

CONF-980521--

First Commercial U.S. Mixed Waste Vitrification Facility: Permits, Readiness Reviews, and Delisting of Final Wasteform

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DOE Contract No. DE-AC09-96SR18500

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WSRC-MS-98-00314

**FIRST COMMERCIAL U.S. MIXED WASTE VITRIFICATION FACILITY:
PERMITS, READINESS REVIEWS, & DELISTING of FINAL WASTEFORM**

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ABSTRACT

Westinghouse Savannah River Co. (WSRC) contracted GTS Duratek (Duratek) to construct and operate the first commercial vitrification facility to treat an F-006 mixed (radioactive/hazardous) waste in the United States. The permits were prepared and submitted to the South Carolina state regulators by WSRC - based on a detailed design by Duratek. Readiness Assessments were conducted by WSRC and Duratek at each major phase of the operation (sludge transfer, construction, cold and radioactive operations, and a major restart) and approved by the Savannah River Department of Energy prior to proceeding. WSRC prepared the first "Upfront Delisting" petition for a vitrified mixed waste. Lessons learned with respect to the permit strategy, operational assessments, and delisting from this "privatization" project will be discussed.

INTRODUCTION

The Savannah River Site (SRS) is a 300 square mile complex which has been dedicated to the production of national defense materials since 1952. The SRS is operated by the Westinghouse Savannah River Co. (WSRC) for the U.S. Department of Energy (DOE). One of the legacies of the production activities was a mixed waste plating line sludge, generated in the Reactor Materials Area (M-Area). This plating line sludge was generated during the wastewater treatment of effluents from the nickel plating of depleted uranium cores, which were subsequently irradiated in the site's reactors to form plutonium-239.

The M-Area plating line sludge is a hazardous waste (F-006 listed waste) and since it contains a significant amount of depleted uranium, it is a "mixed" waste as defined by the Federal Facilities Compliance Act of 1992. In order to comply with the RCRA (Resource Conservation and Recovery Act) laws, the waste has to be treated to meet the Land Disposal Restriction (LDR) regulations [1]. In addition, since the sludge had been stored in on-site tanks longer than allowed by the LDR's, the sludge was subject to a 1991 Federal Facilities Compliance Agreement (FFCA) between the US Environmental Protection Agency (EPA), Region IV and the DOE-Savannah River.

The original concept to stabilize this waste was to construct a small, permanent (75,000 gallon/year) cementitious treatment facility in M-Area. This facility would have treated the on-going generation of sludges from the M-Area facilities, and worked off the stored waste over a 10 year period. However, in 1991, the DOE Savannah River (DOE-SR) directed WSRC to place the M-Area production facilities in standby. Without the on-going generation of new wastes, the construction and operation of a permanent, 10 year life facility was not warranted. WSRC proposed to the DOE-SR and the EPA, Region IV that a temporary facility, owned and operated by an independent sub-contractor, be utilized to treat the stored sludge. This approach was accepted in early 1992, and a Request For Proposals (RFP) was issued June 2, 1992. The technology to be used was not specified, just that the final wasteform had to meet the LDR treatment standards. All of the cementitious and vitrification treatability test results [2] that had been conducted by the Savannah River Technology Center (SRTC) were included with the RFP. A contract was awarded to GTS Duratek of Columbia, MD in November, 1993 - who proposed to treat the M-Area sludge using vitrification in a borosilicate matrix. The was/is the first commercial vitrification of a mixed waste in the United States.

The M-Area Vendor Treatment Facility (VTF) was selected by the DOE as one of five privatization "successes", and presented as such to the US Congress in the spring of 1996. "Privatization" is usually defined as an operation in which a contractor has a direct contract with the DOE, furnishes their own capital funds, and builds and operates the facility. The M-Area VTF has been included in this definition, since although Duratek was sub-contracted by WSRC (instead of DOE), GTS Duratek designed, used its own funds to construct, and has and is operating the VTF. This paper describes the complex interactions between the contractor (WSRC), the DOE-Savannah River (SR) and DOE-Headquarters (HQ), and the sub-contractor that are required to conduct such a "privatized" operation.

NATIONAL ENVIRONMENTAL POLICY ACT - NEPA

During the time the contract was being negotiated and awarded, WSRC prepared an Environmental Assessment (EA), to meet the requirements of the National Environmental Policy Act (NEPA). Since the qualified offerors had proposed both cementitious and vitrification stabilization, both of those options were included in the EA. The EA was initiated in November of 1992, and submitted to the DOE-HQ for approval in October of 1993. The EA included all of the proposed options; a permanent cement facility in M-Area, a permanent centralized cement facility at the SRS, temporary cement or glass treatment a by sub-contractor in M-Area, and a "No Action" option. The total Life Cycle Cost estimates for all of the options were prepared by WSRC Systems Engineering. The preferred option in the EA was treatment by a subcontractor, using either a temporary cement or vitrification facility.

The EA utilized the generic descriptions provided by the offerors to calculate the on and off-site hazardous chemical and radiological risks via the preparation of a Preliminary Hazards Assessment (PHA) by Savannah River Technology Center (SRTC). The radiological and chemical air emission concentrations from a worst case release of the waste sludge were modeled by SRTC, based on the detailed analyses of the wastes that WSRC had completed prior to the Request for

Proposals. Other exposure hazards were based on the chemicals proposed for the treatment technologies. The radiological components in the waste sludge resulted in the VTF being classified as a Low Hazard Nuclear facility. The worst case predicted airborne hazard, due to any chemical constituent present in the sludge or used in the process, resulted from a spill of a process chemical; sodium hydroxide.

When the contract was awarded to Duratek (who proposed a vitrification process) on November 4, 1993, the DOE-HQ requested that the EA be revised to indicate that vitrification by a sub-contractor was the preferred alternative. A revised EA was transmitted from the DOE-SR to DOE-HQ on December 16, 1993. The DOE-HQ was also requested to issue an exemption to the NEPA regulations to allow Title II design to start, prior to the approval of the EA. The DOE-HQ granted the exemption request on January 12, 1994, and Duratek immediately initiated preparation of the Detailed Design. The EA design exemption by DOE-HQ was critical, because WSRC/ DOE-SR had an FFCA commitment to submit the required permits to the regulatory authorities by June 30, 1994.

The revised EA [3] was approved and a Finding of No Significant Impact (FONSI) was issued by DOE-HQ on August 1, 1994. Overall, this took almost 2 years to prepare and approve. The August, 1994 approval timing of the FONSI was also a critical path item, as Duratek had to initiate the procurement of long lead time equipment to meet the contractual construction requirements, and this was not allowed until the EA/FONSI was approved.

NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS (NESHAPS)

Under the federal NESHAPS regulations, the EPA must issue a NESHAPS permit, including an "approval to construct", if the hazardous emissions from a proposed facility managing radioactive materials could exceed an annual dose of 0.1 mrem/yr. to the affected public. This approval must be issued before construction of such a facility may be initiated. Initial calculations prepared by WSRC indicated the vitrification facility would exceed the 0.1 mrem/yr. limit. Therefore, WSRC transmitted an "alternative source term calculation" to the EPA, Region IV, which demonstrated that the uranium compounds in the M-Area waste would not volatilize under the vitrification conditions, and that the annual dose would not exceed the 0.1 mrem/yr. limit. Approval of the federal NESHAPS exemption by the EPA was another critical path item. The "alternative source term calculation" request was granted by the EPA June 22, 1994 - which in conjunction with the FONSI issuance in August of 1994 - allowed Duratek to commence procurement of long-lead time items, and keep the construction schedule on track to meet the FFCA construction commitments.

The calculated potential radioactive emissions were 0.22 mrem/yr., if the baghouse and HEPA filtration systems were not included in the calculations. This exceeded the 0.1 mrem/yr. limit, so Continuous Air Monitoring (CAM) equipment was required. WSRC utilized existing CAM equipment to conduct this monitoring. The CAM had been previously procured for one of the shut-down operational M-Area buildings, and it was modified to meet the vitrification off-gas conditions. Duratek was requested to provide the off-gas connection piping. WSRC installed the CAM, operated and maintained it, and provided the

radiological results to the regulator. WSRC and Duratek had to coordinate closely to maintain the correct humidity and temperature of the off-gas feed to the CAM.

PERMITTING

All of the permits required for operation of the VTF are the responsibility of WSRC. They include an Industrial Wastewater Treatment permit, the NPDES permitted outfall to which the wastewater effluents discharge, and an Air Quality permit; for which the regulator was the South Carolina Department of Health and Environmental Control (SCDHEC). The permits were prepared by WSRC personnel based on the "Detailed Design" (DD) provided by Duratek. The DD was the first deliverable under the contract, and was intended to be as detailed as a "Title II" design for a line-item capital project. As mentioned previously, Duratek could not initiate the DD until the NEPA exemption for design was approved by DOE-HQ on January 12, 1994, and they had 90 days to submit a draft DD, and a total of 150 days to submit the final DD to WSRC. They submitted both draft and final DD's on schedule. WSRC initiated preparation of the Wastewater and Air Permit applications based on the draft, but WSRC had only 2 weeks (June 15 to June 30, 1994) to prepare the final permit applications, obtain WSRC and DOE-SR site approvals, and submit to SCDHEC to meet the FFCA commitment. The permits also had to be signed/certified by a Professional Engineer (PE) licensed in SC. This was provided by Duratek, as the permits were based on Duratek's DD.

The next key contract deliverable was to initiate construction within 15 days after all of the permits were approved by SCDHEC. This was a "floating" date, since the time for regulator's approval could only be roughly estimated. This turned out to be an important "float", since a few months after the Wastewater (WW) and Air permit applications were submitted, Duratek discovered technical problems with the proposed technique to control NO_x emissions. WSRC requested SCDHEC to delay consideration of the WW permit, while Duratek and Catholic University of America (CUA) conducted additional bench and full scale off-gas treatment tests.

WSRC and SRTC also conducted an independent technical review of the proposed new off-gas treatment process, and WSRC participated in a full scale demonstration of the revised process at CUA's 1 ton/day melter in December, 1994. The bench scale and full scale results were incorporated into a revised DD by Duratek; the WW and Air permit applications were revised by WSRC; and the permits were re-submitted to SCDHEC March 27, 1995. The permits were approved by SCDHEC July 13, 1995.

Duratek initiated construction of the VTF one day later by installing the melter support frame into a previously constructed "Butler type" building. Construction of the entire VTF was completed January 22, 1996 (approximately 10 days later than the 180 day contract deliverable). It should be noted that the contract assumed/suggested that a "temporary" facility would be provided by the sub-contractor. However, Duratek decided to construct a much more permanent facility in the expectation of treating additional mixed waste streams after completing treatment of the M-Area sludge. Construction of the VTF in the 180+ day time-frame was a very significant accomplishment.

READINESS ASSESSMENTS

The startup requirements for the VTF were based on the DOE Order 5480.31, "Startup and Restart of Nuclear Facilities". The VTF was defined to be a non-reactor nuclear facility and had been determined to be a "Radiological Facility" by the Hazards Assessment. The VTF was a new facility, but since a "Radiological Facility" is less than Hazards Category 3, only a Readiness Assessment (RA) was required, vs. a full Operational Readiness Review (ORR).

In order to conduct the Readiness Assessment, WSRC had to define exactly how the VTF construction and operation would be assessed vs. the applicable DOE orders and Westinghouse procedures. This was accomplished by the preparation of a Readiness Assessment Action Plan (RAAP). WSRC used and complied with the DOE Order 5480.31, and the WSRC "Startup and Operational Readiness Manual, 12Q" to prepare the RAAP. The RAAP was based on the detailed design of the VTF, the Safety and Health Plan for the VTF (prepared by Duratek, and approved by WSRC Procurement Safety oversight), and all of the operational and maintenance procedures for the VTF (supplied by Duratek). Preparation of the RAAP took approximately one year, with the total dedication of one of the authors of this paper (GAD). The RAAP was approved in March, 1996 by WSRC management (Excess Facilities and Spent Fuel Division), with concurrence by DOE-SR (Reactor Division).

Two of the main conclusions of the RAAP were:

1. The VTF could be constructed under the design and QA requirements for commercial chemical facilities, rather than the requirements of DOE Order 6430.1A, "General Design Criteria for Reactors or Non-Reactor Nuclear Facilities". This was due to the fact that since Duratek owned the completed facility, it was not a Government facility, and as such, 6430.1A did not apply. The design requirement for nuclear facilities are EXTENSIVE, and in the authors' opinion, would have increased the VTF design and construction costs 2-3X.
2. The VTF was constructed under a Purchase Requisition, and the requirements of DOE Order 4700.1 for a DOE cost or capital project construction were not applicable. Again, the authors' estimate the cost savings at an additional 2-3X of Duratek's cost of construction.

The Readiness Assessment was divided into phases, each of which were conducted jointly by WSRC and Duratek, before that operational phase began.

Phase I, Sludge Transfer

Duratek had decided to modify six existing 35,000 gallon tanks, for their use as sludge feed make-up, feed, and storage of off-gas condensate solutions. In order to modify the tanks, the tanks had to be emptied of the mixed waste sludge. The first Readiness Assessment (RA) phase was conducted on all of the Radiological and Operational Procedures that Duratek had developed to remove and transfer the sludge to one of the nearby 500,000 gallon tanks. The RA was

approved May 9, 1995 by WSRC, and Duratek immediately started the sludge transfer activities. It should be noted that these activities did not involve any "construction", or "major modifications" to existing equipment, as the Wastewater Construction Permit had not yet been approved.

Phase II, Construction

The RA phase allowing Duratek to "Start Construction" was approved by WSRC management July 10, 1995. The approved WW permit from SCDHEC was received July 13, 1995. Duratek started construction July 14, 1995.

Phase III, Cold Chemical Operations, and Preparation of First Feed Batch

When construction was completed January 22, 1996 the major phase of the RA was initiated. This phase considered all aspects of the melter and off-gas treatment operations, and transfer of the radioactive feed batches to the melter. Three months were allowed for WSRC to conduct the RA and obtain DOE approval, although it was hoped that it could be completed sooner. Duratek was in a "stand-by" mode during this period, assisting WSRC in the RA, and maintaining the operational readiness and training of their operations personnel. The Readiness Assessment was approved by DOE-SR April 17, 1996. Duratek immediately started preparation of the first radioactive sludge feed batch and initiated cold chemical feeding to the melter, using a temporary feed tank. One additional hold was built into the Readiness Assessment approval to begin full radioactive operations, in that WSRC planned to conduct a Conduct of Operations assessment prior to radioactive feed to the melter.

Phase IV, Conduct of Operations Self Assessment Prior to Radioactive Feed

WSRC completed a Conduct of Operations Self Assessment in July, 1996, which confirmed the readiness to commence radioactive operations. This allowed Duratek full authority to start vitrifying the M-Area sludge.

Phase V, Addendum Self Assessment

During the cold chemical check-out of the melter and ancillary equipment (April to September 1996) Duratek experienced significant equipment problems, mainly associated with the Duramelter™ 5000. In order to ensure that the design and procedural modifications that Duratek implemented during the "Cold Feed" period - to address those problems - WSRC conducted an "Addendum Self-Assessment" prior to radioactive feed to the melter. This was approved by WSRC October 15, 1996, and Duratek started radioactive feed to the melter 3 days later.

It should be noted that while WSRC conducted the self-assessments, Duratek personnel were intimately involved in all aspects of the assessments. In some cases this involved responding to comments on operations procedures, and modifying the procedures; in other cases it involved in-the-field observations of Duratek personnel in all operational activities.

Phase VI, Restart Readiness Review

After operating for approximately 5 months on radioactive feed, Duratek determined that the original melter was no longer reliable and ceased operations March 27, 1997. Duratek removed the original melter and installed a re-designed

melter. WSRC then conducted a "re-start" Readiness Review (RR) to verify satisfactory replacement of the melter, and that the operations personnel had maintained their training and professionalism during the outage. The Restart Review was completed November 11, 1997, Duratek initiated cold chemical feed in late November 1997, and started radiological feed December 10, 1997.

DELISTING PETITION

WSRC has also prepared an "Upfront Delisting Petition" [4] for the vitrified M-Area waste. This is first delisting petition submitted to the EPA for a vitrified mixed waste. Delisting should result in significant cost savings.

Cost Savings

Disposal Cost, \$/cu. Ft.

SRS On-Site Disposal

LLW Mixed Waste

\$30-50 \$700*

Off-Site Disposal (Envirocare)

LLW Mixed Waste

\$10 \$40 - 100**

* Assumes a SRS disposal vault constructed; ** volume dependent

Assuming that vitrification of the M-Area sludge will result in ~150,000 gallons, or ~20,000 cu. ft., the disposal cost savings range from approximately \$13,000,000 to \$1,800,000. Preparation of, and analyzing the final vitrified waste for the delisting petition, will cost \$150,000 to \$250,000. The cost savings for on-site disposal are enormous, but not realistic, as SRS has no plans to build a mixed waste disposal vault on-site. However, if delisted, the glass could be disposed on-site, which is the preferred option. Final disposal at the SRS LLW disposal vault will save approximately \$750,000 (a delta cost of \$50/cu.ft. x 20,000 cu. ft. - \$250,000 to delist) vs. off-site mixed waste disposal.

Constituents of Concern, and Delisting Levels

The constituents of concern in the final vitrified waste were based on all of the total constituent analyses conducted on the sludge and vitrified sludge, and Toxicity Characteristic Leaching Procedure (TCLP) analyses conducted on the glass. No organic constituents were detected in the glass (as expected). Those inorganic constituents which were detected above the analytical detection limit were designated as "Constituents of Concern".

<u>Constituents of Concern</u>	<u>Delisting Level # TCLP, mg/L</u>	<u>Constituents of Concern</u>	<u>Delisting Level # TCLP, mg/L</u>
NH ₃	100	F	400
As	5	Pb	1.5
Ba	200	Hg	0.2
Be	0.4	Ni	10
Cd	0.5	Se	5
Cr	10	Ag	20
Zn	1000		

The delisting level assumes 20,000 cu. ft (~750 cu. yd.) of glass to be disposed in one year, which provides a Dilution-Attenuation Factor (DAF) of 100.

The EPA maximum contaminant Drinking Water Standards (DWS) is multiplied by the DAF of 100 to obtain the TCLP concentration limit for the final waste. For example, the DWS for nickel is 0.100 mg/L times a DAF of 100, which gives a TCLP concentration limit of 10 mg/L for the final glass. It should be noted that all of the TCLP analyses conducted on the vitrified M-Area waste to date have resulted in TCLP levels less than 0.5 mg/L for nickel. This level is 20 times lower than the level needed to delist.

CONCLUSIONS

Westinghouse Savannah River Co., the Department of Energy, and GTS Duratek have worked closely together to demonstrate the first commercial vitrification of a mixed waste plating line sludge in the United States. The keys to a successful, cost effective "privatization" project are:

- preparing a very tight contract Specification and Scope of Work,
- utilizing commercial construction standards, when appropriate for Low Level radioactive waste treatment, and
- eliminating the very costly government project oversight, which can reduce final design and construction costs by 70-80%.

It should be noted that the day-to-day operations costs for such a facility will not differ significantly for a private sub-contractor vs. operation by a Government Owned/Government Operator (GOCO). This is due to the fact that a subcontractor operating on or at a DOE site will have to follow most, if not all, of the DOE operational Orders. The M-Area vitrification project has demonstrated that DOE, WSRC (as the GOCO), and a private sub-contractor can successfully treat a complex mixed waste, using state-of-the-art vitrification technology.

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Keywords

Vitrification

Delisting

Privatization

Mixed Waste

Readiness Assessment

DOE Orders

NEPA (National Environmental Policy Act)

NESHAPS (National Emission Standards for Hazardous Air Pollutants)