


FIGURE 4
A PORTABLE SKID USED TO STABILIZE URANIUM CHIPS



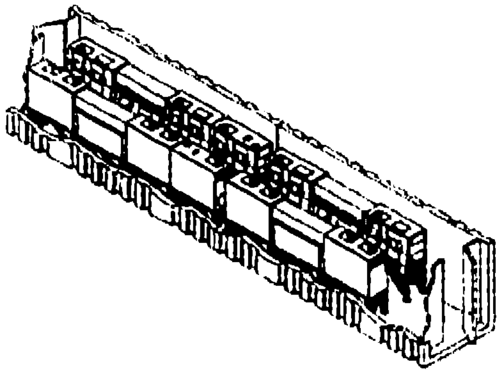


FIGURE 5a **FIGURE 5b**

STAND-ALONE MODULES OF THE GLOVEBOX PROCESS IN AND SKID (FIG. 5a) AND IN A TRANSPORTAINER (FIG. 5b)

The following paper describes the process the team followed to compare solutions to the residue storage and treatment problem at RFETS. By defining the problem and looking at several solutions, the team was able to make a recommendation that met all regulations and requirements. The modular concept was proven feasible.

INITIAL INVITATION TO STUDY THE PROBLEM

At the request of the Department of Energy/Transition and Management (DOE/EM-60), personnel from RFETS, SRS, and LANL studied the feasibility of using modular systems to stabilize plutonium residues. The study determined that modular systems were technically feasible, can meet the rules and requirements for facilities handling plutonium residues, and have a cost benefit over approaches currently planned.

Preconceptual designs for modular systems developed in the study were based on residues at RFETS and treatment schedules competitive with those planned at RFETS. This approach ensured that the modular systems were realistically sized.

Recommendations were made to apply the modular concept at RFETS, and to consider the use of select modular units that perform specific functions at other DOE sites.

THE PROBLEM

Five sites in the DOE complex have significant amounts of plutonium residues. These residues are comprised of multiple chemical and physical forms that were left in the plutonium manufacturing systems when the production of nuclear weapons was halted. Some of the residues are in chemical forms that are not safe for long-term storage or disposal.

The DOE has initiated a program for the stabilization of the above materials, however, the existing facilities, infrastructure, and technical capacity are inadequate for the task. There is insufficient funding to bring all of the facilities up to current standards to treat plutonium residues. Indeed, most of the facilities needed for the task are destined for decommissioning at the end of the program, and therefore, investment in upgrading existing buildings or constructing new buildings is discouraged.

PURPOSE OF THE STUDY

The purpose of the study was to determine the feasibility of using modular treatment systems for actinide residue stabilization. Determining feasibility means documenting that the modular approach can meet technical design requirements; meet the rules and regulations governing operation of facilities handling plutonium; and that there is a cost, schedule, or risk advantage that justifies the modular approach over other alternatives.

THE MODULAR CONCEPT

A modular system is a system that is broken into functional units (modules) that are individually packaged. Connections between modules making up a modular system are standardized so that modules can be reorganized or replaced with modules having other functions to accommodate changing needs with minimum changes to the system. Ideally, modules are small enough to be portable, and thus the entire system is portable.

In its most extreme form, the modular concept provides a stand-alone and fully authorized capability that can receive a drum of residue, stabilize the contents, and package the product and byproduct waste so that it is certified for long-term storage or final disposition. Changes in processing goals for a given residue, or processing of a different residue, are addressed by adding or changing select process modules rather than reconfiguring the entire process line.

The feasibility study considered options for applying the modular concept ranging from packaging the equipment in transportation containers that, when delivered to the site, serve as the operating facility, to modularizing the individual gloveboxes for installation in an existing facility.

Advantages

Advantages of the modular concept are

- minimization or elimination of construction in a radioactive materials management area, lower fabrication cost, and reduced installation schedules;
- flexibility in changing the treatment process or treating different materials with minimal impact on the overall system;
- ability to cold test and train on the system outside a radioactive materials management area;
- ability to use portions of the modular system to handle other materials solving different problems;
- portability and the ability to reuse modular systems at different sites, and
- ability for part or all of the authorization basis to move with the modular system.

APPROACH

The feasibility study was conducted by a Feasibility Team and a Design Team. The Feasibility Team was composed of representatives from RFETS, SRS, and LANL, and included consultants with expertise complementary to the study. The Design Team was composed of engineering and cost-estimating experts from LANL.

The overall approach used to develop the plan is the approach used in the classical solution of any engineering problem:

- define the problem;
- determine what is given to work with;
- determine a basis for solution; and
- solve the problem.

Defining the Problem

The problem is to determine if the modular concept is feasible and that there is a cost, schedule, or risk benefit compared to other options. To be able to compare the modular concepts developed in the study with the current plans, the modular concepts had to be developed around real residues using an appropriate treatment process and completing the treatment in a competitive time.

The feasibility study was based on salt and ash residues at RFETS. The Feasibility Team visited RFETS and gathered information on the salt and ash residue and on treatment plans and schedules. The information on the residues was documented as residue profile sheets and the planned activities for treatment are documented as fact sheets.

Determining What is Given

The givens included all of the conditions and rules that bound the possible solutions or that have an impact on the decision making. Thirty-four fact sheets were prepared that documented requirements and conditions which had an impact on the study. Each member of the Feasibility Team provided quality reviews of the fact sheets generated by the team so that everyone on the team had a common information base on which to make decisions.

Determining a Basis

The Feasibility Team prepared a basis document using the residue profiles and fact sheets that had an impact on the size or configuration of the modular system. The basis document required the Design Team to develop a modular concept—as stand alone as possible—that relies on a selected site for minimum support.

Solving the Problem

The Design Team prepared a preconceptual design and a cost and schedule estimate for a stand-alone modular system to treat the residues at rates, and within constraints, identified in the basis document. The stand-alone system is called the base case.

In addition to the base case, the Feasibility Team identified and rated eight different approaches for using the modular concept. The two top-rated options were defined and assigned to the Design Team for a preconceptual design and a cost and schedule estimate so that the options could be compared with the base case.

Issues that must be resolved for the modular concept to be successfully implemented and options for resolution of those issues were identified and are documented in the report.

The Feasibility Team compared cost, schedule, and risk for the modular options against the planned residue treatment activities at RFETS. Based on the analysis, the Feasibility Team recommends an approach for applying the modular concept and recommends implementation steps—immediate activities—needed to implement the modular concept.

OPTIONS COMPARED

The study methodology resulted in three modular options being compared against current plans for residue stabilization at RFETS. Option numbers used here are consistent with the option titles and identification numbers used in the report.

Base Case: The Stand-Alone System

In the base case, all equipment is mounted in trailers or Department of Transportation (DOT) Type A containers (transportainers), which are used to move the equipment. When located and interconnected, the containers provide the operating space.

The base case is a complete nuclear facility that is mobile. The stand-alone modular system is capable of receiving a drum of residue and

- externally assaying the unopened drum;
- safely venting the drum;
- opening and sorting the contents;
- assaying the drum contents;
- preparing the residue for treatment;
- treating the residue;
- repackaging the treated residue in welded cans;
- assaying and documenting the treated product;
- assaying, repackaging, and certifying the byproduct waste generated; and
- maintaining special nuclear material accountability.

The HEPA-filtered ventilation system, backup power, safety systems, change rooms, and support offices are provided as modules.

External assay equipment is mounted in trailers. The remainder of the equipment is mounted in DOT Type A transportainers that are roughly 12 ft wide by 12 ft high by 30-40 ft long. Approximately 50 modules are needed for the base case, requiring a plot plan space of 240 ft by 200 ft.

(9)

Option #1: the Modular System in a New Building Shell

The modules in the base case handling significant quantities of plutonium are located inside a thick-walled building, enhancing the ability of the system to meet safeguard and security requirements. Utility and support modules are located outside the building.

The building floor space is roughly 11,000 ft^2. Thick concrete walls, floors, and ceilings provide intruder deterrent. The ventilation, lighting, and general utilities for the building are minimal. The HEPA-filtered ventilation system, backup power, and safety systems are provided by modules located outside of the building.

Option #6: Standardized Gloveboxes Installed in an Existing Building.

The external assay equipment is trailer-mounted and operated outside an existing building. The remaining equipment used to unpack, assay, process, repackage, and reassay the residue is mounted in standard gloveboxes located inside an existing building. Support space, personnel support, and utilities are provided as existing components of the building.

Gloveboxes are "racked" or "skid-mounted" according to functional groups. Individual gloveboxes are assembled on a supporting frame at the fabrication shop and moved whole into the operating area. Standard connections allow the gloveboxes and skids to be rearranged for different purposes.

Based on the worst case, salt oxidation followed by salt distillation, the gloveboxes need 5600 ft^2 of floor space. The cost estimates for this option are based on using cell D or E (referred to as building modules at RFETS) in Building 707 at RFETS. The size of either cell meets the floor space requirements.

Planned Salt Oxidation at RFETS

Based on information gathered in July 1995, RFETS planned to modify and add to existing glovebox lines in Building 779 for oxidation of pyrochemical salts. Planned processing of pyrochemical salts did not include external assay or drum venting included in the modular options and relied on existing assay equipment at the site.

The Feasibility Team understands that RFETS has discontinued plans to oxidize salts at Building 779 and is now considering using Building 707 for residue stabilization. This is consistent with the recommendations resulting from this study. However, the work done around Building 779 offered the most complete information for the basic approach, modifying existing gloveboxes in existing buildings, against which the modular concept could be compared.

ANALYSIS ON THE NEED FOR MOBILITY

With the size and complexity of the modular system defined by the preconceptual design, the Feasibility Team evaluated the need for the complete system to be mobile. Sites storing residues were contacted and information was gathered on the ability of the sites to handle on-site residues with existing equipment.

Recognizing that a major portion of the total residue inventory is at RFETS, and that the remaining sites have most of the equipment needed in place, a complete mobile system is not needed. But duplicate modular systems that provide specific functions, such as unpacking, assay, and repackaging, have potential for use at other sites.

COST COMPARISON

The costs of the four options were compared. The costs presented here are the total of the total estimated cost (TEC) and other project cost (OPC), which combined are the cost of taking a project from conception to the start of operation.

For planned stabilization activities, the cost comparison assumes that each time an existing glovebox line in an existing building is modified to process residues, the magnitude of the cost will be the same. The strength of a modular system is that the system can be changed to do different work with relatively small incremental costs. The cost comparison therefore looks at the options in terms of treating pyrochemical salts, ash, combustibles, and odds and ends. Odds and ends are unique problems that will surface as RFETS is remediated. The incremental cost and cumulative cost are shown in the comparison.

Base Case

The cost of the base case is compared as the total cost for the salt oxidation system with the additional treatments (e.g., salt distillation, ash stabilization) shown as the differential cost for adding or replacing process modules.

Option #1

The cost of this option is the same as the base case with a one time cost of $9M for the building shell.

Option #6

The cost is presented in the same manner as for the base case and includes an estimate for modifications to Building 707 at RFETS. The cost of modifications to Building 707 are based on information provided by RFETS and an inspection of the building by the Design Team cost estimators.

Planned Residue Treatment in Building 779

The TEC for salt oxidation is based on a 90% conceptual design report for modification and addition of equipment to Building 779 at RFETS. The OPC was provided by estimators at RFETS. An additional cost has been estimated for the restart of Building 779 based on information provided by RFETS. The total comes to about $47M. Details on this estimate are in the report. The following table (Table 1) compares the costs of the different options and treatments.

TABLE 1
COMPARED COSTS

Treatment	Planned		Base Case		Option #1		Option #6	
	ΔSM	Cum. SM	ΔSM	Cum. SM	ΔSM	Cum. SM	ΔSM	Cum. SM
Salt Oxidation	47	47	79	79	88	88	61.5	61.5
Salt Oxidation and Distillation	not planned		9.5	88.5	9.5	97.5	10.5	72
Ash Stabilization	47	94	5	93.5	5	102.5	4.5	76.5
Combustibles	47	141	7	100.5	7	109.5	6	82.5
Odd & Ends	47	188	5	105.5	5	114.5	4	86.5

Direct comparison of the cost of the modular options to the planned activities is difficult because

- the modular options include equipment that provide functions not included in the TEC for the planned activities in Building 779, such as external assay and drum venting;
- the planned treatment activities rely on support functions located outside of Building 779, the cost of which is not included; and
- the OPC budget for the modular options is significantly more generous then the budget for the planned activities.

The base case incurs an operational cost penalty. Additional guards in secure firing positions are needed to meet safeguards and security requirements for intruder delay. The annual operating cost for the additional guards is estimated as $1.5M per year.

Operating costs are considered equivalent for all options, except the base case, assuming that all options provide the same functions and process the residues over the same time.

Findings

The modular options become more economically appealing as more treatment processes are used.

There is $25-$30M driver to install modular systems in Building 707 over the base case. Option #1 incurs a $9M penalty that provides little long-term value unless the building has a practical use after the residues are treated.

Fundamentally, there is a cost advantage to minimizing the fabrication, assembly, and test work performed inside a radioactive materials management area. Option #6 provides this advantage.

SCHEDULE COMPARISON

The modular options can be fielded, ready for operational testing in three years, and operational on residues within four years. The schedule for modular options does not take advantage of opportunities to condense the schedule because the validity of opportunities to reduce the schedule must be determined based on site-specific conditions and agreements.

The planned activity for pyrochemical salt oxidation at RFETS scheduled treatment to be completed in 1997. But treatment in Building 779 has been canceled and new plans for salt oxidation at Building 707 are in the works. There is high probability that oxidation of salts can not be completed in the original time frame, which is driven by DNFSB 94-1.

In today's world, schedules are driven by the NEPA process and authorization basis requirements, the time requirements for which are similar for all the options. The implementation plan in this report includes assignments to identify and document opportunities to compress the schedule for the recommended option.

COMPARISON OF RISK

The Feasibility Team found that there are no high-risk elements that preclude any of the options from achieving an acceptable authorization basis. There is no significant risk advantage for any of the options at this stage of design.

RECOMMENDATIONS

Based on this study, the Feasibility Team recommended the following:

- apply the modular concept at RFETS using Option #6, rack- or skid-mounted standard gloveboxes installed in Building 707 at RFETS;
- optimize the use of modular components to make the best use of equipmen, and best use of available space in Building 707. Consider parallel treatment of more than one residue; and
- offer duplicate functions of the modular system to the other sites.

CONCLUSIONS

The feasibility study showed that modular systems, ranging from stand-alone systems to skid-mounted equipment installed in an existing building can meet the rules, regulations, and requirements for handling significant quantities of special nuclear material, and that modular systems can have cost and schedule advantages over traditional approaches to handling special nuclear material.

The following are advantages of modular treatment systems:

- minimization or elimination of construction in a radioactive material management area, which lowers the fabrication cost and reduces the installation schedule;
- flexibility in changing the treatment process or treating different materials with minimal impact on the overall system;
- ability to cold test and train on the system outside a radioactive material management area;
- ability to use portions of the modular system to handle other materials, thus solving different problems;
- portability and the ability to reuse modular system equipment at different sites;
- ability to solve the problems of handling special nuclear material without new buildings or restarting aging facilities; and
- ability for part or all of the authorization basis to move with the modular system.

While the feasibility study was directed at actinide residues, results show that modular systems can handle special nuclear material problems ranging from waste processing to handling actinide metals.