

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

October 22, 1996

MEMORANDUM: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: H. W. Massie, Jr.

SUBJECT: Review of Residue Processing Title I and II Design at Rocky Flats Environmental Technology Site, October 7-9, 1996

1. Purpose

This report documents the Defense Nuclear Facilities Safety Board (Board) staff review of the Title I and II design for residue processing systems at the Rocky Flats Environmental Technology Site (RFETS). This review was conducted by H. W. Massie, W. G. Von Holle, L. M. Zull, M. T. Sautman, and J. Leary (outside expert) on October 7-9, 1996. The staff also reviewed the preliminary hazards assessments for residue processing.

2. Summary

As a result of the review, the Board staff noted the following:

- The schedule for chemical processing (aqueous washing/drying) of wet combustible residues remains uncertain, dependent on obtaining Nuclear Regulatory Commission (NRC) approval for yet-to-be-proposed increased wattage limits needed for final drum shipments. Also, final demonstrations of the aqueous washing and drying techniques have not been conducted with plutonium-bearing materials. Extensive work by RFETS is required in this area.
- The Title II design for ash and salt processing in Building 707 is complete. The Title II design for wet combustible processing in Building 371 is 70 percent complete. Since about \$30 million in capital expenditures and committed purchase orders has been made, any project redirection by the Department of Energy (DOE) may delay schedule commitments contained in the 94-1 Implementation Plan.
- The schedule for ash (high-risk slag, sand, and crucible [SS&C]) residue processing remains uncertain based on inconclusive results obtained in the ash treatability study, which used a 500-C calcination temperature. Additional testing by RFETS including use of higher calcination temperatures and a more prototypical furnace is required to confirm stabilization feasibility.
- The material-at-risk for Modules A through H of Building 707 needs to be increased to allow for residue processing. An Unreviewed Safety Question Determination process is under way.

3. Background

Board Recommendation 94-1, Subrecommendation 5, requires "that preparations be expedited to process the containers of possibly unstable residues at Rocky Flats Plant and to convert constituent plutonium to a form suitable for safe interim storage [within 3 years]." In its original Implementation Plan for 94-1, DOE committed to processing higher-risk residues within 3 years, except for the higher-risk combustible residues, which are to be processed within 4 1/2 years.

The start of residue processing has been delayed by a change in operating contractors at RFETS in mid-1995. Apparently, some preparations for residue processing were suspended while the new contractor filled key staff positions and reassessed commitments and priorities. The impact of these delays on the original schedule was provided to the Board in an August 19, 1996, letter from the Secretary of Energy. This letter proposes an amendment to the Implementation Plan that would delay the completion dates for processing of high-risk salts by 6 months and for processing of ash materials by 1 year. Schedule commitments for processing of high-risk combustibles would not change, but the proposed method of processing would now be washing and drying, rather than incineration or wet oxidation. These new schedules are referred to as the baseline at RFETS. The commitment to stabilize all residues by May 2002 would not be affected.

The baseline plans provided in the August 19, 1996, letter include the following treatment methods for high-risk residues:

- Shredding and aqueous washing and drying of wet combustibles (nitrated residues) and low-temperature thermal desorption for organic wet combustibles, both methods taking place in Building 371
- High-temperature calcination of incinerator ash residues in Module E of Building 707
- Pyrochemical oxidation of salt residues in Module A of Building 707

Residue drums (incoming and outgoing) would be staged in Module F of Building 707.

4. Discussion/Observations

The staff reviewed the residue processing systems design for the wet combustibles, ash (including SS&C), and salts. The staff believe that the wet combustibles are one of the highest-risk residues remaining at RFETS. For each residue system, the staff reviewed the process design, flow diagrams, hardware design and procurement status, construction status, generation of secondary waste, waste management, radiation program for maintaining doses as low as reasonably achievable (ALARA), process hazards, vital safety system needs, design review plans, and potential impact on Building 707 material-at-risk. The residue material-at-risk for Building 371 was stated to be within the current authorization basis for Building 371. The review documented

in the present report is an initial review leading toward staff review of several readiness assessments for residue treatments planned by RFETS in late 1997.

The Title II design for processing of ash and salt is complete. The Title II design for processing of wet combustibles is about 70 percent complete. About \$30 million in capital expenditures and committed purchase orders has been made for the Residue Elimination Project, which is a Congressional budget line item.

Wet Combustible Residues. The process design for treatment of wet combustibles entails material shredding and aqueous washing/drying with an absorbent for nitrated combustibles. For organic-based combustibles, low-temperature thermal desorption (i.e., evaporation), following by steam oxidation for drying, is used. The product form consists of a confetti-like material of shredded residue and absorbent stored in plastic bags (double-wrapped), which is placed in 12 inch diameter metal canisters with a taped lid. Two such canisters are placed in 12 inch robust pipe components that are then placed in a 55 gallon drum for interim storage and shipment to the Waste Isolation Pilot Project (WIPP). A major concern is the large number of waste drums (approximately 15,000) created in the process in order to meet WIPP Transuranic Package Transportation II (TRUPAC II) wattage limits (limits on gas generation) for shipment. However, the Safe Sites of Colorado (SSOC) project manager for combustibles has conducted tests that may justify an increase in the drum wattage limits. RFETS must obtain NRC approval for increasing the wattage limits listed in the TRUPAC II safety analysis report.

It is not yet known whether drum reduction could be large enough to make the washing and drying treatment method comparable to other treatment options evaluated in the trade study. However, all high-risk combustibles can be treated by the baseline process defined in the recently approved Environmental Assessment. The RFETS process treatment technologies have not yet been fully demonstrated for plutonium residues, but are under testing at Los Alamos National Laboratory (LANL). The proposed processes are simple and should become workable in time. Major redirection of the wet combustibles project by the DOE Rocky Flats Field Office (RFFO) will likely result in significant schedule delays. SSOC stated that the wet combustibles project is on schedule, with construction expected to start in January 1997, and to be completed in July 1997. The schedule uncertainties associated with completion of LANL tests using the baseline technologies and the need to obtain NRC approval of wattage limits will determine whether the 94-1 Implementation Plan commitments for wet combustibles can be met.

Processing of ion-exchange resins, one of the highest-risk residues at RFETS, is under way. Of 22 drums of resins, 20 have been repackaged (for processing) into about 180 4 liter bottles. About 10 percent of these bottles have now been stabilized by cementation (along with low-level plutonium-bearing solutions from Building 771) in Building 774. Also, all drums of leaded glove- box gloves have been stabilized by simple washing, eliminating a potential explosive hazard to workers.

Ash Residues. Calcination is the baseline technology to be used for stabilization of the 28,000 kg of ash-like residues at Rocky Flats. Stabilization of the ash residues, which

consist primarily of SS&C and graphite fines from previous plutonium production operations, is scheduled to begin by September 1997, and to be completed by May 2002. The ash residues will be stabilized in six furnaces, to be installed in gloveboxes in Building 707, Module E. Design work to modify the gloveboxes to receive, unpack, sort, calcine, and repackage the residues has been completed, with major construction work scheduled from November 1996 to May 1997. The furnaces and most other new equipment are commercially available in-stock items.

The ash residues are planned to be stabilized by heating at 500°C for 1 hour in resistance-type furnaces in the gloveboxes. This heating, or calcination, is intended to stabilize the residues by eliminating pyrophoric plutonium and unoxidized reactive metals, such as calcium and magnesium. However, a treatability study of eight ash residue samples performed to evaluate the process recommended additional testing and further refinement of the process parameters. The project team stated that additional test runs were planned, but the staff found that there was no formal test plan for the additional testing, and there were no specific post-calcination requirements for reactivity or volatile organic compounds. The staff were later told that the project team would work with LANL to define additional testing necessary to determine the final process parameters.

It is not clear that the ash residues can be adequately treated by heating to a temperature of 500°C for 1 hour. A higher calcination temperature, a longer soak time, or mechanical mixing during heating may be required to stabilize the material adequately. Also, the treatability study runs were conducted in an induction furnace, whereas the production runs will use a resistance furnace. Calcination results may differ with different types of furnaces.

The off-gas from the calcination furnaces will be treated in a dry off-gas system containing a sintered ceramic filter and carbon canister. The off-gas system will be located in the same glove-box as the furnace and will vent to the glovebox exhaust ventilation system. The staff were told that the dry off-gas system can treat off-gas up to a 700°C calcination temperature; above this temperature, a wet off-gas system would be required to remove other materials that would be volatilized at higher calcination temperatures. However, the specific basis for the 700°C limit was not discussed. A wet off-gas system would generate liquid radwaste. If the planned additional test runs show that a calcination temperature above 700°C is required, the need for a wet off-gas system would likely increase the project's cost and delay the scheduled start of residue processing.

Finally, with regard to operations and training, detailed procedures for processing of ash residue materials have not been written, nor have operators been selected or operator training developed.

Salt Residues. The salt residue processing project is well under way. The Title II design is complete, and construction is under way and expected to be complete in April 1997. All major equipment, including 10 furnaces and nondestructive assay (NDA) equipment, is on order. Startup of salt processing is planned for August 1997 and represents a contract performance measure for Kaiser-Hill and SSOC. The activity

control envelope, which identifies process hazards to workers, safety risks to the public, and proposed controls, is complete. RFETS will have to amend the Building 707 authorization basis to initiate operations.

The final product form will be an oxidized salt residue stored in an 8802 (2 liter) can with a taped lid, bagged out of the glovebox, with another plastic bag-out after NDA is performed. SSOC stated that this package goes directly into a 55 gallon drum. Although they do not have a container that meets the residue interim storage criteria at this time, work is continuing on an acceptable design.

The critical issues for startup of salt processing are availability of trained process operators, process criticality limits, ALARA considerations for molten salt extraction salts, and completion of all authorization basis work. The new safeguard termination limits (STLs) recently issued by the DOE Office of Safeguards and Security represent a potential concern for meeting 94-1 commitments related to salt processing, if salt oxidation activities are delayed by RFETS. For salts, the STL is 0.2 percent by weight plutonium, meaning that only salts containing less plutonium than this can be disposed of without plutonium separation or placement of the salts into a less desirable form for plutonium recovery. The low STL reflects the relative ease of plutonium recovery and protects against proliferation concerns. Only 6 percent of the high-risk salt residues currently meet the 0.2 percent STL.

Salt distillation, a separation method developed by LANL for electrorefining and molten salt extraction salts, could be used by RFETS to meet the STL by separating out the plutonium metal, which could then be stored with other plutonium metal and oxides. The remaining waste materials can meet the STL for shipment to WIPP. The current baseline does not include salt distillation.

Building 707 Walkdown. The staff toured Building 707 modules, including Module A (for salt processing), Module D (for repacking of classified shapes), Module E (for ash processing), and Module F (for residue staging). The staff also inspected the shipping and receiving dock. Module A was undergoing significant construction activity, including removal of old gloveboxes and preparation for installing a clean glovebox from Building 779. In general, the work in the other gloveboxes was limited to removal of materials and old equipment from inside gloveboxes that are to be used for residue treatment. The gloveboxes were in good condition and were not corroded, probably because aqueous processing operations had not been performed in Building 707. The modules are spacious, with ample room for workers between gloveboxes. Significant construction is planned to start in November 1996 for salt and ash residues. Modifications planned include completion of backlog work orders for maintenance on vital safety systems, addition of seismic supports on glovebox foundations, and installation of salt and ash furnaces.

Hazard and Safety Analysis. The Board staff conducted a preliminary review of hazard analyses for residue processing of salt, ash, and wet combustibles, including the material-at-risk limits for Building 707, process hazards, fire hazards, ALARA design, and nuclear safety analyses. Within the Building 707 overall material-at-risk, RFETS has defined a smaller material-at-risk for Modules A through H, which have relatively

lower seismic resistance. This smaller material-at-risk needs to be increased to allow residue processing in Modules A, D, E, and F of Building 707. RFETS has initiated an Unreviewed Safety Question Determination to increase the material-at-risk for residue processing. Preliminary indications are that the level of risk to the public will not be significantly increased, but the staff will review this area.

For the fire hazards analysis, the worst-case scenario was reported to be an oil fire in Module E caused by oil contained in existing electron beam welders, which will be left in the module although no longer needed because they are too big and expensive to remove. The staff requested that DOE RFFO consider removal of the oil to eliminate this accident scenario. For Module D, the worst case is a residue wood crate fire. For Module F, the worst case is a fire in a drum that is on the shipping dock. For fires postulated within gloveboxes, gloves are breeched and glovebox filters become plugged, but no propagation of fire to other gloveboxes is anticipated. The staff will also review this area.

Vital safety systems were identified for the process hazard evaluation for each of the residue processing projects (ash, salt, and wet combustibles). The vital safety systems for each project are presented in [Attachment A](#) to this report. The Board staff will plan detailed reviews of the safety analyses, process hazard evaluations, and authorization bases consistent with Board Recommendation 95-2.

The Nuclear Materials Stabilization Task Group (EM-66) has completed several important trade studies of options for treating RFETS residues. These studies have provided some valuable insights into this difficult problem, but incorporation of the results of the studies into residue stabilization plans may significantly impact schedule commitments provided in the August 19, 1996, letter. For example, construction for the salt processing project started in September 1996, with completion planned for April 1997. DOE RFFO plans to use the results of the trade studies to rebaseline (e.g., distillation of salt residues) the Residue Elimination Project, which will result in significant uncertainty with regard to meeting Implementation Plan commitments.

5. Future Staff Actions

The Board staff will continue to follow closely the RFETS residue processing design, construction, and readiness preparations in accordance with Recommendation 95-2, *Safety Management*. The staff will also follow and review any proposed rebaselining by DOE RFFO as compared with Recommendation 94-1 requirements.

ATTACHMENT A

PRELIMINARY LIST OF VITAL SAFETY SYSTEMS FOR RESIDUE PROCESSING AT RFETS

Wet Combustible Processing System (Building 371)

- Zone I/II Ventilation
- Exhaust High Efficiency Particulate Air (HEPA) Filtration
- Criticality Detector and Alarms
- Life Safety and Disaster Warning
- Emergency Lighting
- Fire Protection
- Selective Alpha Air Monitoring Alarms

Ash Processing System (Module E of Building 707)

- Gloveboxes
- Zone 1 Heating, Ventilation and Air Conditioning (HVAC)
- Fire Protection

Salts Processing System (Module A of Building 707)

- Zone I/II Ventilation
- Exhaust HEPA Filtration
- Criticality Detection and Alarms
- Life Safety and Disaster Warning System
- Emergency Power
- Fire Protection
- Glovebox Inerting System
- Other Safety Features (Selective Alpha Air Monitoring Alarm, Emergency Lighting, Fail- Safe Process Equipment, Seismic Supports on Gloveboxes)