Office of Environmental Restoration and Waste Management

WASTE ACCEPTANCE PRODUCT SPECIFICATIONS FOR VITRIFIED HIGH-LEVEL WASTE FORMS

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United States Department of Energy

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INTRODUCTION

The DOE Office of Environmental Restoration and Waste Management (EM) developed these Waste Acceptance Product Specifications (EM-WAPS) for the high level waste form producers as the basis for their Waste Acceptance programs. This introduction provides background information detailing: the purpose of the EM-WAPS, the groups involved, their roles in the waste acceptance process, and the deliverables required by that waste acceptance process.

The Waste Acceptance Product Specifications are the technical specifications the waste form producers are required to meet in order to ensure acceptance of their vitrified high level waste (HLW) into the Civilian Radioactive Waste Management System (CRWMS). When the waste acceptance process was first defined in 1985, the Office of Civilian Radioactive Waste Management (RW) was to provide specifications. However, RW is currently redefining its technical and functional baseline. RW has opted to pass to EM the responsibility for providing product specifications to the waste form producers. However, EM is committed to ensure that the EM-WAPS are in concert with the RW technical baseline, as defined in the Waste Acceptance Systems Requirements document (WA-SRD) [1]. It is recognized that the roles of EM and RW in the waste acceptance process are currently in transition.

The EM-WAPS govern all elements of the canistered waste form ("canistered waste form" is intended to be the same as the "HLW standard form" referred to in the WA-SRD). These elements include: the borosilicate waste glass, the stainless steel canister and the sealed canistered waste form. The EM-WAPS also provide quality assurance requirements which must be imposed on high level waste form production, and specifications outlining waste producer, DOE-EM and DOE-RW Waste Acceptance documentation requirements. A table that cross references each EM-WAPS specification to the corresponding WA-SRD requirement is provided in Appendix C.

The underlying rationale for most of the requirements of these EM-WAPS can be traced to the WA-SRD. Appendix A points to the appropriate WA-SRD requirements and provides substantiating rationale information where clarification is needed. The WA-SRD is a binding document, and the waste producers are obliged to comply with it. Some of the specifications in the WA-SRD have been designated "to be resolved" <TBR>. In spite of the <TBR> designation in the WA-SRD, these specifications are binding to the waste producers. EM has opted to reflect this by not extending the <TBR> qualification to the EM-WAPS. <TBR> requirements are identified in Appendix A. Changes to the WA-SRD which change the <TBR> designations will be tracked and these changes will be reflected in subsequent revisions to the EM-WAPS.

The waste acceptance process requires demonstration of compliance with the WAPS via four different documents, each prepared by the producers, reviewed and accepted

by EM, and provided to RW. These four documents are: (1) the Waste Form Compliance Plan (WCP), (2) the Waste Form Qualification Report (WQR), (3) Production Records and (4) Storage and Shipping Records. The contents of these documents are specified throughout the EM-WAPS. The producers include: the Defense Waste Processing Facility (DWPF) at the Savannah River Site, 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.

1. WASTE FORM SPECIFICATIONS

1.1 CHEMICAL SPECIFICATION

The waste form is borosilicate waste glass.

1.1.1 Chemical Composition Projections

In the WQR, the producer shall project the chemical composition, identify crystalline phases expected to be present, and project the amount of each crystalline phase, for each waste type. The method to obtain the required data shall be described by the producer in the WCP. The data shall be provided in the WQR. Waste form compositions not available for reporting in the initial WQR shall be included in an addendum to the WQR.

1.1.2 Chemical Composition During Production

In the Production Records, the producer shall report the oxide composition of the waste form. The reported composition shall include all elements, excluding oxygen, present in concentrations greater than 0.5 percent by weight of the glass, for each waste type. The producer shall describe the method to be used for compliance in the WCP. An estimate of the error of the reported composition and the basis for the estimate shall be reported in the WQR.

1.2 RADIONUCLIDE INVENTORY SPECIFICATION

The producer shall report the inventory of radionuclides (in Curies) that have half-lives longer than 10 years and that are, or will be, present in concentrations greater than 0.05 percent of the total radioactive inventory for each waste type, indexed to the years 2015 and 3115.

1.2.1 Radionuclide Inventory Projections

The producer shall provide in the WQR estimates of the total quantities of individual radionuclides to be shipped to the repository, for each waste type. The producer shall also report the upper limit of these radionuclides for any canistered waste form, and an average calculated radionuclide inventory per canister for each waste type. The method to be used to obtain the required data shall be described by the producer in the WCP. The data shall be provided in the WQR. Radionuclide inventory estimates

not available for reporting in the initial WQR shall be included in an addendum to the WQR.

1.2.2 Radionuclide Inventory During Production

The producer shall provide in the Production Records estimates of the inventories of individual reportable radionuclides for each canister and for each waste type. The producer shall also report the estimated error of these estimates in the WQR.

1.3 SPECIFICATION FOR PRODUCT CONSISTENCY

The producer shall demonstrate control of waste form production by comparing, either directly or indirectly, production samples to the Environmental Assessment (EA) benchmark glass [2]. The producer shall describe the method for demonstrating compliance in the WCP and shall provide verification in the Production Records. The producer shall demonstrate the ability to comply with the specification in the WQR.

1.3.1 Acceptance Criterion

The consistency of the waste form shall be demonstrated using the Product Consistency Test (PCT) [3]. For acceptance, the mean concentrations of lithium, sodium and boron in the leachate, after normalizing for the concentrations in the glass, shall each be less than those of the benchmark glass described in the Environmental Assessment for selection of the DWPF waste form [4]. The measured or projected mean PCT results for lithium, sodium and boron shall be provided in the Production Records. The producer shall define the statistical significance of the reported data in the WQR. One acceptable method of demonstrating that the acceptance criterion is met, would be to ensure that the mean PCT results for each waste type are at least two standard deviations below the mean PCT results of the EA glass.

1.3.2 Method of Compliance

The capability of the waste form to meet this specification shall be derived from production glass samples and/or process control information.

Production Records shall contain data derived from production samples, or process control information used for verification, separately or in combination. When using process control

information to project PCT results, the producer shall demonstrate in the WQR that the method used will provide information equivalent to the testing of samples of actual production glass.

1.4 SPECIFICATION FOR PHASE STABILITY

1.4.1 Phase Stability Information

The producer shall provide the following data for each projected waste type:

(a) The glass transition temperature; and

(b) A time-temperature-transformation (TTT) diagram that identifies the duration of exposure at any temperature that causes significant changes in either the phase structure or the phase compositions.

The method to be used to obtain the required data shall be described in the WCP. The data shall be provided in the WQR.

1.4.2 Control of Temperature for Phase Stability

At the time of shipment, the producer shall certify that after the initial cool-down, the waste form temperature has not exceeded 400°C. The producer shall describe the method of compliance in the WCP.

1.5 HAZARDOUS WASTE SPECIFICATION

The producer shall report in the WQR whether the waste form proposed for storage or disposal in the Civilian Radioactive Waste Management System is hazardous listed waste [5]. If the waste form is determined to be listed hazardous waste the quantity of listed waste introduced into the waste form from the feed stream shall be reported in the WQR.

The producer shall perform the "Toxicity Characteristic Leaching Procedure" (TCLP) [6] and other RCRA characteristic test(s) [7] as appropriate, using prototypical specimens of the projected bounding glass compositions to determine if the waste form is characteristic hazardous waste. The method to be used must be described in the WCP and results documented in the WQR.

If the canistered waste forms are determined to be hazardous, the producer shall include a "Hazardous Waste Manifest" in the Production

Records.

2. CANISTER SPECIFICATIONS

2.1 MATERIAL SPECIFICATION

The waste form canister, the canister label, and any secondary canister applied by the producer shall be fabricated from austenitic stainless steel. Applicable ASTM [8] or other nationally recognized alloy specifications and the compositions of the canister materials, the canister label materials, and any filler materials used in welding shall be included in the WCP. Documentation of compliance shall be included in the Production Records.

2.2 FABRICATION AND CLOSURE SPECIFICATION

The canister fabrication and closure methods shall be identified in the WCP. The outermost closure shall be leaktight to 1×10^{-4} atm-cc/sec helium. The method for demonstrating compliance shall be described by the producer in the WCP. The WQR shall provide evidence that the canister fabrication and closure methods are capable of complying with the leaktightness criterion. Compliance during production shall be documented in the Production Records.

2.3 IDENTIFICATION AND LABELING SPECIFICATION

2.3.1 Identification

The producer shall assign a unique alphanumeric identifier to label each outermost canister that is produced. This label shall appear on the canistered waste form and on all documentation pertinent to that particular canistered waste form.

2.3.2 Labeling

Each canister shall be labeled in two locations: one visible from the top and one from the side of the canister. The identification code shall be printed in a type size of at least 92 points using a sans serif type face. A proposed layout shall be provided in the WCP. Labels shall be applied to the exterior of the outermost canister and shall not cause the dimensional limits (Specification 3.11) to be exceeded.

The label shall be designed to be legible after filling and storage

at the producer's facility and shipment to the repository. The label shall be an integral part of the canister and shall not impair the integrity of the canister.

2.4 SPECIFICATION FOR CANISTER LENGTH AND DIAMETER

The producer must demonstrate in the WCP that the strategy for meeting these specifications will meet the requirements of the WA-SRD.

2.4.1 Length Specification

The overall length of the unfilled canister, after accounting for the closure method, shall be 3.000 m (+ 0.005 m, - 0.020 m), including the neck and handling flange. The measured length of the unfilled canister shall be reported in the Production Records.

2.4.2 Diameter Specification

The outer diameter of the unfilled canister shall be 61.0 cm (+ 1.5 cm, - 1.0 cm). The measured diameter of the unfilled canister shall be reported in the Production Records.

3. CANISTERED WASTE FORM SPECIFICATIONS

3.1 FREE LIQUID SPECIFICATION

The producer shall ensure that the canistered waste form does not contain detectable amounts of free liquids. The producer shall describe the method of compliance in the WCP and provide documentation of the ability to comply, and of the detection limits, in the WQR.

3.2 GAS SPECIFICATION

The producer shall ensure that the canistered waste form does not contain detectable amounts of free gas other than air, the residuals of air, noble and radiogenic gases. The internal gas pressure immediately after closure shall not exceed 150 kPa (22 psia) at 25°C. The producer shall describe the method of compliance in the WCP and provide documentation of the ability to comply with this specification, and of the detection limits, in the WQR. The producer shall also document in the WQR the quantities and compositions of any gases that might accumulate inside the canister from radiogenic decay or after the canister has been subjected to temperatures up to 500°C.

3.3 SPECIFICATION FOR EXPLOSIVENESS, PYROPHORICITY, AND COMBUSTIBILITY

The producer shall ensure that the canistered waste form does not contain detectable amounts of explosive, pyrophoric, or combustible materials. The producer shall describe the method of compliance in the WCP and provide documentation of, the detection limits, and the ability to comply with this specification for the range of waste types, in the WQR. The producer shall document in the WQR that the canistered waste forms remain nonexplosive, nonpyrophoric, and noncombustible after having been subjected to temperatures up to 500°C.

3.4 ORGANIC MATERIALS SPECIFICATION

The producer shall ensure that the canistered waste form does not contain detectable amounts of organic materials. The producer shall describe the method for complying with this specification in the WCP and provide documentation of the ability to comply, and of the detection limits, in the WQR.

3.5 CHEMICAL COMPATIBILITY SPECIFICATION

The producer shall ensure that the contents of the canistered waste form do not cause internal corrosion of the canister which could adversely affect normal handling during storage, or during an abnormal occurrence such as a canister drop accident. The producer shall describe the method of demonstrating compliance in the WCP. Interactions between the canister and its contents, including any reaction products generated within the canistered waste form after exposure to temperatures up to 500°C, shall be discussed in the WQR.

3.6 FILL HEIGHT SPECIFICATION

The producer shall fill the canister to a height equivalent to at least 80% of the volume of the empty canister. The producer shall report this height in the Production Records and describe the method of compliance in the WCP. Documentation supporting the selected method of compliance shall be provided in the WQR.

3.7 SPECIFICATION FOR REMOVABLE RADIOACTIVE CONTAMINATION ON EXTERNAL SURFACES

The level of removable radioactive contamination on all external surfaces of each canistered waste form shall not exceed the following limits at the

time of shipment:

Alpha radiation: 220 dpm/100 cm^2

Beta and Gamma radiation: 2200 dpm/100 cm^2

In addition, the producer shall visually inspect each canistered waste form and remove visible waste glass from the exterior before shipment. The producer shall describe the method of compliance in the WCP and provide contamination level results in the Storage and Shipping Records.

3.8 HEAT GENERATION SPECIFICATION

The heat generation rate for each canistered waste form shall not exceed 1500 watts per canister at the year of shipment.

3.8.1 Heat Generation Projections

The producer shall document in the WQR the expected thermal output of the canistered waste forms and the range of expected variation for each waste type, indexed to the year 2015. The method to be used for demonstrating compliance shall be described by the producer in the WCP. Projections for compositions not available for reporting in the initial WQR shall be included in an addendum to the WQR.

3.8.2 Heat Generation at Year of Shipment

The producer shall report in the Storage and Shipping Records the estimated heat generation rate for each canistered waste form. The producer shall describe the method for compliance in the WCP.

3.9 SPECIFICATION FOR MAXIMUM DOSE RATES

The canistered waste form shall not exceed a maximum surface (on contact) gamma dose rate of 10^5 rem/hr and a maximum neutron dose rate of 10 rem/hr.

3.9.1 Projections of Dose Rates

The producer shall report in the WQR the expected values and the range of expected variation for both gamma and neutron dose

rates indexed to the year 2015. The producer shall describe the method for demonstrating compliance in the WCP.

3.9.2 Dose Rates at Time of Shipment

The producer shall provide in the Storage and Shipping Records either the calculated or measured values for both gamma and neutron dose rates at the time of shipment for each canistered waste form. The producer shall describe the method of compliance in the WCP.

3.10 SUBCRITICALITY SPECIFICATION

The producer shall design a waste form to ensure that, under normal and accident conditions, a nuclear criticality accident is not possible unless at least two unlikely, independent, and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety. The calculated effective neutron multiplication factor, k_{eff}, must be shown to be less than 0.90 after allowing for bias in the method of calculation and the uncertainty in the experiments used to validate the method of calculation. The producer shall describe the method of demonstrating compliance in the WCP and provide supporting documentation in the WQR. The WQR shall also include sufficient information on the nuclear characteristics, such as fissile density, of the canistered waste form to enable subcriticality to be confirmed under transportation, storage and disposal conditions.

3.11 SPECIFICATIONS FOR WEIGHT AND OVERALL DIMENSIONS

The configuration, dimensions, and weight of the canistered waste form shall not exceed the maximum size and weight which can be received, handled, and emplaced in the repository. These parameters shall be controlled as indicated below and shall be documented at the time of shipment. The producer shall describe the method of compliance in the WCP and the basis for compliance in the WQR.

3.11.1 Weight Specification

The weight of the canistered waste form shall not exceed 2,500 kg. The measured weight and estimated error shall be reported in the Storage and Shipping Records.

3.11.2 Specification for Overall Dimensions

The dimensions of the canistered waste form shall be such that, at the time of shipment, the canistered waste form will stand upright without support on a flat horizontal surface and will fit completely without forcing when lowered vertically into a right-circular, cylindrical cavity, 64.0 cm in diameter and 3.01 m in length.

The producer shall estimate in the WQR the minimum canister wall thickness of the filled, decontaminated canister. The producer shall also provide in the WQR an estimate of the amount of canister material that is removed during surface decontamination and the basis for that estimate. The producer shall document the unfilled canister wall thickness in the Production Records.

3.12 DROP TEST SPECIFICATION

The canistered waste form shall be capable of withstanding a 7 meter drop onto a flat, essentially unyielding surface without breaching (leak rate < 1×10^{-4} atm-cc/sec helium). The producer shall describe the method of compliance in the WCP and provide test results and any supporting analyses in the WQR. The test results shall include information on measured canister leak rates and canister deformation after the drop.

3.13 HANDLING FEATURES SPECIFICATION

The canistered waste form shall have a concentric neck and lifting flange. The lifting flange geometry and maximum loading capacity shall be described in the WCP.

The producer shall design a grapple, suitable for use at the repository, which satisfies the following requirements:

(a) The grapple shall be capable of being remotely engaged and disengaged from the flange.

(b) The grapple, when attached to a suitable hoist, and when engaged with the flange, shall be capable of raising and lowering a canistered waste form in a vertical direction.

(c) The grapple shall be capable of engaging and disengaging the canister flange within a right-circular cylindrical cavity with a maximum diameter of 62.5 cm.

(d) The grapple shall be designed to prevent an inadvertent release of a suspended canistered waste form when the grapple is engaged with the flange.

The producer shall describe the grapple in the WCP and provide the designs in the WQR.

4. QUALITY ASSURANCE SPECIFICATION

The producer shall establish, maintain, and execute a quality assurance (QA) program that applies to the testing and analysis activities that demonstrate compliance with these WAPS during waste form qualification, production, handling, storage, and preparation for shipment. The producer shall impose a QA program consistent with the QA requirements that govern HLW as identified in the RW Quality Assurance Requirements and Description (QARD) [9] and the Civilian Radioactive Waste Management System's Waste Acceptance Systems Requirements document (WA-SRD) [1].

The producer shall submit an action plan, signed by authorized personnel through EM to DOE-RW for correction or disposition of nonconforming waste forms for verification and documented approval from RW.

5.0 DOCUMENTATION AND OTHER REQUIREMENTS

5.1 SPECIFICATION FOR WASTE ACCEPTANCE DOCUMENTATION

The following waste acceptance documentation shall be developed by the waste producer, maintained as permanent records, and provided to RW:

5.1.1 Waste Form Compliance Plan (WCP)

The WCP shall describe the Producer's plan for demonstrating compliance with the requirements of the WAPS, including tests, analysis and process controls to be performed by the producer and records that will be provided as evidence.

5.1.2 Waste Form Qualification Report (WQR)

The WQR shall compile the results from waste form testing and analysis to demonstrate the ability of the producer to comply with the requirements of the WAPS.

5.1.3 Production Records (PR)

The PR shall describe each canistered waste form through production.

5.1.4 Storage and Shipping Records

The Storage and Shipping Records shall describe the physical attributes of each canistered waste form and identify any abnormal events, such as thermal excursions, which have occurred during storage.

Specifications 5.2-5.14 are requirements from the WA-SRD which are imposed on either the producer, or DOE, i.e. EM and/or RW, as designated. These specifications are included in the EM-WAPS for completeness. Documentation addressing specifications 5.2-5.14 will not appear in either the WCP or the WQR. The required format for complying with Specifications 5.2-5.14 must be developed between DOE-EM and DOE-RW and direction provided to the producers.

5.2 SPECIFICATION FOR TEST PLANS AND PROCEDURES

WA/producer shall demonstrate conformance of the system elements requirements as required in the verification matrix in Table 4-1 of the WA-SRD.

5.3 SPECIFICATION FOR DELIVERY OF NON-STANDARD WASTE

The producer shall obtain delivery and procedure confirmation from DOE prior to delivery of other than standard waste.

5.4 SPECIFICATION FOR DOE OBSERVATION AT TIME OF SHIPMENT

The producer shall allow a designated RW representative access to the producer's site to observe preparatory activities prior to canistered waste form shipment.

5.5 SPECIFICATION FOR DOE NOTIFICATION OF IMPROPERLY DESCRIBED WASTE

The producer shall not transfer title of improperly described canistered waste form unless DOE-RW agrees in writing to accept title. If the canistered waste form is determined by WA to have been improperly described prior to acceptance by RW, RW reserves the right to refuse acceptance.

5.6 SPECIFICATION FOR RESOLUTION OF IMPROPERLY DESCRIBED ACCEPTED WASTE

WA shall notify the producer, if subsequent to its acceptance, WA finds a canistered waste form which has been improperly described. In this event, the producer must provide WA a proper description within 30 days.

5.7 SPECIFICATION FOR TRANSFER OF TITLE TO DOE

The producer shall make available a loading facility at his site, designated for transfer of the canistered waste forms to DOE-RW.

5.8 SPECIFICATION FOR HLW ANNUAL REPORT

EM shall provide to RW annual reports of waste generation and projections of quantities of canistered waste forms requiring disposal.

5.9 SPECIFICATION FOR FINAL DESCRIPTION OF WASTE

EM shall describe in writing the material in each shipping lot 60 days prior to the scheduled transport of that lot.

5.10 SPECIFICATION FOR FEE PAYMENT

EM shall execute a suitable interagency agreement with RW reflecting the terms and conditions specified in 10CFR961.11 with regard to the payment of disposal fees.

5.11 SHIPPING CASK CONDITION SPECIFICATION

RW/producer shall provide written documentation of the cask conditions and contents prior to transfer of the canistered waste forms.

5.12 CASK SYSTEM PACKAGING SPECIFICATION

RW/EM/the producer shall provide written documentation and certification that the transportation cask system has been packaged to meet DOE, DOT, and NRC requirements and to transfer care, custody, and control of the shipment.

5.13 SPECIFICATION FOR RADIOTOXICITY AT TIME OF SHIPMENT

The producer shall provide in the Storage and Shipping Records the

name of each radionuclide, in order of decreasing radiotoxicity, whose activity comprises 1% or greater of the total activity, at the time of shipment.

5.14 HLW RECEIPT

The producer shall provide and pay the costs of interim storage, until HLW is accepted by WA.

GLOSSARY FOR THE WASTE ACCEPTANCE PRODUCT SPECIFICATIONS

Borosilicate waste glass - glass typically containing approximately 20 to 40 wt.% waste oxides, 35 to 65 wt.% silica, 5 to 10 wt.% boron oxide, and 10 to 20 wt.% alkali oxides, plus other oxide constituents.

Canister - the metal vessel into which borosilicate waste glass is poured during waste form fabrication.

Canister breach - loss of canister leaktightness.

Canistered waste form - the waste form in a sealed canister.

Combustible material - any material that can be ignited readily, and when ignited, burns rapidly. Combustible materials are considered to be "chemically reactive".

Corrosiveness - the tendency of a substance to wear away or alter a material by a chemical or electrochemical (essentially oxidizing) processes. Corrosive materials are considered to be "chemically reactive".

Civilian Radioactive Waste Management System (CRWMS) - is the composite of the sites, and all facilities, systems, equipment, materials, information, activities, and the personnel required to perform those activities, necessary to manage canistered waste form disposal.

Detectable - the limits of equipment, and/or ability, to measure physical presence.

Explosive material - a substance that, in its normal condition, is characterized by a chemical state that remains unchanged with time, but may be made to undergo rapid chemical change without an outside source of oxygen, whereupon it produces a large quantity of energy generally accompanied by the evolution of hot gases. These substances include those specified in 49 CFR Part 173, Subpart C, Classes A and B.

Free gas - any gas, including radiogenic gases and cover gases like helium, argon, or air, that could contribute to the pressurization of a canister. This includes gases generated by chemical reaction and radiolytic decomposition.

Free liquid - liquid that could be drained from the canister either initially or after the canistered waste form has been subjected to temperatures up to 500°C.

Glass transition temperature - upon heating, the temperature at which the glass transforms from a rigid solid to a viscous liquid. This temperature corresponds to glass viscosity of ~10^{13} poise, and is < 500°C, for most, if not all, borosilicate waste glasses.

Grapple - a device designed to mate with the lifting flange, used to suspend the canistered waste form from an overhead crane for lifting and transporting.

Hazardous waste - waste which is defined as hazardous in 40CFR261.3.

Leaktightness - a leakage rate of 10^{-4} atm-cm^3/sec or less based on dry helium at 25°C and a pressure differential of 1 atm against a vacuum of 10^{-2} atm or less (modified from ANSI N14.5-1987, "American National Standard for Leakage Tests on Packages for Shipment of Radioactive Materials" or ASME's "Boiler and Pressure Vessel Code," Section V, Article 10, Appendix IV (1986)).

Lifting flange - a protruding rim, edge, rib or collar used to handle the canister.

Non-standard waste - nonconforming canistered waste forms that have been reviewed by DOE-RW and deemed acceptable.

Organic material - any material based on methane or methane derivatives, carbon chains or rings, generally containing hydrogen with or without oxygen, nitrogen, or other elements, whether or not derived from living organisms. Free carbon, carbon monoxide, carbon dioxide, and cyanide compounds are excluded.

Production Records - the documentation, provided by the producer, that describes the actual canistered waste forms.

Pyrophoric material - any liquid that will ignite spontaneously in air below 54.4°C. Any solid material, other than one classed as an explosive, which under normal conditions is liable to cause fires through friction, retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious transportation, handling, or disposal hazard. Included are spontaneously combustible and water-reactive materials, and especially the materials specified in 49 CFR Part 173, Subpart E.

Radiogenic gas - any gas produced by radioactive transformation; that is, the transmutation of an element into a gaseous element by a change in the atomic nucleus through radioactive decay.

Removable radioactive contamination - radioactive material not fixed to a surface. The level of this contamination is determined by wiping an area of 300 cm^2 with an absorbent material, using moderate pressure, and measuring the activity on the wiping material (from 10 CFR 71.87).

Residuals of air - components of air present in other than normal proportions.

Storage and Shipping Records - the document that describes the physical attributes of

each canistered waste form which is stored at the producer's site and later shipped to the repository. These records also identify any unexpected events, such as thermal excursions, which have occurred during storage.

Waste Acceptance (WA) - is the system element or organization that manages the Accept Waste function which includes acceptance of canistered waste forms into the CRWMS from the producer of such waste.

Waste form - the radioactive waste materials in a borosilicate glass matrix (10 CFR 60.2) [10].

Waste Form Compliance Plan (WCP) - the document that describes the producer's plan for demonstrating compliance with each waste acceptance specification in the WAPS. The WCP includes descriptions of the tests, analyses, and process controls to be performed by the producer, including the identification of records to be provided to demonstrate compliance with the specifications.

Waste Form Qualification Report (WQR) - a compilation of results from waste form testing and analysis which develops in detail the case for compliance with each waste acceptance specification.

Waste type - The waste material fed to each vitrification facility, whose composition and properties will remain relatively constant over an extended period of time during waste form production.

APPENDIX A

RATIONALE FOR WASTE ACCEPTANCE PRODUCT SPECIFICATIONS FOR VITRIFIED HIGH-LEVEL WASTE FORMS

1. WASTE FORM SPECIFICATIONS

1.1 RATIONALE FOR THE CHEMICAL SPECIFICATION

Refer to: 3.7.1.2.1A, 3.7.1.2.1.2.1A, in the WA-SRD [1].

1.2 RATIONALE FOR THE RADIONUCLIDE INVENTORY SPECIFICATION

Refer to: 3.7.1.2.1.2.8, in the WA-SRD.

A period of 1100 years has been selected as the indexing time frame to account for approximately 100 years of facility operation and 1000 years of postclosure performance (10 CFR 60).

1.3 RATIONALE FOR THE SPECIFICATION FOR PRODUCT CONSISTENCY

Refer to: 3.7.1.2.1.2.13A-B in the WA-SRD.

The primary justification for this specification is the need to ensure a consistent glass product by control of the vitrification process. This specification formally establishes the Environmental Assessment for the selection of the DWPF waste form [3] as a benchmark for the waste form producers. This specification has been designated <TBR> in the WA-SRD.

The waste producers may choose any valid statistical method to demonstrate compliance with this specification which meets the needs of their respective facilities.

1.4 RATIONALE FOR THE SPECIFICATION FOR PHASE STABILITY

Refer to: 3.7.1.2.1.2.11A-B, 3.7.1.2.1.2.1B(6), of the WA-SRD.

The 400°C temperature limit, which is ~50-100°C below the glass transition temperature, was chosen to provide a conservative, discrete control target. No changes have been detected in phase structure when glass is maintained at or below the glass transition temperature for reasonable test periods.

1.5 RATIONALE FOR THE HAZARDOUS WASTE SPECIFICATION

Refer to: 3.7.1.2.1.2.12A-D, of the WA-SRD.

2. CANISTER SPECIFICATIONS

2.1 RATIONALE FOR THE MATERIAL SPECIFICATION

Refer to: 3.7.1.2.1.2.7, of the WA-SRD.

2.2 RATIONALE FOR THE FABRICATION AND CLOSURE SPECIFICATION

Refer to: 3.7.1.2.1.2.1B(7), of the WA-SRD.

2.3 RATIONALE FOR THE IDENTIFICATION AND LABELING SPECIFICATIONS

Refer to: 3.7.1.2.1.2.15A-F, 3.7.1.2.1.2.1B(8), of the WA-SRD.

2.4 RATIONALE FOR THE CANISTER LENGTH AND DIAMETER SPECIFICATION

The canister must fit freely within the transportation system and the disposal container, within the limits established by the WA-SRD. By demonstrating that the unfilled canisters fall within the dimensional envelope, and by compliance with Specification 3.11 at the time of shipment, these criteria are satisfied.

Refer to: 3.7.1.2.1.2.1B(1-2), of the WA-SRD.

3. CANISTERED WASTE FORM SPECIFICATIONS

Specifications 3.2, 3.3 and 3.5 dictate a fixed 500°C temperature index for reporting purposes. 500°C was chosen because it is a discrete control target which bounds the glass transition temperature for the expected range of waste glass compositions. The glass transition temperature is the temperature above which glass devitrification may occur.

3.1 RATIONALE FOR THE FREE LIQUID SPECIFICATION

Refer to: 3.7.1.2.1B, of the WA-SRD.

3.2 RATIONALE FOR THE GAS SPECIFICATION

Refer to: 3.7.1.2.1.2.9A, of the WA-SRD.

3.3 RATIONALE FOR THE SPECIFICATION FOR EXPLOSIVENESS, PYROPHORICITY, AND COMBUSTIBILITY

Refer to: 3.7.1.2.1C-D, of the WA-SRD.

3.7.1.2.1C. of the WA-SRD states: "The waste form shall not contain explosive, pyrophoric, or chemically reactive materials in an amount that could compromise the repository's ability for waste isolation." "Chemically reactive" is a very broad classification. For purposes of these WAPS, combustible material is considered to be the only credible chemically reactive material possible within the canistered waste form which would compromise the performance of the canistered waste form in the repository as required by the WA-SRD.

3.4 RATIONALE FOR THE ORGANIC MATERIALS SPECIFICATION

Refer to: 3.7.1.2.1.2.9B, of the WA-SRD.

3.5 RATIONALE FOR THE CHEMICAL COMPATIBILITY SPECIFICATION

Refer to: 3.7.1.2.1.2.5, of the WA-SRD.

3.6 RATIONALE FOR THE FILL HEIGHT SPECIFICATION

Refer to: 3.7.1.2.1.2.1B(4), of the WA-SRD.

3.7 RATIONALE FOR THE SPECIFICATION FOR REMOVABLE RADIOACTIVE CONTAMINATION ON EXTERNAL SURFACES

Refer to: 3.7.1.2.1.2.10A-C, of the WA-SRD.

3.8 RATIONALE FOR THE HEAT GENERATION SPECIFICATION

Refer to: 3.7.1.2.1.2.1B(5), of the WA-SRD.

3.9 RATIONALE FOR THE SPECIFICATION FOR MAXIMUM DOSE RATES

Refer to: 3.7.1.2.1.2.17, of the WA-SRD.

3.10 RATIONALE FOR THE SUBCRITICALITY SPECIFICATION

Refer to: 3.7.1.2.1.2.4, of the WA-SRD.

The regulatory requirements as outlined in 10 CFR 60.131(b)(7) state that, "The calculated effective multiplication factor (k_{eff}) must be sufficiently below unity, to show

at least a 5 percent margin, after allowance for the bias in the method of calculation and the uncertainty in the experiments used to evaluate the method of calculation." A k_{eff} of ≤0.90 assures more than the 5 percent margin required by the regulation.

3.11 RATIONALE FOR THE SPECIFICATIONS FOR WEIGHT AND OVERALL DIMENSIONS

Refer to: 3.7.1.2.1.2.1B(3), 3.7.1.2.1.2.18, of the WA-SRD.

3.12 RATIONALE FOR THE DROP TEST

Refer to: 3.7.1.2.1.2.14 Canister Impact Characteristics, of the WA-SRD. This requirement has a <TBR> designation in the WA-SRD.

The drop height of 7 m is based on the maximum lift design height during repository operation. The 7 meter drop of an unprotected canister, i.e. without shipping cask, is an extremely severe test of canister robustness. This test cannot be performed on radioactive canistered waste forms; and cannot be deferred until time of shipment. Therefore prototypical canistered waste forms, containing simulated waste glass, will be dropped. This drop test, in conjunction with Specifications 3.1-3.5, will be used to demonstrate canister robustness.

3.13 RATIONALE FOR THE HANDLING FEATURES SPECIFICATION

Refer to: 3.7.1.2.1.2.16A-E, of the WA-SRD.

4. RATIONALE FOR THE QUALITY ASSURANCE SPECIFICATION

Refer to: 3.9A-D, of the WA-SRD.

5.1 RATIONALE FOR THE SPECIFICATION FOR WASTE ACCEPTANCE DOCUMENTATION

Refer to: 3.7.1.2.1.2.19, 3.7.1.2.1.2.19.1-4, 3.7.3.2.1D-E, of the WA-SRD.

5.2 RATIONALE FOR THE SPECIFICATION FOR TEST PLANS AND PROCEDURES

Refer to: 3.4.4, of the WA-SRD.

5.3 RATIONALE FOR THE SPECIFICATION FOR DELIVERY OF NON-STANDARD WASTE

Refer to: 3.7.1.2.8A-B of the WA-SRD.

5.4 RATIONALE FOR THE SPECIFICATION FOR DOE OBSERVATION AT TIME OF SHIPMENT

Refer to: 3.7.3.2.5A-B, of the WA-SRD.

5.5 RATIONALE FOR THE SPECIFICATION FOR DOE NOTIFICATION OF IMPROPERLY DESCRIBED WASTE

Refer to: 3.7.3.2.6, of the WA-SRD.

5.6 RATIONALE FOR THE SPECIFICATION FOR RESOLUTION OF IMPROPERLY DESCRIBED ACCEPTED WASTE

Refer to: 3.7.4.2.1, of the WA-SRD.

5.7 RATIONALE FOR THE SPECIFICATION FOR TRANSFER OF TITLE TO DOE

Refer to: 3.7.3.2.4B-C, of the WA-SRD.

5.8 RATIONALE FOR THE SPECIFICATION FOR HLW ANNUAL REPORT

Refer to: 3.7.1.2.1.2.20, of the WA-SRD.

5.9 RATIONALE FOR THE SPECIFICATION FOR FINAL DESCRIPTION OF WASTE

Refer to: 3.7.1.2.10, of the WA-SRD.

5.10 RATIONALE FOR THE SPECIFICATION FOR DOE/EM FEE PAYMENT

Refer to: 3.7.1.2.2E&H, of the WA-SRD.

5.11 RATIONALE FOR THE SHIPPING CASK CONDITION SPECIFICATION

Refer to: 3.7.3.2.1A, 3.7.3.2.3, of the WA-SRD.

5.12 RATIONALE FOR CASK SYSTEM PACKAGING SPECIFICATION

Refer to: 3.7.3.2.1B, of WA-SRD.

5.13 RATIONALE FOR SPECIFICATION FOR RADIOTOXICITY AT TIME OF SHIPMENT

Refer to: 3.7.3.2.1C of the WA-SRD.

5.14 HLW RECEIPT

Refer to: 3.2.1.2 of the WA-SRD.

Section III(a)(5) of the Nuclear Waste Policy Act (NWPA) states:

> The generators and owners of high-level waste and spent nuclear fuel have the primary responsibility to provide for, and the responsibility to pay the costs of, the interim storage of such waste and spent fuel until such waste and spent fuel is accepted by the Secretary of Energy in accordance with the provisions of this act.

The waste producers interpret 3.2.1.2 of the WA-SRD to also include HLW, although the text does not specifically mention HLW. The requirement does reference the above citation from the NWPA.

APPENDIX B

REFERENCES FOR WASTE ACCEPTANCE PRODUCT SPECIFICATIONS FOR VITRIFIED HIGH-LEVEL WASTE FORMS

[1] U.S. Department of Energy, Waste Acceptance (WA) Systems Requirements, Revision 0.

[2] U.S. Department of Energy, Environmental Assessment-Waste Form Selection for SRP High-Level Waste, USDOE Report DOE/EA 0179, Washington, DC (1982).

[3] Jantzen, C.M., "Nuclear Waste Product Consistency Test Method Version 5.0," WSRC-TR-90-539, Westinghouse Savannah River Company (January 1992).

[4] C. M. Jantzen, "Characterization of the Defense Waste Processing Facility (DWPF) Environmental Assessment (EA) Glass Standard Reference Material," WSRC-TR-92-346, Westinghouse Savannah River Company, Aiken, SC (September 1992).

[5] 40CFR261.20 through 40CFR261.24

[6] 40CFR261.31 through 40CFR261.33

[7] 56 Federal Register 26986

[8] ASTM Book of Standards

[9] U.S. Department of Energy, Quality Assurance Requirements and Description for the Civilian Radioactive Waste Management Program, DOE/RW-0333P, rev.0 (December 1992).

[10] 10CFR60

APPENDIX C

CROSS REFERENCE BETWEEN THE EM-WAPS SPECIFICATIONS AND THE WA-SRD REQUIREMENTS

EM-WAPS	WA-SRD
1.1	3.7.1.2.1A, 3.7.1.2.1.2.1A
1.1.1	3.7.1.2.1.2.6A
1.1.2	3.7.1.2.1.2.6B
1.2	3.7.1.2.1.2.8
1.2.1	-
1.2.2	-
1.3	3.7.1.2.1.2.13A
1.3.1	3.7.1.2.1.2.13A-B
1.3.2	-
1.4.1	3.7.1.2.1.2.11B
1.4.2	3.7.1.2.1.2.11A, 3.7.1.2.1.2.1B(6)
1.5	3.7.1.2.1.2.12A-D
2.1	3.7.1.2.1.2.7
2.2	3.7.1.2.1.2.1B(7)
2.3.1	3.7.1.2.1.2.1B(8), 3.7.1.2.1.2.15A
2.3.2	3.7.1.2.1.2.15B-F
2.4.1	3.7.1.2.1.2.1B(1)
2.4.2	3.7.1.2.1.2.1B(2)
3.1	3.7.1.2.1B
3.2	3.7.1.2.1.2.9A
3.3	3.7.1.2.1C
3.4	3.7.1.2.1.2.9B
3.5	3.7.1.2.1.2.5
3.6	3.7.1.2.1.2.1B(4)
3.7	3.7.1.2.1.2.10A-~~C~~ B
3.8	3.7.1.2.1.2.1B(5)
3.8.1	-
3.8.2	-
3.9	3.7.1.2.1.2.17
3.9.1	-
3.9.2	-
3.10	3.7.1.2.1.2.4
3.11.1	3.7.1.2.1.2.1B(3)
3.11.2	3.7.1.2.1.2.18 → 3.7.1.2.1.2.10C

CROSS REFERENCE BETWEEN THE EM-WAPS SPECIFICATIONS AND THE WA-SRD REQUIREMENTS (continued)

EM-WAPS	WA-SRD
3.12	3.7.1.2.1.2.14
3.13	3.7.1.2.1.2.16A-E, 3.7.1.2.1.2.1A
4	3.9A-D, 3.7.1.2.1D, 3.7.1.2.8B
5.1	3.7.1.2.1.2.19, 3.7.1.2.1.2.19.1-4, 3.7.3.2.1D-E
5.2	3.4.4
5.3	3.7.1.2.8A
5.4	3.7.3.2.5A-B
5.5	3.7.3.2.6
5.6	3.7.4.2.1
5.7	3.7.3.2.4B-C , 3.7.1.2.2H
5.8	3.7.1.2.1.2.20
5.9	3.7.1.2.10
5.10	3.7.1.2.2E
5.11	3.7.3.2.1A, 3.7.3.2.3
5.12	3.7.3.2.1B
5.13	3.7.3.2.1C
5.14	3.2.1.2

Note: WA-SRD 3.7.1.2.1.2.2 and 3.7.1.2.1.2.3 are definitions; not requirements.