United States
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Office of Environmental Management

Waste Acceptance Product Specifications (WAPS)
For Vitrified High-Level Waste Forms

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WASTE ACCEPTANCE PRODUCT SPECIFICATIONS
FOR VITRIFIED HIGH-LEVEL WASTE FORMS

WAPS

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INTRODUCTION

The U.S. Department of Energy (DOE) Office of Environmental Management (EM) developed these Waste Acceptance Product Specifications (WAPS) for the canistered vitrified high-level radioactive waste (HLW) form Producers and Federal Waste Custodians as the basis for their waste acceptance programs. This introduction provides background information detailing: the purpose of the WAPS, the groups involved, their roles in the waste acceptance process, and the deliverables required by that waste acceptance process.

The WAPS are the technical specifications the waste form Producers are required to meet in order to ensure acceptance of their vitrified HLW waste form into the DOE Civilian Radioactive Waste Management System (CRWMS). The CRWMS was managed under the DOE Office of Civilian Radioactive Waste Management (RW) and will therefore be referred to as RW throughout the WAPS. When the waste acceptance process was first defined in 1985, the DOE Office of Civilian Radioactive Waste Management (RW)[1] was to provide specifications. However, RW was redefining its technical and functional baseline as new Congressional/ regulatory policy was enacted and/or new technical compliance specifications were approved by the appropriate regulatory agencies. RW has opted to pass to EM the responsibility for providing product specifications to the waste form Producers. EM is committed to ensuring that the WAPS are in concert with the technical baseline listed in the Waste Acceptance System Requirements Document (WASRD) [1]. The RW technical baseline is defined in the (WASRD) [1], the EM/RW Memorandum of Agreement (MOA) for Acceptance of Department of Energy Spent Nuclear Fuel (SNF) and High-Level Radioactive Waste (HLW) [2], and the RW Integrated Interface Control Document (IICD), Volume 1 [3].

The WAPS governs all elements of the canistered vitrified HLW waste form. These elements include: the borosilicate waste glass, the stainless steel canister and the sealed canistered waste form. The WAPS also provides quality assurance requirements which must be imposed on high level waste production and specifications outlining waste Producer, EM and RW waste acceptance documentation requirements. Appendix C provides a table which cross-references each WAPS specification to the corresponding WASRD, MOA, or the IICD requirement(s).

The underlying rationale for most of the WAPS requirements can be traced to the MOA, the IICD, or the WASRD. Appendix A points to the appropriate WASRD, IICD, and/or MOA requirements and provides substantiating information where clarification is needed. The MOA, IICD and the WASRD are binding documents, and the waste form Producers are obliged to comply with it them. Three of the specifications in the WASRD are "to be verified or determined" <TBV/ D>. In spite of the <TBV/ D> designation in the WASRD, these specifications are binding to the waste form Producers. EM has opted to reflect this by not extending the <TBV/D> qualification to the WAPS. Changes to the WASRD, IICD, or the MOA, which change HLW requirements, specifications, or the <TBV/ D> designations will be tracked and these changes will be reflected in subsequent revisions to the 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 for concurrence as specified in the MOA. These four documents are: (1) the Waste Form Compliance Plan

[1] The DOE Office of Civilian Radioactive Waste Management (RW) is referred to throughout this document although it is recognized that this DOE office no longer exists and was abolished on September 30, 2010. However, its name has been retained in this document until DOE names a replacement organization(s) that performs the previously defined RW functions and activities. The DOE Memorandum of Acceptance for Maintenance of the Yucca Mountain Site, September 16, 2010, identifies the DOE offices that were assigned selected RW responsibilities.

(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 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; the Waste Treatment and Immobilization Plant (WTP), Hanford Reservation, Richland, Washington; and the Idaho National Laboratory (INL), Idaho[2].

All HLW waste forms shall comply with the applicable provisions of the Nuclear Waste Policy Act of 1982 (as amended)[3], appropriate Department of Transportation (DOT), and Nuclear Regulatory Commission (NRC) regulations for transportation, storage, and final disposal. The Code of Federal Regulations that apply to immobilized HLW waste forms for disposal in an NRC licensed repository are 10 CFR 63 [4] and 10 CFR 71-73 [5,6,7] inclusive.

The following public internet World Wide Web (www) addresses list NRC and DOE web sites that provide general information:

U.S. NRC: www.nrc.gov
DOE Headquarters: www.energy.gov
National Spent Nuclear Fuel Program (NSNFP): http://nsnfp.inl.gov
DOE Office of River Protection: www.hanford.gov
DOE Savannah River Site: www.srs.gov
DOE West Valley Demonstration Project: www.wv.doe.gov

This revision of the WAPS was prepared to address changes to the RW acceptance requirements as reflected in Revision 5, ICN 01 of the WASRD, dated May 2007 [1], the Integrated Interface Control Document (IICD), Revision 4, ICN 1, dated August [3], and Revision 2 of the MOA, effective in January 2007 [2]. Major changes reflected in this Revision 3 of the WAPS include the following:

- Incorporation of the WTP 4.5 m canister, including maximum specifications for heat, mass, and dimensions;
- Introduction of new requirements or changes to existing HLW waste form requirements stemming from RW revisions to the technical baseline (e.g., metric tons of heavy metal, defect reporting, preclosure and postclosure criticality requirements) deletion of certain requirements (e.g., canister fill height) transfer of selected EM Producer fees, shipping, and program requirements to the MOA, and incorporation of selected physical requirements from the IICD;
- Clarification for hazardous waste;
- Listing of internet web sites for DOE HLW information;
- Revision of the HLW waste form canister summary data sheet;
- Addition of an appendix providing guidance for recording and submitting nonconforming HLW waste forms; and
- Revision/ addition of new HLW waste form source requirements and documents.

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[2] Formerly, the DOE Idaho (ID) High-Level Waste treatment method had been to vitrify the calcine. However, recent DOE ID plans now specify Hot Isostatic Processing (HIP) instead. Future WAPS revisions will address these changes.

[3] 42 U.S.C. 10101 et seq, *The Nuclear Waste Policy Act of 1982* (as amended).

1.0 WASTE FORM SPECIFICATIONS

1.1 CHEMICAL SPECIFICATION

The standard vitrified HLW form is borosilicate glass inside a sealed canister [8]. Subject to review and approval by the Office of Civilian Radioactive Waste Management (RW), alternative HLW waste forms are possible, if the HLW waste form complies with the HLW definition listed in the Nuclear Waste Policy Act of 1982 (as amended) [9].

1.1.1 Chemical Composition Projections

In the Waste Form Qualification Report (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 Waste Form Compliance Plan (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), including an estimate of inventory uncertainty, 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)[4] benchmark glass [10]. 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) [11]. 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 [8]. 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. A suggested 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. Alternative acceptance criteria methods are possible, subject to RW review and approval.

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

[4] Appendix F contains the PCT results of the EA glass reference material from the DWPF and WVDP testing programs.

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

(a) The glass transition temperature [12,13,14]; 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 [12,13,14]. The Producer shall describe the method of compliance in the WCP.

1.5 HAZARDOUS WASTE SPECIFICATION

Prior to acceptance of HLW by RW, Producers and Federal Waste Custodians, must determine and document that Resource Conservation and Recovery Act (RCRA 1976) Subtitle C regulated wastes are not present, and develop appropriate data to assure state and/or U.S. Environmental Protection Agency (EPA) RCRA requirements are addressed. The Producer shall determine and report to RW the presence or absence of any regulated hazardous waste listed in 40 CFR 261.31 through 40 CFR 261.33, in the waste or in any feed stream proposed for storage or disposal [15]. Any RCRA-listed component in a waste shall require the Producer to petition EPA and receive exemption to delist the waste.

The Producer shall perform the appropriate tests and procedures, as described in 40 CFR 261.20 through 40 CFR 261.24, using samples from production runs or prototypical specimens to determine if the waste that will be received by RW, for transportation and disposal, has hazardous characteristics or concentrations that would subject the waste to regulation under RCRA, unless granted exception as may be stipulated in response to the aforementioned petition for exemption [16]. Any waste that is shown to have hazardous characteristics shall be treated to remove such characteristics.

Prior to transfer to RW, the Producer shall report and certify in the WQR that the waste is not regulated as hazardous waste and has neither characteristic nor listed waste. The characteristic testing methods to be used shall be described in the WCP and the results documented in the WQR. Any modification to these methods needs prior review and approval from RW.

1.6 IAEA SAFEGUARDS REPORTING FOR HLW

The Producer shall comply with the 10 CFR 75.33 [17] radionuclide reporting requirements (Implementation of US/IAEA Agreement) by completing the NRC Form 741, Nuclear Material Transaction Report, as provided in NUREG/BR-0006, "Instructions for Completing Nuclear Material Transaction Reports," U.S. NRC, Office of Nuclear Material Safety and Safeguards [18]. The IAEA requires reporting of certain data to ensure safeguards and security of radioactive materials. The Producer shall report this basic technical radionuclide information in the Production Records, in such a manner, to allow any additional calculations, data processing, or analysis necessary to complete the NRC Form 741, Nuclear Material Transaction Report, prior to offsite shipment of the canistered waste form.

2.0 CANISTER SPECIFICATIONS[5]

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 [19] or other nationally recognized alloy specifications and the compositions of the canister materials, the canister label materials, any secondary canister material, canister closure plug/lid or repair plug/lid, and any filler materials used in welding shall be described 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 less than $1x10^{-4}$ ref-cc/sec [20]. 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

[5] The High-Level Waste Summary Data pertaining to the canister and the canistered waste form is provided, in table format, in Appendix E.

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 describe in the WCP that the strategy for meeting these specifications will meet the requirements of the WASRD. All dimensions are measured at a temperature of 21.11^{0}C +/- 4.440^{0}C, unless otherwise specified in the WQR.

2.4.1 Length Specification

There are two separate distinct HLW waste form canister types: the DOE Savannah River Site (DOE SRS) Defense Waste Processing Facility (DWPF)/ West Valley Demonstration Project (WVDP) short canister; and the DOE Waste Treatment and Immobilization Plant (WTP), Office of River Protection (ORP), Hanford, long canister. For DWPF and WVDP, the length of the unfilled short canister, after accounting for the closure method, shall be 3.000 m (+ 0.005 m, - 0.020 m), including the neck and lifting flange. For WTP, the length of the unfilled long canister, after accounting for the closure method, shall be 4.500 m (+ 0.005 m, - 0.020 m), including the neck and lifting 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 DWPF, WVDP short and the WTP long unfilled canisters 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.

3.0 CANISTERED WASTE FORM SPECIFICATIONS

3.1 FREE LIQUID SPECIFICATION

The Producer shall determine that the sealed HLW canistered waste form contains no residual water beyond that condensing from water vapor inside the canister as it cools. 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 TAMPER INDICATING SEALS FOR HIGH-LEVEL WASTE CANISTERS

All HLW waste form canisters that contain special nuclear material greater than low strategic significance, as defined in 10 CFR 74.4, Definitions [21], and that are not sealed, consistent with 10 CFR 74.55(a)(2), Item Monitoring [21], and Nuclear Regulatory

Commission (NRC) guidance in NUREG-1280, Rev. 1, Section 2.1.3 must have an intact, properly installed tamper-indicating device [22]. Welding (for HLW waste form canisters) is an acceptable method to meet this requirement. If alternative tamper-indicating devices (TIDs) are employed, they must be equivalent to the functional features outlined in the NRC's Regulatory Guide 5.15, Tamper Indicating Seals for the Protection and Control of Special Nuclear Material [23].

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 in the event that the temperature exceeds 400°C [12,13,14]. If a canistered waste form exceeds 400°C, it is nonconforming and shall be resolved in accordance with Section 4.0. Data/information reporting in the WQR, during the qualification process, shall be limited to temperatures up to 500°C. The HLW Producer must ensure, through information provided in the WCP or WQRs, that the amounts of explosive, pyrophoric, or combustible materials do not impact waste treatment activities or final canistered waste form integrity.

3.4 ORGANIC MATERIALS SPECIFICATION

The Producer shall ensure that after closure, the canistered waste form does not contain detectable amounts of organic materials. Specific DWPF, WVDP or WTP allowances for organic concentrations in the borosilicate glass waste form are determined and listed in the individual site's WCP. The HLW Producer must ensure, through information provided in the WCP or WQRs, that the organic concentration does not impact waste treatment activities or final canistered waste form integrity. 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 canister materials or contents of the canistered waste form do not cause chemical, electrochemical, or other reactions (such as internal corrosion) of the canister that could adversely affect normal handling, during storage, transportation, repository emplacement, containment, isolation, 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, in the event that the temperature exceeds 400°C, shall be discussed in the WQR. If a canistered waste form exceeds 400°C, then it is nonconforming and shall be resolved in accordance with Section 4.0. Data/information reporting in the WQR, during the qualification process, shall be limited to temperatures up to 500°C.

3.6 HIGH LEVEL CANISTERED WASTE FORM METRIC TONS OF HEAVY METAL CONTENT

The HLW Producer shall record the Metric Tons of Heavy Metal for each HLW produced canister and document this value in the Shipping and Storage Records and WQRs [24].

3.7 SPECIFICATION FOR REMOVABLE RADIOACTIVE CONTAMINATION ON EXTERNAL SURFACES

The level of non-fixed (removable) radioactive contamination on the exterior surface of each canistered waste form may be determined by wiping an area of 300 cm^2 of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material. At the time of shipment, the nonfixed radioactive contamination on the wiping material shall not exceed 22,000 dpm/100 cm^2 of canister surface wiped for beta and gamma emitting radionuclides and 2,200 dpm/100 cm^2 of canister surface wiped for alpha emitting radionuclides. Sufficient measurements shall be taken in the most appropriate locations to yield a representative assessment of non-fixed contamination levels.

In addition, the Producer shall visually inspect each canistered waste form and remove visible waste glass from the exterior before shipment.

Per the MOA, EM is responsible for interim storage of the canistered HLW. Therefore for this specification, the local DOE site EM HLW Manager shall determine whether to require external canister decontamination removal before relocation to an on-site interim storage facility, or schedule the decontamination removal before off-site shipment to RW. For either choice, the HLW canister must meet the removable radioactive limits listed in the first paragraph of this section before final off-site shipment.

The Producer shall describe the plans for demonstrating compliance in the WCP. The Producer shall provide the non-fixed radioactive 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 [25].

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, at the time of shipment.

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

3.10.1 Pre-Closure Criticality

The HLW Producer shall provide qualified data to ensure RW can demonstrate preclosure safety requirements relating to criticality, as follows: demonstrate that the HLW and its canister, in conjunction with the facility systems, structures, and components, shall provide the basis for ensuring subcriticality at the time of delivery to the geologic repository and during all subsequent handling operations, including all event sequences that are important for criticality and have at least one chance in 10,000 of occurring before permanent closure. The HLW Producer will provide methodology to account for the biases and uncertainties in both the calculations and experimental data used in the development of the effective neutron multiplication factor (k_{eff}), and will also include a technically justified administrative margin (Δkm) following the guidance in Fuel Cycle Safety & Safeguards-Interim Staff Guidance [26]

3.10.2 Post-Closure Criticality

HLW Producers shall provide qualified data to ensure RW can demonstrate postclosure safety requirements relating to criticality, as follows: The methodology described in the Disposal Criticality Analysis Methodology Topical Report (YMP/TR-004Q) shall be used to meet 10 CFR 63 postclosure criticality requirements to demonstrate that the total probability of criticality for all HLW canisters shall not cause the total probability of criticality for all waste forms to exceed one chance in 10,000 over the first 10,000 years after permanent closure of the repository [27].

The Producer shall describe the method of demonstrating compliance in the WCP and provide supporting documentation in the WQR.

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

There are two distinct maximum canister mass limits. The weight of a filled and sealed HLW the canistered waste form shall not exceed 2,500 kg for the DWPF/WVDP 3.0 m short canister or 4,200 kg for the WTP 4.5 m long canister. The measured weight and estimated error shall be reported in the Storage and Shipping Records.

3.11.2 Specification for Overall Dimensions

There are two distinct overall dimensional limits. The dimensions of the canistered waste form shall be such that, at the time of delivery, 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 for the DWPF/WVDP short canister or 64.0 cm in diameter and 4.51 m in length for the WTP long canister. 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 or dispersing radionuclides (i.e., canister

gas leak rates shall be leaktight <$1x10^{-4}$ ref-cc/sec after a canister drop) [20]. 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 in loading and unloading a transportation cask with a standard 3.0 m short or a 4.5 m long HLW canister at the repository, which satisfies the following requirements:

(a) The grapple shall be capable of being remotely engaged with and remotely 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 (standard) 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 (standard) 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.

3.14 CONCENTRATION OF PLUTONIUM IN EACH CANISTER SPECIFICATION

The total sum concentration of fissile isotopes (uranium and plutonium) in each HLW standard 3.0 m short or 4.5 m long canister shall be equal to or less than 897 grams per cubic meter as evaluated by the Yucca Mountain Project [28]. The sum concentration shall be reported in the Production Records. Subsequent future WAPS revisions will address this value and/or provide clarification, as necessary.

4.0 QUALITY ASSURANCE SPECIFICATION

4.1 QUALITY ASSURANCE

The Producer shall establish, maintain, and execute a quality assurance (QA) program that applies to the testing and analysis activities that demonstrate compliance with the WAPS during waste form qualification, production, acceptance, 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 QARD [29]; and the Civilian Radioactive Waste Management System Waste Acceptance System Requirements Document (WASRD) [1]; and the QA requirements in the MOA [2].

4.2 NON-CONFORMANCES

The HLW Producer shall submit an action plan for disposition of nonconformances that will be reviewed and concurred in by EM and Headquarters personnel and reviewed and approved by RW. The action plan must adequately identify and describe the nonconformance, the extent of the nonconformance, any action to change or correct the nonconformance, an evaluation of how the nonconformance will impact RW HLW requirements, and any actions needed to preclude recurrence. A nonconforming waste form will not be accepted by RW unless RW reviews and approves an action plan. Only action plans concurred by EM and approved by RW will be implemented. For classification and reporting purposes, nonconforming HLW is that which fails to meet any of the WAPS requirements listed herein or that fail to perform its stated function during cask loading, transportation, handling, or interim storage. The HLW/SNF MOA [2] outlines the method to disposition nonconforming waste forms. Action plan guidance, listing the minimal information required in an action plan, is provided in Appendix D, Guidance For Completing Waste Acceptance Action Plans. Also, improperly described HLW shall be dispositioned per the MOA.

Additionally, EM will comply with Code of Federal Regulations, Reporting of Defects and Noncompliance 10 CFR 21, by reporting defects or noncompliance to RW using the nonconformance Action Plan process listed in this section, the MOA, and Appendix D, Guidance for Completing Waste Acceptance Actions Plans [30]. RW (or its successor organization), as the "licensee," retains the responsibility for 10 CFR 21 reporting to the NRC. Approved EM Action Plans will be provided to RW for their use in fulfilling 10 CFR 21 reporting requirements to the NRC. Currently, the extent of the applicability of the NRC's 10 CFR 21 reporting for the HLW canister and the HLW borosilicate glass waste is not well defined for EM HLW Producers and Federal Waste Custodians. Subsequent revisions to the WAPS will provide compliance clarification, as necessary.

5.0 DOCUMENTATION AND OTHER REQUIREMENTS

5.1 SPECIFICATION FOR WASTE ACCEPTANCE DOCUMENTATION

The following waste acceptance documentation shall be developed by the waste form Producer, revised as necessary, maintained as lifetime QA 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 a description of 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.

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. APPENDIX G: SUMMARY OF CONTENTS OF HIGH-LEVEL WASTE PRODUCTION AND SHIPPING AND STORAGE RECORDS, lists the WAPS sections that require PR or Storage and Shipping Record information.

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. APPENDIX G: SUMMARY OF CONTENTS OF HIGH-LEVEL WASTE PRODUCTION AND SHIPPING AND STORAGE RECORDS lists the WAPS sections that require PR or Storage and Shipping Record information.

WAPS Specifications 5.2 through 5.6 are derived from the WASRD. The WASRD provides them as guidance to Producers and DOE and the WAPS includes them for completeness. At the option of the EM HLW site manager, the Documentation addressing specifications 5.2-5.6 may appear in either the WCP or the WQR. The format for complying with specifications 5.2-5.6 is encompassed in the specifications themselves.

5.2 SPECIFICATION FOR HIGH-LEVEL WASTE TRANSACTION REPORTING

At time of HLW canistered waste form delivery to RW, the Producer shall provide a completed DOE/NRC Form-741 Nuclear Material Transaction Reports, traceable to individual canister labels in accordance with applicable instructions and requirements in NRC NUREG/BR-0006 [18]. Transfers shall be reported on a per-shipment basis and each item (e.g., canister) shall be entered as a line item on the form. EM shall establish and enter applicable element and isotope values on Form-741. Additionally, a properly completed off-site radioactive shipment record, in accordance with 49 CFR 172 describing cask contents, must be prepared by authorized EM representatives [31].

5.3 SPECIFICATION FOR DELIVERY OF NONCONFORMING WASTE FORMS

The Producer shall not ship nonconforming waste forms until RW has reviewed and approved the appropriate nonconforming waste form action plan. See WAPS, Section 4.0 and the MOA for further details. Emergency acceptance of EM HLW may be made as agreed to by RW.

5.4 SPECIFICATION FOR TRANSFER OF HLW TO RW

The Producer shall provide a designated facility at their site for HLW and records packages (Production Records and Shipping and Storage Records) transfer and acceptance of the canistered waste forms to RW. Copies of records packages shall be made available to the

RW administrator for review and approval at a time mutually agreeable to EM and RW, prior to the scheduled acceptance.

5.5 SPECIFICATION FOR HLW ANNUAL REPORT

EM HLW Producers shall report annually on the production of HLW waste forms, projections of remaining production, and any production trends which may influence properties of canistered waste forms[6]. Additionally, reports shall identify any nonconforming waste forms and the status of actions to address the nonconforming condition(s).

5.6 HLW RECEIPT

The Producer or EM shall be responsible for interim storage of HLW canisters until acceptance by RW. EM shall be responsible for construction and maintenance of EM facility capability and assurance of DOE site infrastructure (e.g., access to rail, loading facility) to support RW acceptance.

6 For the interim, EM will be the recipient office for this annual report(s) to meet this specification.

GLOSSARY FOR THE WASTE ACCEPTANCE PRODUCT SPECIFICATIONS

Borosilicate waste glass – For EM HLW production definition purposes, it's the immobilized solid glass form typically containing approximately 20 to 60 wt.% waste oxides, 33 to 65 wt.% silica, 3 to 20 wt.% boron oxide, and 5 to 22 wt.% alkali oxides, plus other oxide constituents. See APPENDIX H for additional chemical, physical, and technical information on borosilicate glass.

Canister – is the structure surrounding the waste form (e.g., HLW immobilized in borosilicate glass) that facilitates handling, storage, transportation, and/or disposal. A canister for solidified HLW is a metal receptacle whose purpose is a pour mold. HLW canister dimensions are provided in WAPS Section 3.11.

Canister breach – loss of canister leaktightness.

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

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

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 chemical or electrochemical (essentially oxidizing) processes. Corrosive materials are considered to be "chemically reactive".

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 173, Subpart C, Classes A and B.

Federal Waste Custodian – is the DOE field office site organization responsible for the management of SNF and HLW under the oversight of the Office of Environmental Management.

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, and subsequently cooled.

Glass transition temperature – upon heating, the temperature at which the glass transforms from a rigid solid to a viscous liquid. The temperature corresponds to < 500°C, for most, if not all, borosilicate waste glasses.

Grapple – a mechanical device designed to mate with (i.e., physically attach to) the HLW canister's lifting flange, and used to suspend the canistered waste form from an overhead crane for lifting and movement.

Hazardous waste – waste which is defined as hazardous in the Code of Federal Regulations, Definition of Hazardous Waste, 40 CFR 261.3.

High-Level Radioactive Waste (HLW) – means (1) the highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentration, and (2) other highly radioactive material that the Nuclear Regulatory Commission, consistent with existing law, determines by rule requires permanent isolation (Nuclear Waste Policy Act of 1982, as amended). For the purposes of this document, vitrified HLW is a borosilicate waste glass solid that has been cast in a stainless steel canister.

Leaktightness – a leakage rate of less than $1x10^{-4}$ ref-cc/sec at a pressure of 1 atmosphere, absolute (760 mm Hg) and 25°C. ANSI N14.5-1997, *Radioactive Materials – Leakage Tests on Packages for Shipment*, February 5, 1998.

Lifting flange – a protruding rim, edge, rib or collar located on the top of a standard 3.0 m short or 4.5 m long HLW canister. The flange is used to facilitate handling or movement of the canister.

Nonconforming canistered waste – is an individual HLW waste form that has been produced, handled, or stored such that its compliance with the WAPS, WASRD, IICD, or the MOA requirements, for waste forms, cannot be demonstrated.

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.

Producer – is any generator of HLW resulting from atomic energy defense activities or any Producer or Federal Waste Custodian of vitrified commercial HLW activities who has executed an acceptance and disposal contract. For purposes of this document, the WVDP, which has commercial HLW, will be considered a Producer.

Product Consistency Test (PCT) – the PCT is an ASTM-approved (ASTM C1285), crushed glass leachability test procedure used to measure the concentration of chemical species released from a crushed glass to a test solution. The PCT is not a measure of glass composition itself.

Production Record (PR) – is the document, generated and provided by the HLW Producer that describes an actual produced canistered waste form. See Appendix G for a listing of PR specifications.

Pyrophoric Material – is any liquid material that will ignite spontaneously in air below 54.4^{0}C, or is any solid material which is not classified as explosive material, and that is likely or capable of igniting spontaneously through friction or retained heat form processing, and burns vigorously and persistently when ignited under conditions specific to HLW storage, transportation and/or handling. Also defined in 49 CFR 172.

Rem or **rem** – roentgen equivalent man. A unit used, in radiation protection, to measure the amount of damage to human tissue from a dose of ionizing radiation.

Shipping and Storage Record (SSR) – is the document, generated and provided by the HLW Producer that describes the physical attributes of each (individual) canistered waste form and identifies any abnormal events, such as thermal excursions, which have occurred during storage. See Appendix G for a listing of SSR specifications.

Waste Form – the radioactive waste materials and any encapsulating or stabilizing matrix (source: 10 CFR 63.2)

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 very descriptive results, data, information, tables, analysis, process flow charts, graphs, and diagrams from waste form testing and analysis which develops in detail the case for compliance with each waste acceptance specification as defined in the WAPS, as necessary.

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. 0 WASTE FORM SPECIFICATIONS

RATIONALE FOR THE CHEMICAL SPECIFICATION

Refer to: 4.2.4, 4.8.1.A in the WASRD.

1.2 RATIONALE FOR THE RADIONUCLIDE INVENTORY SPECIFICATION

Refer to: 5.4.1.B(2) in the WASRD.

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 [9]. The index years are 2015 and 3115. Future WAPS revisions will change these index years as necessary.

1.3 RATIONALE SPECIFICATION FOR THE PRODUCT CONSISTENCY

Refer to: 4.8.1.B.1 in the WASRD.

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 [10] as a benchmark for the waste form Producers. 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 SPECIFICATION FOR THE PHASE STABILITY

Refer to: 5.4.1.B(3) of the WASRD.

The glass transition temperature is the temperature point where the borosilicate glass turns from a rigid solid to a viscous liquid. This temperature point corresponds to a glass temperature less than 500°C for most borosilicate glass.

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. References:

- DWPF WQR Volume 7, WSRC-IM-91-116-7, Phase Stability and Control of the Temperature of the DWPF Product (U);

- Carol M. Jantzen, Sharon L Marra., Amy A. Ramsey, Westinghouse Savannah River Company, Aiken, S.C., "*DWPF Glass Transition Temperatures – What They Are and Why They Are Important*", Ceramic Transactions V.23, G.G. Wicks, D.F. Bickford, R. Bunnell (Eds.); American Ceramic Society, Westerville, OH., Nuclear Waste Management IV, 465-473 (1991) [13];.
- S. L. Marra, R. E. Edwards, C. M. Jantzen, Westinghouse Savannah River Company; Savannah River Site, Aiken, South Carolina, "*Thermal History and Crystallization Characteristics of The DWPF Glass Waste Form* (U)", WSRC-MS-92, 018, DE92 015323 [14]; and
- DOE Yucca Mountain Repository License Application Safety Analysis Report, DOE/RW-0573, update No. 1, November 2008, Chapter 1, Section 1.5.1.2.1.2.3, *Canister Thermal Controls* [12].

1.5 RATIONALE FOR THE HAZARDOUS WASTE SPECIFICATION

Refer to: 4.2.2 of the WASRD.

1.6 RATIONALE FOR THE IAEA SAFEGUARDS REPORTING FOR HLW SPECIFICATION

Refer to: 3.2.A, 4.8.10, and 5.4.1.B(10) of the WASRD,10 CFR 75.33, Safeguards on Nuclear Material- Implementation of US/IAEA Agreement, Accounting Reports [17] and U. S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, NUREG/BR-0006, Instructions for Completing Nuclear Material Transaction Reports (DOE/NRC Forms 741 and 740M), Revision 7, effective date: January 1, 2009 [18]. The IAEA requires reporting of certain data to ensure safeguards and security of radioactive materials.

2.0 CANISTER SPECIFICATIONS

2.1 RATIONALE FOR THE MATERIAL SPECIFICATION

Refer to 4.2.3.C, 4.2.8, 5.4.1.B(5) of the WASRD and MOA sec. VI.A.2.

2.2 RATIONALE FOR THE FABRICATION AND CLOSURE SPECIFICATION

Refer to: 4.8.6 of the WASRD.

2.3 RATIONALE FOR THE IDENTIFICATION AND LABELING SPECIFICATIONS

Refer to: 4.8.7, 5.4.1.B(8) of the WASRD.

2.4 RATIONALE FOR THE CANISTER LENGTH AND DIAMETER SPECIFICATION

Refer to: 4.2.3.C, 4.8.3 of the WASRD and IICD Sec. 5.1, & 13, Appendix C Figures C-7/8/9.

3.0 CANISTERED WASTE FORM SPECIFICATIONS

3.1 RATIONALE FOR THE FREE LIQUID SPECIFICATION

Refer to: 4.8.9 of the WASRD.

3.2 RATIONALE TAMPER INDICATING SEALS SPECIFICATION FOR THE HIGH LEVEL WASTE CANISTERS

Refer to: 4.2.9.A of the WASRD, NRC NUREG-1280, and 10 CFR 74.55(a)(2)

3.3 RATIONALE SPECIFICATION FOR EXPLOSIVENESS, PYROPHORICITY, AND COMBUSTIBILITY

Refer to: 4.2.5, 5.4.1.B(9), 5.4.3.C of the WASRD.

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. Glass transition temperature references:

- DWPF WQR Volume 7, WSRC-IM-91-116-7, Phase Stability and Control of the Temperature of the DWPF Product (U);
- Carol M. Jantzen, Sharon L Marra., Amy A. Ramsey, Westinghouse Savannah River Company, Aiken, S.C., "*DWPF Glass Transition Temperatures – What They Are and Why They Are Important",* Ceramic Transactions V.23, G.G. Wicks, D.F. Bickford, R. Bunnell (Eds.); American Ceramic Society, Westerville, OH., Nuclear Waste Management IV, 465-473 (1991);
- S. L. Marra, R. E. Edwards, C. M. Jantzen, Westinghouse Savannah River Company; Savannah River Site, Aiken, South Carolina, "*Thermal History and Crystallization Characteristics of The DWPF Glass Waste Form* (U)", WSRC-MS-92, 018, DE92 015323; and
- DOE Yucca Mountain Repository License Application Safety Analysis Report, DOE/RW-0573, update No. 1, November 2008, Chapter 1, Section 1.5.1.2.1.2.3, *Canister Thermal Controls.*

3.4 RATIONALE FOR THE ORGANIC MATERIALS SPECIFICATION

Refer to: 4.2.6, 5.4.1.B(4), 5.4.3.C of the WASRD.

3.5 RATIONALE FOR THE CHEMICAL COMPATIBILITY SPECIFICATION

Refer to: 4.8.2 of the WASRD. Glass transition temperature reference: Carol M. Jantzen, Sharon L Marra., Amy A. Ramsey, Westinghouse Savannah River Company, Aiken, S.C., "*DWPF Glass Transition Temperatures – What They Are and Why They Are Important",* Ceramic Transactions V.23, G.G. Wicks, D.F. Bickford, R. Bunnell (Eds.); American Ceramic Society, Westerville, OH., Nuclear Waste Management IV, 465-473 (1991).

3.6 HIGH LEVEL CANISTERED WASTE FORM METRIC TONS OF HEAVY METAL CONTENT SPECIFICATION

Refer to: 5.4.1.B(13), and 5.4.3.D of the WASRD and Department of Energy DOE 1985, *An Evaluation of Commercial Repository Capacity for the Disposal of Defense High-level Waste, DOE/DP/0020/1).*

3.7 RATIONALE SPECIFICATION FOR THE REMOVABLE RADIOACTIVE CONTAMINATION ON EXTERNAL SURFACES

Refer to: 4.8.12 of the WASRD and IICD sec. 9.2.1.

3.8 RATIONALE FOR THE HEAT GENERATION SPECIFICATION

Refer to: 4.8.13 of the WASRD. The source for the 1500 watts per canister is, *Environmental Assessment-Waste Form Selection for SRP High-Level Waste*, DOE/EA-0179 (1982). In this reference, the maximum watts per canister is defined as the heat emitted by the decay of the radionuclides in the waste and is measured and documented in the TTT ranges//limits.
Also see reference, DWPF WQR Volume 7, WSRC-IM-91-116-7, Phase Stability and Control of the Temperature of the DWPF Product (U).

3.9 RATIONALE SPECIFICATION FOR MAXIMUM DOSE RATES

Refer to: 5.4.1.B.11, 5.4.3.C of the WASRD and IICD, Section 13, Appendix C Figures C-7/8/9.

3.10 RATIONALE FOR THE SUBCRITICALITY SPECIFICATION

Refer to: 4.8.11.A/B, 5.4.1.B(10) of the WASRD and YMP/TR-004Q, *Disposal Criticality Analysis Methodology Topical Report*, Revision 0, 11/30/98, and FCSS ISG-10, Rev. 0 *Justification for Minimum Margin of Subcriticality for Safety*, Fuel Cycle Safety & Safeguards-Interim Staff Guidance, June 15, 2006.

3.11 RATIONALE SPECIFICATIONS FOR THE WEIGHT AND OVERALL DIMENSIONS

Refer to: 4.8.3, 4.8.4 of the WASRD and IICD sec.13, Appendix C Figures C-7/8/9.

The canister must fit freely within the transportation cask subsystem and the disposal container, within the limits established by the WASRD and the IICD. 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.

3.12 RATIONALE FOR THE DROP TEST SPECIFICATION

Refer to: 4.8.8 of the WASRD.

The drop height of 7 meters is based on the maximum lift design height during repository or shipping cask operations. 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. These drop tests, in conjunction with Specifications 3.1 through 3.5 will be used to demonstrate canister robustness.

3.13 RATIONALE FOR THE HANDLING FEATURES SPECIFICATION

Refer to: 4.8.3, 4.8.5.A/B/C/D/E, and 5.4.1.B(7) of the WASRD.

3.14 RATIONALE FOR THE CONCENTRATION OF PLUTONIUM IN EACH CANISTER SPECIFICATION

Refer to: 5.4.1.B(10) of the WASRD and TDR-MGR-NU-000002, Rev. 01, "*Preclosure Criticality Safety Analysis,*" Bechtel SAIC Company LLC, March 2008, Table 3, Fissile Isotopes in HLW Glass Canisters, page 39.

4.0 RATIONALE FOR THE QUALITY ASSURANCE SPECIFICATION

4.1 Refer to: 4.2.11/12 of the WASRD and MOA Section IV.

4.2 Refer to: 4.2.11 of the WASRD, MOA Sections IV.B.3,VII.A.4.a/b, VII.B.2.a/b, and 10 CFR 21. The extent of the applicability of 10 CFR 21 reporting for the HLW canister and borosilicate glass is unknown at this time. Presumably, for EM HLW Producer and Federal Waste Custodian preliminary planning and reporting purposes, the defective components to be reported are the HLW borosilicate glass waste form and the HLW canister including the exterior closure or repair plugs or lids.

For example, the HLW canister was determined to be Important to Safety (ITS) on the Yucca Mountain Project because credit was taken for no canister breaching, during pre-closure if a canister drop occurred. Thus, in the absence of RW guidance, reporting threshold criteria or clarification, EM presumes that defects in the HLW canister are to be evaluated by RW under 10 CFR 21 and reported to the NRC.

Another example is that the Yucca Mountain Project took credit for the dissolution rate of the HLW borosilicate glass waste form during post-closure. Therefore, it was determined to be Important to Waste Isolation (ITWI) and defects in the waste form would be evaluated by RW under 10 CFR 21 and reported to the NRC. The results of this testing for SRS are documented in the DWPF WQRs.

The above two examples are provided for illustration purposes only. As stated above, the full extent of the applicability 10 CFR 21 reporting is not defined at this time.

5.0 DOCUMENTATION AND OTHER REQUIREMENTS

5.1 RATIONALE SPECIFICATION FOR THE WASTE ACCEPTANCE DOCUMENTATION

Refer to: 5.4.1.A, 5.4.3.A/B/C of the WASRD and MOA sec. V.B.2.a.

5.2 RATIONALE FOR THE HLW TRANSACTION REPORTING

Refer to: 4.8.10, 5.4.4.A of the WASRD, MOA Sections VII.B.1/3, and U. S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, NUREG/BR-0006, Instructions for Completing Nuclear Material Transaction Reports (DOE/NRC Forms 741 and 740M), Revision 7, effective date: January 1, 2009.

5.3 RATIONALE SPECIFICATION FOR THE DELIVERY OF NONCONFORMING WASTE FORMS

Refer to: 5.4.3.A/B/C of the WASRD and MOA Sections VII.A.4.a/b & VII.E.

5.4 RATIONALE SPECIFICATION FOR THE TRANSFER OF HLW TO RW

Refer to: MOA Sections V.E.6, VII.C.2 and VII.C.1.a.

5.5 RATIONALE SPECIFICATION FOR THE HLW ANNUAL REPORT

Refer to: 5.4.2 of the WASRD.

5.6 RATIONALE SPECIFICATION FOR THE HLW RECEIPT

Refer to: MOA sec. VI.A.1/3 & V.A.1.

APPENDIX B

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

[1] U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Waste Acceptance System Requirements Document, U.S. DOE Document Number DOE/RW-0351P Rev. 05, ICN 01, March 2008.

[2] Memorandum of Agreement for Acceptance of Spent Nuclear Fuel and High-Level Waste between the Assistant Secretary for Environmental Management (EM) U.S. Department of Energy (DOE), Washington D.C. and the Director Office of Civilian Radioactive Waste Management (RW) U.S. DOE, Washington D.C., Revision 2, January 2007.

[3] U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Integrated Interface Control Document, U.S. DOE Document Number DOE/RW-0511, Volume 1 Rev. 4, March 2008.

[4] 10 CFR 63, Code of Federal Regulations, *Disposal of High-Level Radioactive Waste In A Geologic Repository At Yucca Mountain Nevada.*

[5] 10 CFR 71, Code of Federal Regulations, *Packaging and Transportation of Radioactive Material.*

[6] 10 CFR 72, Code of Federal Regulations, *Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor – Related Greater Than Class C Waste.*

[7] 10 CFR 73, Code of Federal Regulations, *Physical Protection of Plants and Materials.*

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

[9] U.S. Code 42 U.S.C. 10101, Nuclear Waste Policy Act of 1982, amended December 22, 1987.

[10] C. M. Jantzen, et. al. "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.

[11] ASTM Standards, American Society of Testing and Materials, Test Methods for Determining Chemical Durability of Nuclear Waste Glasses: The Product Consistency Test (PCT), C-1285.

[12] U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Yucca Mountain Repository License Application Safety Analysis Report, Section 1.5.1.2.1.2.3 Canister Thermal Controls, DOE/RW-0573, Revision 0, November 2008.

[13] Sharon L. Marra, Carol M. Jantzen, Amy A. Ramsey, Westinghouse Savannah River Company, Aiken, S.C., "DWPF GLASS TRANSITION TEMPERTURES – WHAT THEY ARE AND WHY THEY ARE IMPORTANT", Ceramic Transactions V.23, G.G. Wicks, D.F. Bickford, R. Bunnell (Eds.), American Ceramic Society, Westerville, OH., Nuclear Waste Management IV, 465-473 (1991).

[14] S. L. Marra, R.E. Edwards, C. M. Jantzen, Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina, "THERMAL HISTORY AND CRYSTALLIZATION CHARACTERISTICS OF THE DWPF GLASS WASTE FROM (U)", WSRC-MS-92, 018, DE92 015323.

[15] 40 CFR 261.31 through 40 CFR 261.33, Code of Federal Regulations, *Protection of Environment, Subpart D – Lists of Hazardous Wastes.*

[16] 40 CFR 261.20 through 40 CFR 261.24, Code of Federal Regulations, *Protection of Environment, Subpart C – Characteristics of Hazardous Wastes.*

[17] 10 CFR 75.33, Code of Federal Regulations, *Safeguards On Nuclear Material—Implementation Of US/IAEA Agreement, Accounting Reports.*

[18] U. S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, NUREG/BR-0006, Instructions for Completing Nuclear Material Transaction Reports (DOE/NRC Forms 741 and 740M), Revision 7, effective date: January 1, 2009.

[19] Annual Book of ASTM Standards, American Society of Testing and Materials, Easton, MD (1987).

[20] American National Standards Institute (ANSI) N14.5-1997, Radioactive Materials-Leakage Tests on Packages for Shipment, publication February 5, 1998.

[21] 10 CFR 74, Code of Federal Regulations, *Material Control and Accounting of Special Nuclear Material, Part 74.4 Definitions, and Part 74.55(a)(2) Item Monitoring.*

[22] U.S. Nuclear Regulatory Commission, office of Nuclear Material Safety and Safeguards, Standard Format and Content Acceptance Criteria for the Material Control and Accounting (MC&A) Reform Amendment, 10 CFR 74, Subpart E, NUREG-1280, Revision 1, Published April 1995.

[23] U.S. Nuclear Regulatory Commission, Regulatory Guide 5.15, Tamper – Indicating Seals for Protection and Control of Special Nuclear Material, Revision 1, March 1997.

[24] U. S. Department of Energy, Assistant Secretary for Defense Programs, DOE/DP/0020/1, *An Evaluation of Commercial Repository Capacity for the Disposal of Defense High-level Waste,* June 1985.

[25] U.S. Government Department of Energy Memorandum, February 6, 2006, To: Mr. W. John Arthur III, Deputy Director, For Repository Development, U.S Dept. of Energy, Office of Civilian Radioactive Waste Management, Office of Repository Development, From: Mr. Mark R. Arenaz, Manager, National Spent Nuclear Fuel Program, Idaho Operations Office, "*Request for Updated U.S. Dept. of Energy Canister Thermal Output Limits in Support of Repository Design,* (EM-FMDP-06-006).

[26] U. S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, Fuel Cycle

Safety and Safeguards FCSS-ISG-10, Justification for Minimum Margin of Subcriticality for Safety, Revision 0, June 15, 2006.

[27] U. S. Department of Energy, Office of Civilian Radioactive Waste Management, YMP/TR-004Q, Disposal Criticality Analysis Methodology Topical Report, Revision 0, November 22, 1996.

[28] TDR-MGR-NU-000002, Rev. 01, "*Preclosure Criticality Safety Analysis*," Bechtel SAIC Company LLC, March 2008, Table 3, Fissile Isotopes in HLW Glass Canisters, page 39.

[29] U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Quality Assurance Requirements and Description for the Civilian Radioactive Waste Management Program, U.S. DOE Document Number DOE/RW-0333P.

[30] 10 CFR 21, Code of Federal Regulations, *Reporting of Defects and Noncompliance.*

[31] 49 CFR 172, Code of Federal Regulations, *Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans, Subpart B - Table of Hazardous Materials and Special Provisions.*

[32] SRS Waste Form Qualification Report, Technical Bases For the DWPF Glass Product Control Program (U), WSRC-IM-91-116-5, Rev. 3, Table 2, page 8.

[33] WVDP, Waste Form Qualification Report, WVDP-186, WQR-1.3, Rev. 3, Table 4, page 36.

APPENDIX C
CROSS REFERENCES BETWEEN THE WAPS SPECIFICATIONS AND THE SOURCE DOCUMENT REQUIREMENTS

WAPS Rev. 3	Source Document & Section
1.1	WASRD Rev. 5 sec. 4.2.1.B, 4.2.4, 4.8.1.A, MOA sec. V.A.1
1.1.1	WASRD Rev. 5 sec. 5.4.1.B(1)
1.1.2	WASRD Rev. 5 sec. 5.4.1.B(1)
1.2	WASRD Rev. 5 sec. 5.4.1.B(2)
1.2.1	WASRD Rev. 5 sec. 5.4.3.C
1.2.2	WASRD Rev. 5 sec. 5.4.3.C
1.3	WASRD Rev. 5 sec. 4.8.1.B.1
1.3.1	WASRD Rev. 5 sec. 4.8.1.B.2
1.3.2	WASRD Rev. 5 sec. 5.4.1.B(4)
1.4.1	WASRD Rev. 5 sec. 5.4.1.B(3)
1.4.2	WASRD Rev. 5 sec. 5.4.1.B(3)
1.5	WASRD Rev. 5 sec. 4.2.2
1.6	WASRD Rev. 5 sec. 3.2.4.A, 4.8.10, 5.4.1.B(10)
2.1	WASRD Rev. 5 sec. 4.2.3.C, 4.2.8, 5.4.1.B(5); MOA sec. VI.A.2
2.2	WASRD Rev. 5 sec. 4.8.6
2.3.1	WASRD Rev. 5 sec. 4.8.7
2.3.2	WASRD Rev. 5 sec. 5.4.1.B(8)
2.4	WASRD Rev. 5 sec. 4.2.3.C; IICD Rev. 4 sec. 5.1, (1)
2.4.1	WASRD Rev. 5 sec. 4.8.3; IICD Rev. 4 sec. 13, Appendix C, Figures C-7/8/9
2.4.2	IICD Rev. 4 sec. 13, Appendix C, Figures C-7/8/9
3.1	WASRD Rev. 5 sec. 4.8.9
3.2	WASRD Rev. 5 sec. 4.2.9.A
3.3	WASRD Rev. 5 sec. 4.2.5, 5.4.1.B(9)
3.4	WASRD Rev. 5 sec. 4.2.6, 5.4.1.B(4), 5.4.3.C
3.5	WASRD Rev. 5 sec. 4.8.2
3.6	WASRD Rev. 5 sec. 5.4.1.B(13), 5.4.3.D
3.7	WASRD Rev. 5 sec. 4.8.12; IICD Rev. 4 sec. 9.2.1
3.8	WASRD Rev. 5 sec. 4.8.13
3.8.1	WASRD Rev. 5 sec. 5.4.3.C
3.8.2	WASRD Rev. 5 sec. 5.4.3.C
3.9	IICD Rev. 4 sec. 13, Appendix C, Figures C-7/8/9
3.9.1	WASRD Rev. 5 sec. 5.4.3.C
3.9.2	WASRD Rev. 5 sec. 5.4.1.B(11)
3.10	WASRD Rev. 5 sec. 4.8.11.A/B
3.11.1	WASRD Rev. 5 sec. 4.8.4; IICD Rev. 4 sec. 13, Appendix C, Figures C-7/8/9
3.11.2	WASRD Rev. 5 sec. 4.8.3; IICD Rev. 4 sec. 13,

	Appendix C, Figures C-7/8/9
3.12	WASRD Rev. 5 sec. 4.8.8
3.13	WASRD Rev. 5 sec. 4.8.3, 4.8.5.A/B/C/D/E, 5.4.1.B(7)
3.14	WASRD Rev. 5 sec. 5.4.1.B(10)
4.0	WASRD Rev. 5 sec. 4.2.11/12; IICD Rev. 4 sec. 4.0; MOA sec. I.C.2, IV, IV.B, VII.A.1, VII.A.4.a/b, VII.C.4, XI
4.1	IICD Rev. 4 sec. 4.0
4.2	WASRD Rev. 5 sec. 4.2.11/12, 5.4.3.A/B; MOA sec. IV.B.3, VII.A.4.a/b
5.1.1	WASRD Rev. 5 sec. 5.4.1.A, 5.4.3.C, MOA sec. V.B.2.a
5.1.2	WASRD Rev. 5 sec. 5.4.1.A, 5.4.3.C, MOA sec. V.B.2.a
5.1.3	WASRD Rev. 5 sec. 5.4.1.A, 5.4.3.A/B/C, MOA sec. V.B.2.a
5.1.4	WASRD Rev. 5 sec. 5.4.1.B(6/10/11/12/13), 5.4.3.C, MOA sec. V.B.2.a
5.2	WASRD Rev. 5 sec. 4.8.10, 5.4.4.A; MOA sec. VII.B.1/3
5.3	WASRD Rev. 5 sec.5.4.3.A-C; MOA sec. VII.A.4.a/b, VII.E
5.4	MOA sec. V.E.6, VII.C.1.a, VII.C.2
5.5	WASRD Rev. 5 sec. 5.4.2
5.6	MOA sec. V.A.1, VI.A.3
Appendix D, Guidance for Completing Waste Acceptance Actions Plans	WASRD Rev. 5 sec. 4.2.11, MOA sec. IV.B.3, VII.A.4.a/b and VII.B.2.a/b

APPENDIX D
GUIDANCE FOR COMPLETING WASTE ACCEPTANCE ACTION PLANS

The following guidance and format are provided to assist in the completion and disposition of action plans for nonconforming HLW forms. This guidance contains, but is not limited to, a set of key information that is necessary for an action plan:

Waste Acceptance Action Plan

Action Plan for (Facility Designation) Canister No.

Non-Conformance Report (NCR) No.

1. **WAPS Specification Nonconformance:** Include in this section the specific WAPS specification(s) in which the nonconformance occurred.

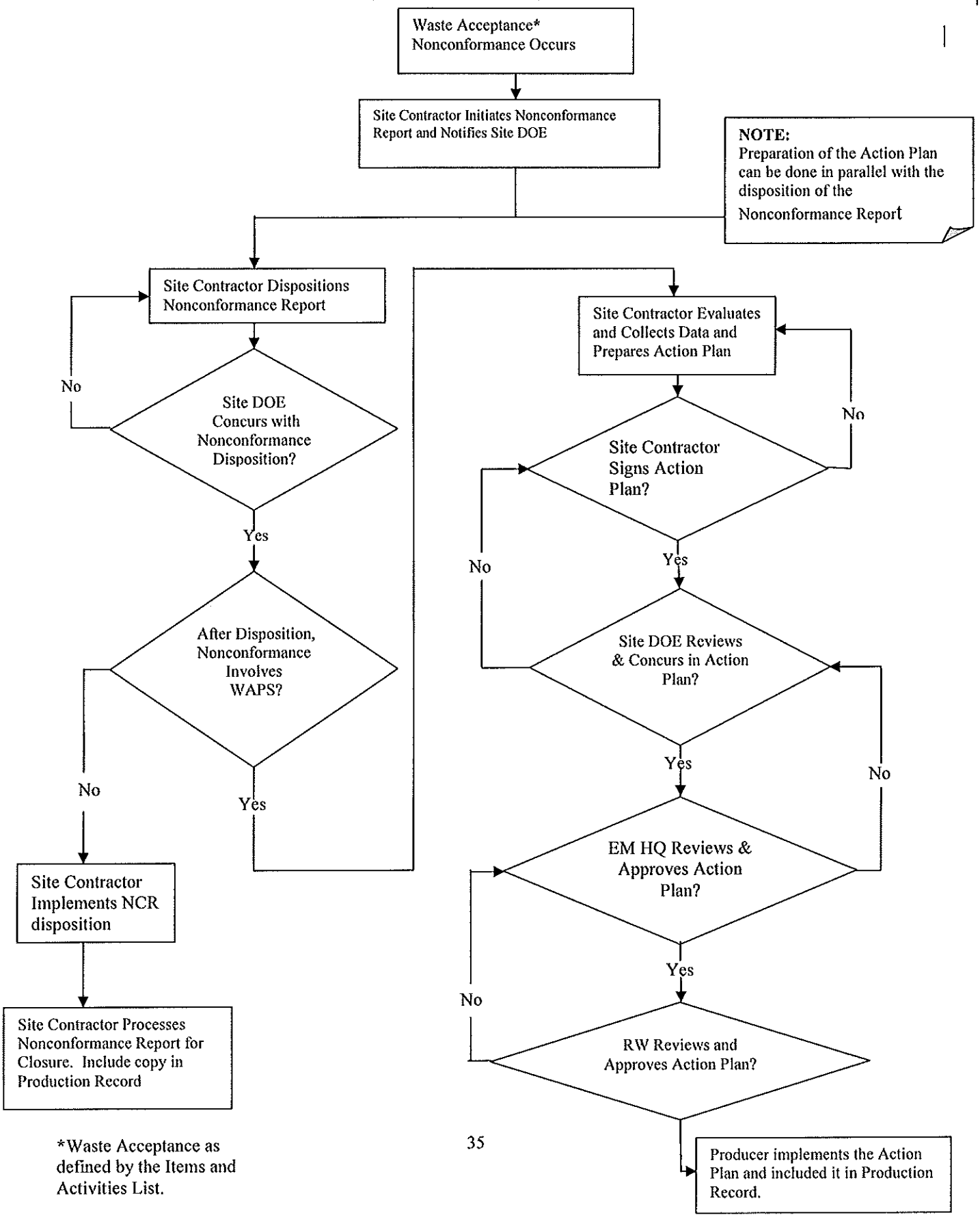
2. **Description of Nonconformance:** Describe the nonconformance in clear and unambiguous terms. There should not be any inconsistency with the information contained in the action plan and facility nonconformance report. If an inconsistency exists, an explanation is required. List all WAPS specifications not complied with, the nonconformance effects, any implications, particularly those that affect any WASRD specifications, and the exact nature of the nonconformance. Include the date and time the nonconformance was identified.

3. **Disposition of Nonconformance:** The Site HLW Producer will recommend a disposition of the nonconforming item(s). Address nonconformance disposition requirements contained in QARD Section 15.0, *Nonconformance*. The disposition of "use-as-is", "reject", "repair", or "rework" for nonconforming items shall be identified and documented. The technical justification for the acceptability of a nonconforming item that has been dispositioned "repair" or "use-as-is" shall be documented. Items that do not meet original design requirements that are dispositioned "use-as-is" or "repair" shall be subject to design control measures commensurate with those applied which do not meet original design requirements. The disposition of an item to be reworked or repaired shall contain a requirement to reexamine (inspect, test, or nondestructive examination) the item to verify acceptability. A repaired or reworked item shall be reexamined using the original process and acceptance criteria unless the nonconforming disposition has established alternate acceptance criteria. Include in this action plan section any information, such as drawings, calculations, etc., necessary to provide backup support for the disposition, when the implementation of the action plan will or has been verified and the permanent location of the approved action plan, associated nonconformance report and verification of the corrective action documentation. Also, list any actions or plans completed or to be taken/ implemented to prevent reoccurrence of this nonconformance.

4. **Site Contractor, Site EM HQ review/concurrence and RW review/approval of the Action Plan:** Identify the office and personnel performing the review, evaluation and approval of the action plan. Action plan and nonconformance review shall include determining the need for corrective action according to the requirements of QARD Section 16.0, Corrective Action. Personnel performing evaluations of recommended dispositions shall have demonstrated competence in the specific area they are evaluating, an adequate understanding of the requirements, and access to pertinent background information.

NOTE: Disagreements, between EM and RW, will be resolved prior to any action plan implementation. Also, applicable sections of HLW/SNF MOA IV.B.3, VII.A.4.a/b and VII.B.2.a/b outline the method to disposition nonconforming waste forms. The following is a flow diagram of the typical process for handling nonconforming vitrified HLW canisters.

APPENDIX D: WASTE ACCEPTANCE NONCONFORMANCE AND ACTION PLAN PROCESS



*Waste Acceptance as defined by the Items and Activities List.

APPENDIX E
EM HIGH-LEVEL WASTE SUMMARY CANISTER DATA

The following WAPS summary information is specific to DWPF, WVDP or WTP canister waste forms:

Specification	DWPF & WVDP short Canister	WTP long canister	WAPS Section
Canister Length	2.980 – 3.005 m	4.480 - 4.505 m	2.4.1
Organic compounds in the waste form	Existing WCPs list numerical concentrations	TBD in the WTP WCP	3.4
Max. Filled & Sealed Canister Mass	2,500 kg[7]	4,200 kg[7]	3.11

The following summary data is common to all DWPF, WVDP, and WTP HLW canister waste forms:

Requirement	Explanation	Section #
Waste Form	Vitrified borosilicate waste glass in a solid physical form.	1.1
Waste Form Product Consistency Test	See Appendix F, PCT Results of EA Glass Standard Material, for DWPF and WVDP values.	1.3.1
Waste Form	Certify waste form temperature < 400^0C at shipment.	1.4.2
Resource Conservation Recovery Act	HLW, that is subject to regulation as hazardous waste under RCRA Subtitle C, is not permitted.	1.5
Waste Form	Comply with 10 CFR 75.33 by completing NRC Form 741 as provide in NUREG/BR-0006 for IAEA safeguards reporting.	1.6
Canister Material	Austenitic stainless steel (typically ASTM 240 type 304L)	2.1
Canister Closure	Leak tight < 1 x 10^{-4} ref-cc/sec.	2.2
Canister Labeling	Two locations; one visible from the top & one from the side.	2.3
Canister Diameter	Range: 60.0 – 62.5 cm unfilled.	2.4.2
Canister Tamper Indicating Device	Must have TID sealed consistent with 10CFR74.55(a)(2) and NUREG-1280, Rev. 1 for SNM. Welding is acceptable.	3.2
Metric Tons of Heavy Metal (MTHM)	Record the MTHM value for each individual HLW canister at shipment in the SSR.	3.6
Removable Contamination on External Surface	Remove visible waste glass form canister's exterior surface; 22,000 dpm/100 cm^2 for beta & gamma; 2,200 dpm/100 cm^2 for alpha on canister surface maximum limit.	3.7
Max. Canister Heat Generation Rate	1,500 Watts per canister maximum at time of shipment.	3.8
Max. Estimated Surface Dose Rate	Measure/calculate canistered waste form's max. surface gamma and neutron dose rates. Max. Limits are 100,000 rem/hr gamma and 10 rem/hr neutron at canister surface.	3.9
Canister Drop Test	7 meters maximum onto a flat essentially unyielding surface.	3.12
Maximum concentration of plutonium/ canister	Total concentration of all plutonium isotopes per canister must not exceed 897 grams/m^3 maximum.	3.14

NOTES:

7 The average unfilled canister mass for DWPF is ~500 kg; for WVDP~300 kg; and for WTP it is estimated at approximately 699 kg. These empty canister weight average values are not specification requirements. These are approximate values and are for informational purposes only.

APPENDIX F

Product Consistency Test (PCT)
Results of the Environmental Assessment (EA) Glass Standard Material

The Producer must demonstrate the consistency of the waste form using the Product Consistency Test (PCT). The PCT is a glass leaching test developed at Savannah River National Laboratory for use in characterizing production glass samples. The average releases of Boron (B), Sodium (Na), and Lithium (Li) from the Environmental Assessment (EA) glass for the testing programs at DWPF and WVDP are shown below [32, 33]. The differences are due to the number of laboratories, test methods, analytical instrument accuracy, etc. that analyzed the EA glass to yield the PCT values. DWPF and WVDP independently tested the EA glass, resulting in the limits listed below:

Defense Waste Processing Facility PCT EA Limits

Element	EA Limit, g/L
B	16.70
Na	13.35
Li	9.57

SRS Waste Form Qualification Report, Technical Bases For the DWPF Glass Product Control Program (U) [32].

West Valley Demonstration Project Testing

Element	EA Limit, g/L
B	16.28
Na	12.92
Li	8.61

WVDP, Waste Form Qualification Report [33].

APPENDIX G

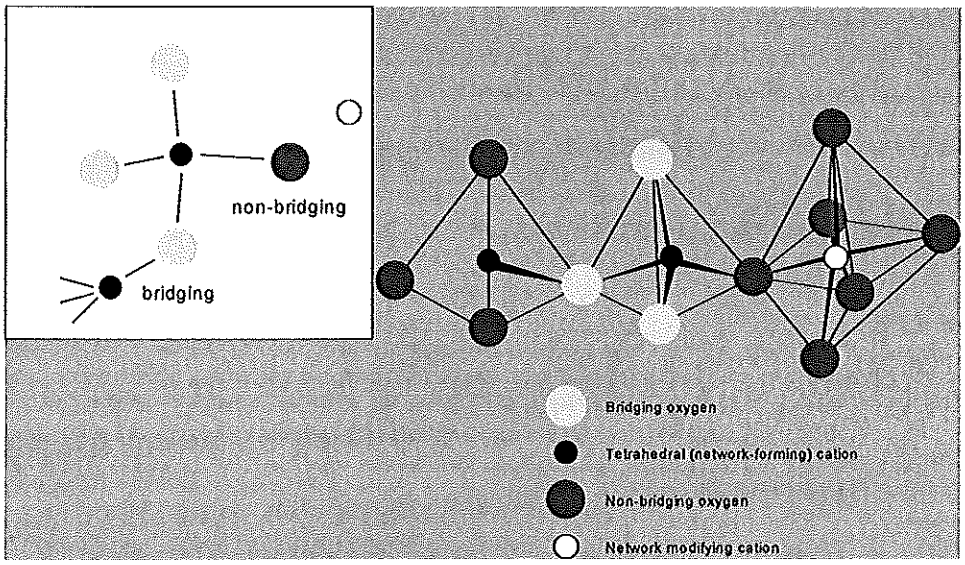
SUMMARY CONTENTS OF HIGH-LEVEL WASTE PRODUCTION AND SHIPPING AND STORAGE RECORDS

PRODUCTION RECORD SPECIFICATIONS		
WAPS SECTIONS	SPECIFICATION	SUBJECT AREA
1.1.2	Chemical Composition During Production	Glass Waste Form
1.2.2	Radionuclide Inventory During Production	Glass Waste Form
1.3.1 & 1.3.2	Acceptance Criterion and Method of Compliance	Glass Waste Form
1.6	IAEA Safeguards Reporting for HLW	Glass Waste Form
2.1	Canister Material Verification, Procurement, & Requirements (Canister, primarily/ secondary lids)	Canister
2.2	Canister Fabrication & Closure	Canister
2.3	Canister Labeling/Identification	Canister
2.4	Canister Length & Diameter Dimensions	Canister
3.1, 3.3-3.5	Foreign Material Exclusion (Free liquid, explosiveness, pyrophoricity, combustibility, organics, & chemicals)	Canistered Waste Form
3.14	Concentration of Uranium & Plutonium In Each Canister	Canistered Waste Form
4.0	Quality Assurance Specification	Canistered Waste Form

STORAGE & SHIPPING RECORD SPECIFICATIONS		
WAPS SECTIONS	SPECIFICATION	SUBJECT AREA
1.4.2	Control of Temperature For Phase Stability	Glass Waste Form
3.6	High Level Canistered Waste Form Metric Tons of Heavy Metal Content	Canistered Waste Form
3.7	Removable External Canister Surface Contamination	Canistered Waste Form
3.8, 3.8.1, 3.8.2	Canister Heat Generation Projections and Heat Generation at Year of Shipment	Canistered Waste Form
3.9.2	Shipment Dose Rates	Canistered Waste Form
2.4 & 3.11.1	Filled & Sealed Canistered Weight and Overall Dimensions	Canistered Waste Form
5.4	Shipping Records for Transfer of HLW to RW.	Canistered Waste Form

APPENDIX H
ALKALI BOROSILICATE WASTE GLASS TECHNICAL INFORMATION

HLW borosilicate waste glass contains several key elements in a solid matrix: silica (SiO_2), boria (B_2O_3), soda (Na_2O), and calcium (CaO). A waste borosilicate schematic representation of the structure is shown below:



Glass is an amorphous structure of $(SiO_4)^{-4}$, $(AlO_4)^{-5}$, $(BO_4)^{-5}$, $(PO_4)^{-3}$ and $(FeO_4)^{-5}$ tetrahedral and $(BO_3)^{-3}$ trigonal structural units that share corner oxygen (bridging). Any unshared oxygen (non-bridging) atomically bond to other species (network modifiers) such as the radionuclides and Na^+, Ca^{2+}, Sr^{2+}, etc.

Some Key Physical Characteristics of Borosilicate Glass

Density	Nominal 2.75 g/cc (at 100^0C)
Tensile Strength	57 million Pascals (i.e., 8,265 pounds/in.^{2})
Compressive Strength	550 million Pascals (i.e., 79,750 pounds/in.^{2})
Thermal Conductivity	0.95 W/mK (at 100^0C)
Heat Capacity	0.83 J/gK (at 25^0C)
Softening Point	502^0C
Annealing Range	450 – 500^0C
Viscosity (Poise) Range all at 1150^0C	Nominally 40-60; Range: 4 – 150 Poise

Typical Borosilicate Glass Composition Percentage by Weight

Silica (SiO_2)	33-65%
Boria (B_2O_3)	3-20%
Soda (Na_2O)	4-22%
Alumina (Al_2O_3) typically; Maximum	3-20% < 30%
Metal Oxides (Fe_2O_3, MnO, NiO, MgO, etc.) Range; Typically	 0-50% ~24%

APPENDIX I

Acronyms & Abbreviations

The following acronyms and abbreviations are used in the WAPS:

Acronyms:

ANSI	American National Standards Institute
ASTM	American Society of Testing & Materials
CFR	U.S. Code of Federal Regulations
CRWMS	Civilian Radioactive Waste Management System
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DWPF	Defense Waste Processing Facility located at Savannah River Site, Aiken, South Carolina
EA	Environmental Assessment (for the bench mark borosilicate glass)
EM	DOE Office of Environmental Management
EPA	U.S. Environmental Protection Agency
HLW	High-Level Radioactive Waste
IAEA	International Atomic Energy Agency
IICD	RW Integrated Interface Control Document
INL	Idaho National Laboratory
MOA	the Memorandum of Agreement for Acceptance of SNF and HLW between EM and RW
MTHM	Metric Tons Heavy Metal
NCR	(Site specific) Nonconformance Report
NRC	U.S. Nuclear Regulatory Commission
NUREG	NRC Nuclear Regulation
NWPA	Nuclear Waste Policy Act of 1982
ORP	DOE Office of River Protection, Hanford Site, Richland, Washington
PCT	Product Consistency Test
PR	(Site specific) Product Record(s)
QA	Quality Assurance
QARD	Quality Assurance Requirements and Description
RCRA	Resource Conservation and Recovery Act
RW	DOE Office of Civilian Radioactive Waste Management
SNF	Spent Nuclear Fuel
SNM	Special Nuclear Material
SRS	DOE Savannah River Site, Aiken, South Carolina
SSR	(Site specific) Storage & Shipping Record(s)
TBV/D	To Be Verified/ Determined
TID	Tamper Indicating Device
TTT	Time-Temperature-Transformation Diagram
WAPS	Waste Acceptance Product Specifications
WASRD	Waste Acceptance System Requirements Document
WCP	(Site specific) Waste Form Compliance Plan
WQR	(Site specific) Waste Form Qualification Report(s)
WTP	Waste Treatment and Immobilization Plant, Richland, Washington
WVDP	DOE West Valley Demonstration Project, West Valley, New York

Abbreviations:

atm	atmospheres
dpm	disintegrations per minute
^0C	degrees Celsius
cm	centimeters
cm^2	squared centimeters
cc	cubic centimeters
g	gram(s)
hr	hour(s)
in^2	squared inches
J	joule(s)
K	Kelvin
k_{eff}	effective neutron multiplication factor
kg	kilogram(s)
L	liter(s)
m	meter(s)
m^2	squared meters
ref	reference
rem	roentgen equivalent man
sec	second
wt.%	weight percent
W	watts
Δkm	technically justified administrative margin

WAPS Record of Revision

Revision Number	Description of Changes	Date
0	Original Issue	February 1993
1	To incorporate and update the document to reflect changes in the DOE/RW WASRD Rev. 1, February 1994	May 1995
2	This revision of the WAPS was prepared to address changes to the RW technical baseline requirements as reflected in Revision 2 of the WASRD, which was issued in May 1996. Changes to the WASRD include the following: 1. addition of a specification that precludes RW acceptance of HLW components which are regulated as hazardous under the Resource Conservation and Recovery Act (RCRA); 2. addition of a specification for data reporting requirements to meet the international Atomic Energy (IAEA) safeguards for radioactive material control and accounting; 3. addition of a new HLW standard from requirement which limits the concentration of plutonium in the canister to less than 2,500 grams/cubic meter for a standard HLW canistered waste form. 4. Relaxation of specification for removable contamination on the HLW canister by a factor of 10 (to be applicable at the time of shipment). Other changes t the WASRD are considered minor in that no significant impact on the producer is foreseen with respect to current waste compliance strategy.	December 1996
3	Revised WAPS to address/incorporate additions, deletions, and changes in WASRD Rev. 5, ICN 01 issued 2008 the IICD Rev. 4, issued March 2008, and the MOA Rev. 2 issued January 2007. Major WAPS changes are: 1. Addition of Hanford WTP 4.5 m canister physical requirements, Metric Tons of Heavy Metal requirement, and Tamper Indicating Device specifications, internet web information sites addresses, generic nonconformance process flow diagram, Production and Shipping and Storage Record specification summary table, acronym and abbreviation lists, borosilicate glass information, HLW transaction reporting, and nonconformance waste form guidance/ information. 2. Changes/ clarifications to criticality, HLW canister summary data, organic materials, nonconforming canister processes, cross references, glossary definitions, source document references/ requirements, Quality Assurance requirements and defects, index years, hazardous waste requirements, IAEA safeguards reporting requirements, and canister leaktight units of measure. 3. Deletion of the canister gas specification, canister fill height, and several other specifications in section 5.0 Documentation and Other Requirements that specified fee, shipping cask, or cask packaging requirements. These were moved to the MOA.	September 2011