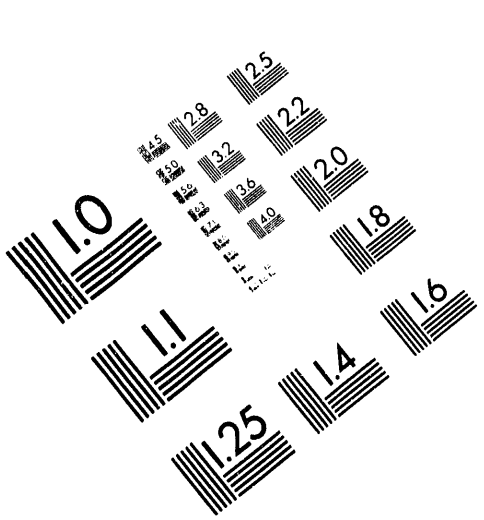

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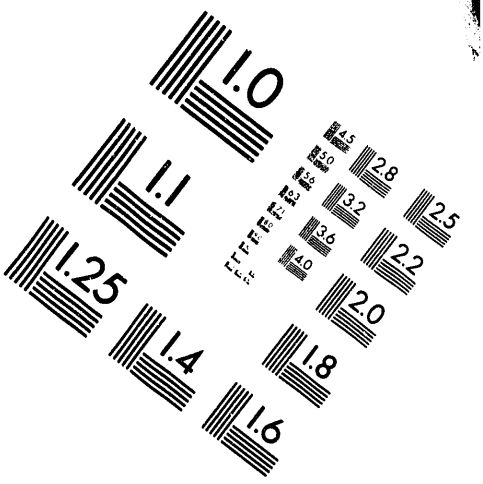

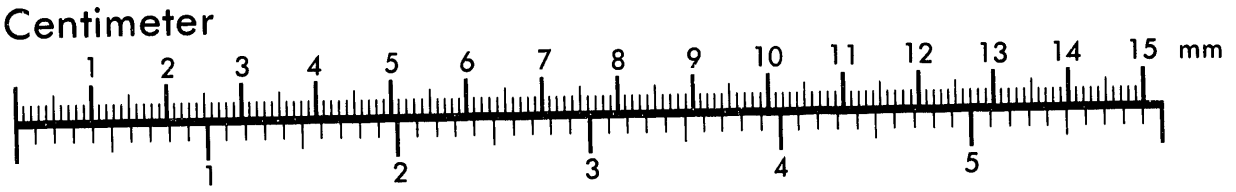

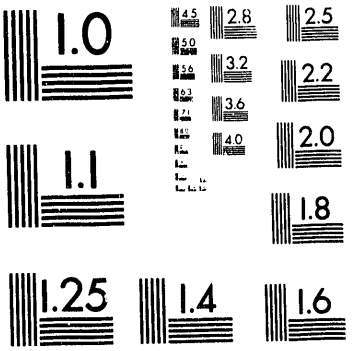

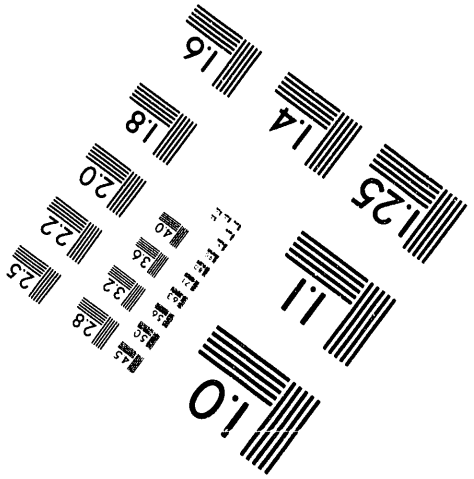

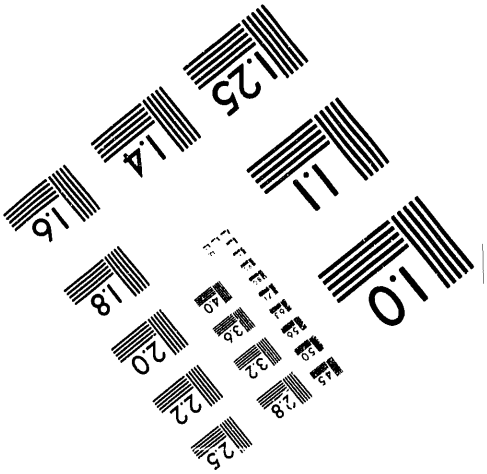

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WASTE ACCEPTANCE PRODUCT SPECIFICATIONS FOR VITRIFIED HIGH-LEVEL WASTE FORMS (U)

by

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DISCLAIMER

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ABSTRACT

The Department of Energy (DOE) Office of Environmental Restoration and Waste Management (EM) has developed Waste Acceptance Product Specifications (EM-WAPS). The EM-WAPS will be the basis for defining product acceptance criteria compatible with the requirements of the Civilian Radioactive Waste Management System (CRWMS). The relationship between the EM-WAPS and the CRWMS Systems Requirements document (WA-SRD) will be discussed. The impact of the EM-WAPS on the Savannah River Site (SRS) Defense Waste Processing Facility's (DWPF) Waste Acceptance Program, Waste Qualification Run planning, and startup schedule will also be reported.

DEVELOPMENT OF SPECIFICATIONS

The Nuclear Waste Policy Act of 1982 mandated that all high-level waste (HLW) be sent to a federal geologic repository for permanent disposal. DOE published the Environmental Assessment in 1982 which identified borosilicate glass as the chosen HLW form.[1] In 1985 the Department of Energy instituted a Waste Acceptance Process to assure that DWPF glass waste forms would be acceptable to such a repository. This assurance was important since production of waste forms will precede repository construction and licensing. As part of this Waste Acceptance Process, the DOE Office of Civilian Radioactive Waste Management (RW) formed the Waste Acceptance Committee (WAC). The WAC included representatives from the candidate repository sites, the waste producing sites and DOE. The WAC was responsible for developing the Waste Acceptance *Preliminary* Specifications (WAPS) which defined the requirements the waste forms must meet to be compatible with the candidate repository geologies. The bases for the WAPS were drawn largely from Nuclear Regulatory Commision regulations[2] and from open literature[3] which described scoping

work by the waste producers regarding vitrification of defense waste. The DWPF initiated its Waste Acceptance program in 1986.

The WAPS were refined in 1989, and again in 1991, to reflect repository-specific political decisions and to better represent HLW vitrification process designs. In 1991, DOE/RW opted not to formally issue Revision 2 of the WAPS. The DOE Office of Environmental Restoration and Waste Management (EM) directed DWPF to continue implementation of its Waste Acceptance Program, and development of the required documentation, to the draft WAPS until a suitable alternate approved basis could be provided.

In 1992, DOE/RW developed the Waste Acceptance Systems Requirements document (WA-SRD).[4] The WA-SRD governs spent fuel and HLW, and provides administrative, programmatic, and documentation responsibilities in addition to technical requirements. The WA-SRD was identified as higher tier to subsequent DOE/EM technical product specifications.

DOE/EM issued the Waste Acceptance Product Specifications for Vitrified High Level Waste Forms (EM-WAPS), February 12, 1993.[5] The EM-WAPS are very similar to preceding DOE/RW draft WAPS and are in alignment with the requirements of the WA-SRD.

INTRODUCTION

Over 130,000,000 liters of high-level radioactive waste is currently stored at the Savannah River Site (SRS) in Aiken, South Carolina. These wastes have been generated as a by-product of defense-related nuclear fuels production. Similar wastes are stored at other DOE sites. The wastes are stored as alkaline slurries in underground carbon steel tanks. Vitrification of SRS high-level radioactive waste will be performed at the Defense Waste Processing Facility. This method of waste treatment will immmobilize the nuclear waste in a borosilicate glass matrix, which will mitigate migration of radioactive species into the groundwater and surrounding environment. The DWPF HLW form will be produced by mixing HLW with borosilicate glass-formers, feeding the mixture to an electric melter, pouring the resultant glass melt into stainless steel canisters, and sealing the canisters with an upset resistance weld. This process is detailed in the open literature.[6-8] Production of the DWPF waste form will be performed remotely and will be tightly controlled.[9]

The DOE Office of Environmental Restoration and Waste Management developed the Waste Acceptance Product Specifications (EM-WAPS) for the high level waste form producers to use as the basis for their Waste Acceptance programs. The EM-WAPS are the technical specifications the waste form producers are required to meet in order to ensure acceptance of their HLW into

the federal repository. The producers subject to the EM-WAPS include: the Defense Waste Processing Facility (DWPF) at the Savannah River Site, Aiken, South Carolina; the West Valley Demonstration Project (WVDP) at West Valley, New York; and the Hanford Waste Vitrification Plant (HWVP) at the Hanford Reservation, Richland, Washington.

The EM-WAPS govern all elements of the canistered waste form. These elements include: the borosilicate waste glass, the stainless steel canister and the sealed canistered waste form. The EM-WAPS also provide quality assurance and Waste Acceptance documentation requirements, and address ownership and accountability issues. These administrative requirements were included to maintain consistency with the WA-SRD.

The waste acceptance process requires demonstration of compliance with the EM-WAPS via four different documents, each prepared by the producers, reviewed and accepted by DOE/EM, and provided to DOE/RW. These four documents are the:

(1) Waste Form Compliance Plan (WCP) The plan for demonstrating compliance with each specification is detailed in the WCP; including descriptions of testing, analyses, and process control strategies.

(2) Waste Form Qualification Report (WQR) The WQR compiles the results from testing and analysis that present the evidence that the canistered product will comply with each specification during actual waste form production. Sources of uncertainty in the testing results and analysis are also provided. The WQR is divided into 13 volumes, prepared in a phased manner. Initial development is based upon projections and scoping work, and the final WQR will be augmented with Startup Testing results.

(3) Production Records The documentation that describes the production and characterization of each actual canistered waste form is included in the Production Records.

(4) Storage and Shipping Records These records describe the physical attributes of the canistered waste forms immediately prior to the time of shipment, including any unusual events that may have occurred during interim storage.

The contents of each of these documents are specified in the EM-WAPS. The hierarchy of documents is represented in Figure 1.

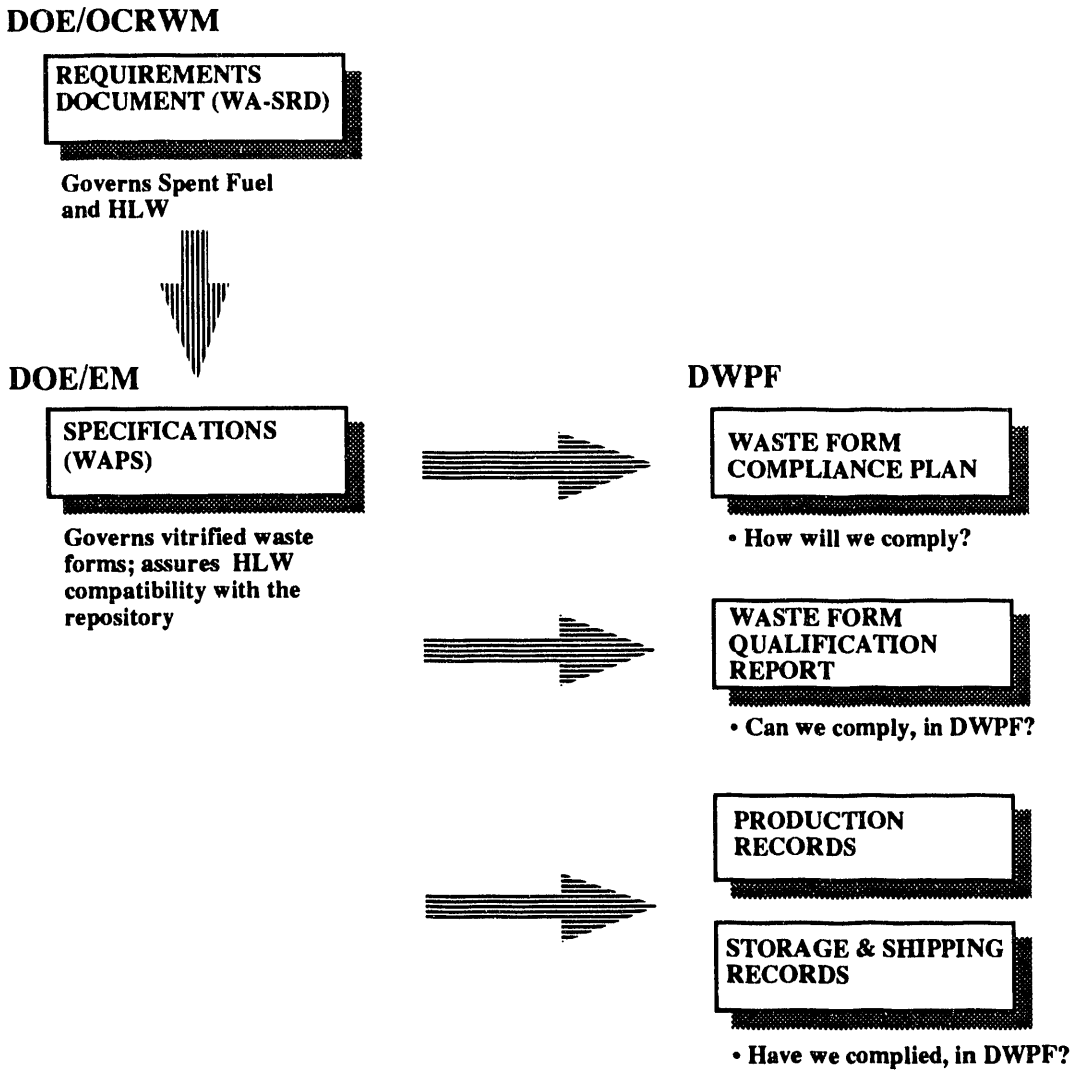

Figure 1. Hierarchy and function of Waste Acceptance documentation

WASTE ACCEPTANCE PRODUCT SPECIFICATIONS

The EM-WAPS were modelled after the Waste Acceptance *Preliminary* Specifications to maintain consistency with existing Waste Acceptance programs. The EM-WAPS are divided into five sections, each dealing with a different element of the canistered waste form and/or its production. Section 1 provides requirements for the waste glass element of the canistered waste form. It requires that the waste form is borosilicate glass, and that its chemical composition and radionuclide content be projected prior to production and reported during production. It also requires demonstration of a consistent, chemically durable product through administrative and process controls,

characterization of the glass phase stability for each projected waste type, and a determination of whether the glass is hazardous (as defined by the Resource Conservation and Recovery Act). The hazardous waste specification is a new requirement that was added to the EM-WAPS to maintain consistency with the WA-SRD. It has already demonstrated that DWPF glass will not be RCRA-hazardous,[10] but additional work is planned to update and expand the documentation. As additional assurance, the Environmental Protection Agency (EPA) has chosen vitrification to be the Best Demonstrated Available Technology (BDAT) for high level radioactive waste processing.[11]

Section 2 of the EM-WAPS provides specifications for the canister. These specifications require: that the canister be fabricated from nationally recognized austenitic stainless steel alloys, that the outermost closure is leaktight, that the exterior is uniquely labeled in two locations, that the overall length, after accounting for the closure method, is 3.000 m (+ 0.005 m, - 0.020 m), and that the outer diameter is 61.0 cm (+ 1.5 cm, - 1.0 cm).

Section 3 of the EM-WAPS governs the canistered waste form during and after production. These specifications prohibit introduction of extraneous materials, i.e. free liquids and gases, and organic, explosive, pyrophoric, and combustible materials. They also require chemical compatibility between the waste glass and the canister, that the canister is glass filled to a level consistent with at least 80% of the canister volume, and that the external surface is decontaminated. Section 3 also specifies that the heat generation and dose rate of the canistered waste forms must be projected prior to production and reported after production in the appropriate documents. The producer must ensure that a nuclear criticality accident is not possible, even under incredible accident conditions. The configuration, dimensions, and weight of the canistered waste forms must not exceed the maximum size and weight which can be received, handled, and emplaced in the repository. Section 3 also requires the canistered waste forms to be sufficiently robust to withstand a 7 meter drop onto an unyielding surface without breaching, and that a grapple be designed that is suitable for use at the repository.

Section 4 of the EM-WAPS requires establishment, maintenance, and execution of a quality assurance (QA) program consistent with that identified in the EM Quality Assurance Requirements Description (QARD)[12] and the WA-SRD.

Section 5 was added to the EM-WAPS in order to provide a direct correlation with the WA-SRD. It specifically calls out the scope, and function of the: WCP, WQR, Production Records, and Storage and Shipping Records. Some additional requirements are also included in Section 5 which address transportation, packaging and title transfer issues, conformance with system

requirements, and non-standard or improperly described waste. A caveat precedes these additional requirements which allows deferral of demonstration of compliance until the programmatic and legal details are resolved by DOE/RW and DOE/EM. Since these requirements do not become issues until the time for waste acceptance by the Civilian Radioactive Waste Management System (CRWMS) draws near, this is a reasonable and appropriate path forward.

DWPF WASTE ACCEPTANCE PROGRAM

The DWPF has had an active Waste Acceptance Program since 1986 when it addressed the Waste Acceptance *Preliminary* Specifications in the first draft of its WCP.[13] In addition, a large portion of the DWPF Startup Test Program was designed to comply with the WAPS.[14] The purpose of the DWPF Startup Test Program is to checkout and verify the design and operation of the facility and processing equipment, and to qualify the vitrification process and equipment for the projected range of conditions DWPF will experience during its operating lifetime. The Startup Test Program was designed to gain the maximum benefit possible from each test. This approach streamlines the program without compromising its quality. It is also important for the Startup Test Program to be representative and thorough since it is the most visible mechanism for defending the DWPF to outside regulatory agencies such as the Defense Nuclear Facilities Safety Board (DNFSB), the Nuclear Waste Technical Review Board (NWTRB), and the Nuclear Regulatory Commission (NRC). The results of the qualification portion of the Startup Test Program will be interpreted and documented in the WQR. Evidence that the DWPF will be in compliance during radioactive operations will be provided by the testing performed during DWPF Waste Qualification Runs. The Qualification Runs are one portion of the Startup Test Program. This information will provide the necessary assurance to DOE/RW that the DWPF canistered waste form is acceptable for disposal in the CRWMS.

To date, DWPF's WCP has been approved by DOE/EM, and concurrence by DOE/RW is anticipated prior to initiating DWPF Waste Qualification Runs. The preliminary WQR, which draws information from pilot testing and scoping research, has been largely developed. DOE/EM has reviewed and approved the portions of the WQR which detail the stategies required for WAPS compliance that will be tested during the Waste Qualification Runs. DWPF also has programmatic guidelines in place which describe accumulation of Production Records and Waste Acceptance participation in remediation of process controls. The Waste Acceptance documentation is a focal point with regard to the DWPF startup schedule. The documentation must be in place and approved by DOE/EM prior to processing of actual radioactive sludge at the DWPF. Waste Acceptance is keyed to the DWPF schedule such that particular phases of the program must be complete in order to proceed with DWPF startup milestones. These logic ties are presented in Figure 2.

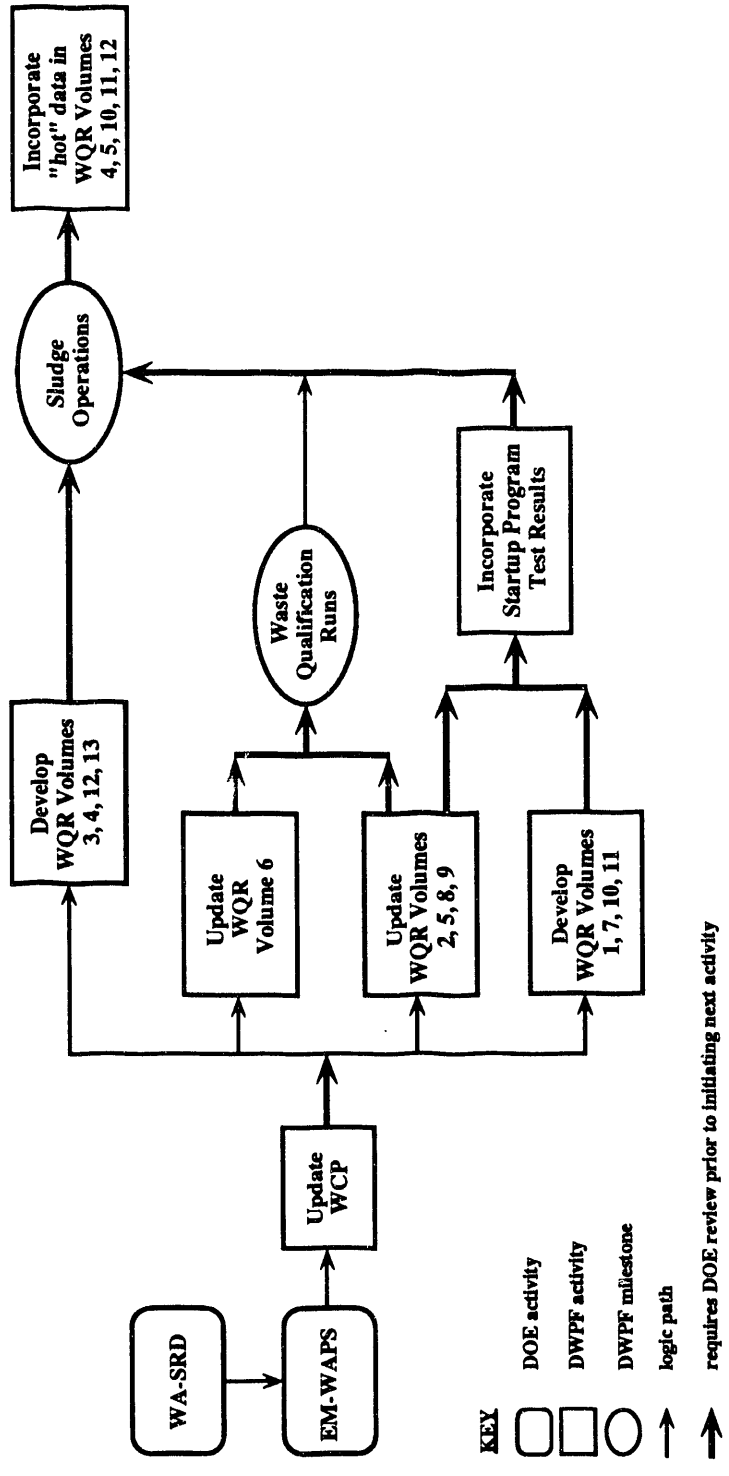

Figure 2. Waste Acceptance prerequisites to DWPF milestones.

ACKNOWLEDGEMENTS

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