

encl. to 5/30/86 memo to
Linehan from Greeves
Response to DOE on WAPS 109.1

109.1/ENCLOSURE 1

- 1 -

ENCLOSURE 1

NRC COMMENTS ON DRAFT WASTE ACCEPTANCE PRELIMINARY SPECIFICATIONS FOR THE WEST VALLEY DEMONSTRATION PROJECT HIGH-LEVEL WASTE FORM and for the DEFENSE WASTE PROCESSING FACILITY HIGH-LEVEL WASTE FORM.

1. Page 3. Section 1.1 CHEMICAL SPECIFICATION

The first sentence states that the waste form is borosilicate glass.

This statement is consistent with the definition in the glossary (page 11) of the term "borosilicate glass" but we believe the term should be "borosilicate waste (emphasis added) glass". This first sentence on page 3, therefore, should be revised to state that the waste form is borosilicate waste glass.

2. Page 3. Paragraph 1.1.2 Chemical Composition During Production

The first sentence states that the waste form producer shall include in the production records the elemental composition of the glass waste form for all elements, excluding oxygen, present in concentrations greater than 0.5 percent by weight...

We understand the difficulty in measuring oxygen, but we also wish to point out that it may be desirable to determine the valence state of some of the elements present. This may not be possible if the oxygen content is not reported.

Also, it should be clarified whether the measurements of elemental composition will be made on production waste forms themselves, or samples of production glass, or "cold" glass or calculated from the charge.

3. Page 3. Paragraph 1.2.1 Radionuclide Inventory Projections

This paragraph states that the Waste Qualification Report shall contain the producer's estimates of the total quantities of individual radionuclides to be shipped to the repository. It also requires that he provide estimates of the inventories of individual radionuclides expected to be present in canistered waste forms at the facility and the expected range of variations due to process variations during the life of the facility. These estimates are to be calculated for the year 2025.

There seem to be redundant requirements in this paragraph. It is not clear that estimates of total quantities of individual radionuclides to be shipped to the repository (first sentence) is any different than estimates (second sentence) of individual radionuclides expected to be present in canistered waste forms at the facility (because all waste forms emplaced at the repository will be canistered). It also is not clear what is meant by expected range of variations (of inventories of individual radionuclides) due to process variations during the life of the facility.

4. Page 3. Paragraph 1.2.2 Radionuclide Inventory During Production

This paragraph requires the producer to provide at the time of shipment estimates of inventories of individual radionuclides in the canistered waste forms.

This requirement appears to be redundant to the previous paragraph on radionuclide inventory projections. Also, it is not clear whether this means the inventories in individual canisters or the total inventory in a shipment of canisters.

5. Pages 3 and 4. Section 1.3 SPECIFICATION FOR RADIONUCLIDE RELEASE PROPERTIES

This paragraph requires the producer to document that the radionuclide release properties of the waste form have been controlled so that the production waste glass can meet the limits specified in tests to be specified by the repositories. The paragraph also requires the producer to describe the intended method for demonstrating compliance with each repository requirement in the Waste Compliance Plan. The producer is required to provide in the Waste Qualification Report supporting technical documentation for the selected method of compliance.

A schedule should be provided for completion of the action required by this paragraph, i.e.,

- a. Acceptance tests or criteria to be specified by the repositories
- b. The Waste Compliance Plan
- c. The Waste Qualification Report

We would appreciate an opportunity to review the schedule for these three items and the items themselves (Steps 9, 10 and 11 of the Waste Acceptance Process).

6. Page 4. Section 1.4 SPECIFICATION FOR CHEMICAL AND PHASE STABILITY

The last paragraph requires the producer to certify that the maximum waste form temperature is at least 100°C below the transition temperature. In addition, the producer is required to certify that after initial cooldown, the waste forms are handled, stored and shipped in such a manner that the transition temperature of the waste form is not exceeded.

The waste form producer should be required to obtain prior approval from the repository project(s) for the methods to be used to support the required certification.

7. Page 5. Section 2.1 MATERIAL SPECIFICATION

This section requires that the waste form canister and any secondary canisters be fabricated from austenitic stainless steel. It also requires that the ASTM alloy specification and the composition of the canister material, the secondary canister material, and any filler material in the welding be included in the Waste Compliance Plan. The producer is required to describe the method for demonstrating compliance in the Waste Compliance Plan and document it in the Waste Qualification Report.

- a. There should be a materials specification over and above the ASTM alloy specification. This specification should specify the attributes and the acceptance tests or criteria for the canister material, the secondary canister material and any weld filler material, including destructive and non-destructive testing methods and frequency.
- b. The producer should be required to obtain prior approval from the repository project(s) of the methods he will use to demonstrate compliance.
- c. The term "documented" should be defined, i.e., each document to be included and its content should be identified.

8. Page 5. Section 2.2 FABRICATION AND CLOSURE SPECIFICATION

This section requires the producer to identify the canister fabrication methods, as well as those for any secondary canisters that the producer may apply, in the Waste Compliance Plan and document them in the Waste Qualification Report. The section also requires that the method for

demonstrating compliance with the leaktightness specification (ANSI-14.5-1977) be described by the producer in the Waste Compliance Plan and documented in the WQR.

The producer should be required to gain prior approval from the repository project(s) of the acceptance tests that he plans to use to demonstrate compliance with the Waste Acceptance Specification. The producer should then publish the process that will be used to fabricate the canister and make the closure after the canister is filled with waste glass.

The producer should then fabricate an agreed upon quantity of qualification waste forms (using the process that was published) and evaluate them using the acceptance tests for which prior approval had been obtained. Only after the approved acceptance tests show that the qualification waste forms are acceptable should the producer be released for production. It is not clear that this sequence of events is anticipated. A schedule would be helpful in this regard.

9. Page 5. Paragraph 2.3.2 Labeling

The label material, method of attachment and design life should be specified.

10. Page 6. Section 3.2 GAS SPECIFICATION

The third sentence states that the maximum internal gas pressure immediately after closure shall be 7 psig at 25°C.

The rationale for the 7 psig should be given. Also, the specification should provide a limit on maximum internal pressure generated subsequently by internal processes/mechanisms. The rationale for the limit on subsequently generated internal pressure should also be provided.

11. Page 7. Section 3.6 SPECIFICATION FOR REMOVABLE RADIOACTIVE CONTAMINATION ON EXTERNAL SURFACES

This section includes a requirement that the producer remove visible waste glass on the exterior of the canistered waste form before shipment. This section should also specify that removal of the glass from the exterior of the canister shall not impair the integrity of the canister.

12. Page 6. Section 3.7 FREE-VOLUME SPECIFICATION and Section 3.5 Page A-5, RATIONALE,

This section requires that after closure the free-volume within the canistered waste form shall not exceed 20 percent of the total internal volume of an empty canister.

The rationale for the 20 percent maximum free-volume should be provided.

13. Page 7. Section 3.7 HEAT GENERATION SPECIFICATION and Section 3.7 RATIONALE, Page A-5.

The heat generation rate of 800 watts is almost twice the design value for DHLW for the Salt Project (423 watts). This discrepancy should be explained.

14. Page 8. Paragraph 3.11.1 Weight Specification

The second sentence states that the measured weight shall be specified in the production records.

Does "specified" mean "reported"?

15. Page 8. Paragraph 3.11.3 Diameter Specification

The diameter is specified as 61.0 cm for the West Valley Demonstration Project High-Level Waste Form.

We note that the diameter of the NNWSI high-level waste form was specified as 32 cm in UCID 19926, December 1983. This apparent discrepancy should be resolved.

Also, no dimensions are given for the possible secondary canister mentioned in Section 2.1.

16. Page 9. Section 3.12 DROP TEST SPECIFICATION

This section requires the canistered waste form to be capable of withstanding a drop of 7 meters onto a flat surface without breaching.

The repository designs for surface handling of the canister show the possibility of a drop on a sharp corner. The 7 meter drop on a flat surface, therefore, does not appear to represent the maximum credible drop accident.

17. Page 9. Section 3.13 HANDLING FEATURES SPECIFICATION

This section requires the producer to design and provide the canistered waste form with a neck and a lifting flange that meets very general criteria, e.g., "that meets applicable codes and standards for use at the repository."

The applicable codes and standards should be identified.

18. Page 11. Glossary Organic Material and Page A-4, Section 3.4
RATIONALE FOR THE ORGANIC MATERIALS SPECIFICATION

Organic material is defined in the glossary as any material based on carbon chains or rings, generally containing hydrogen with or without oxygen, nitrogen or other elements, whether or not derived from living organisms.

This definition should be more definitive so as to consider carbon compounds which are not organic materials but which may react with other materials to form organic materials (e.g., carbon dioxide and carbon monoxide reacting with water to form organics such as formaldehyde and formic acid within the canisters).

19. Page A-2. Section 1.4- RATIONALE FOR THE SPECIFICATION FOR CHEMICAL
AND PHASE STABILITY

The first paragraph states that the borosilicate glass waste forms will retain release properties similar to those obtained under Specification 1.3 (RADIONUCLIDE RELEASE PROPERTIES) so long as the phase structures and compositions of the glass are unchanged from those provided under Specification 1.1 (CHEMICAL SPECIFICATION).

We do not think the above statement has been substantiated. We believe changes in release properties may result from any energy input. DOE should state that (1) tests to date support the conclusion that neither energy input nor radioactive decay contribute to degradation of the glass structure during the design life of the waste form (the appropriate references should be included) and that (2) it is unlikely that any spontaneous transitions, such as that of beta dicalcium silicate to gamma dicalcium silicate at about 525°C as reported in studies of cement chemistry, will occur (appropriate references should also be provided for this statement). Any other mechanisms for structural degradation that were observed during development of the glass waste form should be noted and the reasons for dismissal stated. For example, the cracking of the waste form during cooling and the cooling rate needed to minimize cracking should be discussed.

20. Page A-5. Section 3.6 RATIONALE FOR THE SPECIFICATION FOR REMOVABLE RADIOACTIVE CONTAMINATION ON EXTERNAL SURFACES

The second paragraph in this section states that the specification limits chosen are used extensively in the nuclear industry practice and regulations to indicate surfaces are free of removable contamination. The appropriate references should be cited.

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**WASTE ACCEPTANCE
PRELIMINARY SPECIFICATIONS
for the
Defense Waste Processing Facility
High Level Waste Form**

Draft for Concurrence

April, 1986

**U.S. Department of Energy
Office of Civilian Radioactive Waste Management
Washington, D.C. 20585**

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Waste Form and Waste Acceptance Preliminary
Specifications"

Appendix B - "Explanation of Reserved Items"

WASTE ACCEPTANCE
PRELIMINARY SPECIFICATIONS
for the
Defense Waste Processing Facility
High-Level Waste Form

*only to the extent that the
maximum heat generation
rate is specified.*

Introduction

These Waste Acceptance Preliminary Specifications (WAPS) specify the properties and requirements for the high-level waste (HLW) forms to be produced by the Defense Waste Processing Facility (DWPF) at the Savannah River Plant, South Carolina. The WAPS establish the minimum requirements which the DWPF waste form must meet in order to be compatible with any of the three geologic media (i.e., basalt, salt, or tuff) under consideration for the first geologic repository.

The WAPS has been developed by the Waste Acceptance Committee (WAC), which is responsible for the preparation of the various site-specific and generic documents identified in the Waste Acceptance Process (WAP). The development and the approval of the WAPS have been carried out in accordance with procedures outlined in the WAC charter. The WAPS specify technical requirements that the waste form must meet and documentation that the producer must provide in order to fulfill the producer's role in the repository licensing process. The WAPS also provide the bases for developing design specifications for the repository and the waste package. The rationale for each specification is presented in Appendix A.

This will have to be a part of the performance Assessment Analysis.

It is recognized that some individual canistered waste forms may not comply in every respect with these specifications. For these cases, the producer will identify nonconformities and propose a remedy for evaluation by the receiving repository on a case-by-case basis. The repository will evaluate the proposed remedy, and a final disposition of the nonconforming waste form will be determined in accordance with the repository license.

Within the waste acceptance process, the WAPS follow the repository-site-specific, waste-form-specific Waste Acceptance Specifications. Where possible, the WAPS reflect generic requirements; however, in one case (i.e., Specification 1.3, Specification for Radionuclide Release Properties), it is not possible to set a single specification that is adequate for all repositories. In this case, producers must demonstrate compliance with repository-specific requirements, at least until the site for the first repository is chosen. The required release properties for the waste form will be based on the overall performance allocation for different parts of the engineered barrier system since containment and isolation requirements are to be met by the total engineered barrier system and not necessarily by the waste form alone. The WAPS require demonstration of compliance via three different documents, each prepared by the producer and concurred with by the repository projects through the waste acceptance process: (1) the Waste Form Compliance Plan (WCP), (2) the Waste Form Qualification Report (WQR), and (3) Production Records.

The Waste Form Compliance Plan (WCP) is the producer's plan for demonstrating compliance with each specification in the WAPS. The WCP is to include detailed descriptions of the testing (including detailed test

*"to be met by waste pkg during the
containment -1- period."*

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when?
Definition?
Waste Form Acceptance Committee?
Waste Form Compliance Plan

procedures), analyses, and process controls to be performed by the producer, including the identification of production records to be provided, to demonstrate compliance with the specifications. The plan for compliance with each specification is to be concurred with by each of the repository projects. To meet schedule demands, it may be necessary for WCP preparation and concurrence to proceed specification by specification, and such an approach is permissible, with the agreement of the WAC Chairman. Concurrence by repository projects means that the producer's proposed method of compliance will satisfactorily meet the intent of the specification, acceptance criteria (as applicable), and support requirements for licensing arguments.

Waste Qualification Report

The WQR is a compilation of all results from testing and analysis that presents detailed evidence of compliance with each specification. This document is also prepared by the producer and concurred with by each repository project. Concurrence by the repository projects will be required for each specification and will mean that the testing and analysis as described and documented provide a satisfactory demonstration of compliance with the specification and are adequate for the intended use in repository licensing. Again, consideration of the basis of individual specifications is permissible if the WAC Chairman concurs.

Production Records refers to documentation, provided by the producer, that describes the actual canistered waste forms for review by the repository operator before the waste is shipped. The format and the content of the production records will be specified in the WCP. Concurrence means that the canistered waste forms described are in compliance with the specifications and are therefore acceptable for disposal.

The WAPS are based on the best available information current as of the date of issue. They are likely to be revised as the repository program proceeds through design and licensing. Eventually the WAPS will evolve into the Updated Waste Acceptance Specifications (WAS), which will be used for the License Application, and ultimately into the Final WAS, after the incorporation of applicable NRC licensing technical specifications. All changes will be made in accordance with the Waste Acceptance Process, through the WAC.

When these WAPS were prepared, there was insufficient information available to firmly fix several of the specifications. These specifications remain reserved and are denoted by [R#] in the text of the specification. An explanation of all reserved items is found in Appendix B.

Like building the hse before it is designed.

1. WASTE FORM SPECIFICATIONS

1.1 CHEMICAL SPECIFICATION

The waste form for DWPF is borosilicate glass.

1.1.1 Chemical Composition Projections

The producer shall include in the Waste Form Qualification Report (WQR), sufficient chemical and microstructural data to characterize the elemental composition and crystalline phases for the product of the waste production facility and expected variations in the product due to process variations during the life of the facility. The method to be used to make these projections shall be described by the producer in the Waste Form Compliance Plan (WCP).

1.1.2 Chemical Composition During Production

For the production waste forms the producer shall include in the production records the elemental composition of the glass waste form for all elements, excluding oxygen, present in concentrations greater than 0.5 percent by weight ~~with a precision~~ and an accuracy to be reported in the WCP. The producer shall describe the method to be used for compliance in the WCP.

1.2 RADIONUCLIDE INVENTORY SPECIFICATION

For all radionuclide inventory estimates required by this specification, the producer shall report all radioisotopes that have half-lives longer than 10 years and are present in concentrations greater than 0.05% (curies) [R1] of the total radioactivity inventory (aggregate or canistered waste form, as applicable) at any time up to 1100 years after production.

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 and of the uncertainties in the expected values. The producer shall also provide in the WQR estimates of the inventories of individual radionuclides expected to be present in canistered waste forms produced at the facility and the expected range of variations due to process variations during the life of the facility. These estimates shall be calculated for the year 2025. The method used to make these projections shall be described by the producer in the WCP.

1.2.2 Radionuclide Inventory During Production

At the time of shipment, the producer shall provide in the production records estimates of inventories of individual radionuclides in the canistered waste forms. The producer shall also report the expected precision and accuracy of these estimates in the WCP. (*Waste Form Compliance Plan*)

1.3 SPECIFICATION FOR RADIONUCLIDE RELEASE PROPERTIES

The producer shall document that the radionuclide release properties of the waste form have been controlled so that the production waste glass can meet the limits specified in repository-specified tests TBD* [R2]. Before

shipment the producer shall document that the waste forms at time of TBD* [R4] are in compliance with the radionuclide release specifications for the receiving repository. The producer shall describe the intended method for demonstrating compliance with each repository-site-specific requirement in the WCP. Supporting technical documentation for the selected method of compliance shall be included in the WQR.

1.4 SPECIFICATION FOR CHEMICAL AND PHASE STABILITY

The producer shall provide the following data on the borosilicate glass waste form:

- (a) The transition temperature where the slope of the thermal expansion vs. temperature curve shows a sharp increase.
- (b) A time-temperature transformation (TTT) diagram that identifies temperatures and the duration of exposure at the temperature that causes significant changes in either the phase structure or the phase compositions of the borosilicate glass waste form. The producer shall provide TTT diagrams characteristic of the expected range of waste form composition. The waste form radionuclide release properties called for under Specification 1.3 shall also be provided for representative samples covering the same ranges of temperature, duration of exposure, and waste form composition.

The requested data, analysis, and appropriate technical support shall be provided in the WQR. The method used to produce these data shall be described in the WCP.

At the time of shipment, the producer shall certify that the maximum waste form temperature is at least 100°C below the transition temperature of 1.4(a) above. In addition, the producer shall certify that after the initial cooldown, the waste forms to be shipped have been handled and stored in a manner such that the maximum temperature of the waste form has not exceeded the transition temperature specified in Specification 1.4(a). Waste forms shall be transported under conditions that ensure that the transition temperature of Specification 1.4(a) above is not exceeded; certification that this has been accomplished will be required on receipt at the repository.

* TBD - to be determined.

2. CANISTER SPECIFICATIONS

2.1 MATERIAL SPECIFICATION

The waste form canister and any secondary canisters applied by the producer shall be fabricated from austenitic stainless steel. The ASTM alloy specification and the composition of the canister material, the secondary canister material, and any filler material used in welding shall be included in the WCP.

2.2 FABRICATION AND CLOSURE SPECIFICATION

The canister fabrication methods, as well as those for any secondary canister applied by the producer, shall be identified in the WCP and documented in the WQR. The outermost closure shall be leaktight in accordance with the definition of "leaktightness" in ANSI N14.5-1977, "American National Standard for Leakage Tests on Packages for Shipment of Radioactive Materials." The method for demonstrating compliance shall be described by the producer in the WCP and documented in the WQR.

2.3 IDENTIFICATION AND LABELING SPECIFICATIONS

2.3.1 Identification

The producer shall assign an alphanumeric code to each canister or secondary canister, if one is used, that is produced. This alphanumeric code shall appear on the labels of the canistered waste form and on all documentation pertinent to that particular canistered waste form.

2.3.2 Labeling

Each canister shall be labeled with the identification code specified above. Two labels shall be firmly affixed, with 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 point using a sans serif type face (Megaron Bold Condensed or equivalent). A proposed layout shall be provided in the WCP. Labels, meeting the requirements above, shall be applied to the exterior of the outermost canister. Labels affixed to the outside of the outermost canister shall not cause dimensional limits of Specification 3.11 to be exceeded.

3. CANISTERED WASTE FORM SPECIFICATIONS

3.1 FREE-LIQUID SPECIFICATION

After closure the canistered waste form shall not contain free-liquids that could be drained from the canister either initially or after having been subjected to the transition temperature of Specification 1.4(a). The producer shall describe the method of compliance in the WCP and provide documentation in the WQR.

3.2 GAS SPECIFICATION

After closure, the canistered waste form shall not contain free-gas other than cover and radiogenic gases. Cover gases shall be helium, argon, other inert gases, or air or combinations thereof. The maximum internal gas pressure immediately after closure shall 7 psig at 25°C. The producer shall describe the method of compliance in the WCP and shall document in the WQR the quantities and compositions of any gases that might accumulate inside the canister after the canister has been subjected to temperatures up to the transition temperature of Specification 1.4(a).

The producer shall also document in the WQR the quantities and compositions of any gases that might accumulate inside the canisters as a result of radioactive decay.

3.3 SPECIFICATION FOR EXPLOSIVENESS, PYROPHORICITY, AND COMBUSTIBILITY

After closure the canistered waste form shall not contain explosive, pyrophoric, and combustible materials. The producer shall describe in the WCP those administrative controls and other factors that prevent the introduction of explosive, pyrophoric, or combustible materials into canistered waste form. The producer shall present in the WQR an evaluation of the canistered waste form to demonstrate that, for the range of material compositions, it remains nonexplosive, nonpyrophoric, and noncombustible after having been subjected to temperatures up to the transition temperature of Specification 1.4(a).

3.4 ORGANIC MATERIALS SPECIFICATION

After closure the canistered waste form shall not contain organic materials. The producer shall describe the method for complying with this specification in the WCP and document the detection limit for organic materials in the WQR.

3.5 FREE-VOLUME SPECIFICATION

After closure, the free-volume within the canistered waste form shall not exceed 20 percent [R3] of the total internal volume of an empty canister. The producer shall identify the nominal free-volume and expected range of variation in the WCP and describe the method of compliance in the WCP. The producer shall also provide in the WCP the expected frequency distribution of free-volumes in the canistered waste forms.

3.6 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:

Alpha radiation: 220 dpm/100 cm²

Beta and Gamma radiation: 2200 dpm/100 cm²

In addition, the producer shall visually inspect the canistered waste forms and remove visible waste glass on the exterior of the canistered waste form before shipment. The producer shall describe the method of compliance in the WCP and provide supporting documentation in the WQR.

3.7 HEAT GENERATION SPECIFICATION

The canistered waste form shall not exceed a total heat generation rate of 800 watts per canister at the time of shipment to the repository.

3.7.1 Heat Generation Projections

The producer shall document in the WQR the expected thermal output and the range of expected variation due to process variation during the life of the production facility. The method to be used in making these projections shall be described by the producer in the WCP.

3.7.2 Heat Generation During Production

The producer shall specify in the production records the heat generation rate and its accuracy to $\pm 15\%$ for canistered waste forms at time of shipment. The expected accuracy of the heat generation rates shall be supplied in the WCP. The producer shall describe the plan for compliance in the WCP.

3.8 SPECIFICATION FOR MAXIMUM DOSE RATES

At the time of shipment the canistered waste form shall not exceed a maximum surface gamma dose rate of 10⁵ rem/hr and a maximum neutron dose rate of 10³ rem/hr.

3.8.1 Projections of Maximum Dose Rates

The producer shall specify in the WQR the expected values and the range of expected variation for both gamma and neutron dose rates. The producer shall describe in the WCP the method to be used in making these projections.

3.8.2 Maximum Dose Rates at Time of Shipment

The producer shall provide in the production records the gamma and neutron dose rates for the canistered waste forms at the time of shipment. The producer shall describe the method of compliance in the WCP.

3.9 CHEMICAL COMPATIBILITY SPECIFICATION

The contents of the canistered waste form shall not lead to internal corrosion of the canister such that there will be an adverse effect on normal

handling during storage, transportation, and repository operation. The producer shall describe the method of compliance in the WCP and document in the WQR the extent of corrosiveness and chemical reactivity among the waste form, the canister, and any filler materials. Corrosion, chemical interactions, and any reaction products generated within the canistered waste forms after exposure to temperatures up to the transition temperature of Specification 1.4(a) shall be evaluated in the WQR.

3.10 SUBCRITICALITY SPECIFICATION

The producer shall ensure that the canistered waste form will remain subcritical under all credible conditions likely to be encountered from production through receipt at the repository. The calculated effective neutron multiplication factor, k_{eff} , shall be sufficiently below unity to show at least a 5% margin after allowance for the 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 compliance in the WCP and provide supporting documentation in the WQR. The WQR shall also include sufficient information on the nuclear characteristics of the canistered waste form to enable the repository designer to confirm subcriticality under repository storage and disposal conditions.

3.11 SPECIFICATIONS FOR WEIGHT, LENGTH, DIAMETER, AND OVERALL DIMENSIONS

The configuration, dimensions, and weights of the canistered waste form shall be controlled as indicated below, and the following parameters of the canistered waste form shall be documented at the time of shipment.

3.11.1 Weight Specification

The weight of the canistered waste form shall not exceed 3,000 kg. The measured weight shall be specified in the production records, accurate to within $\pm 5\%$.

3.11.2 Length Specification

The overall length of the final canistered waste form at the time of shipment shall be 3.000 m (+ 0.005 m, - 0.020 m)

3.11.3 Diameter Specification

The outer diameter of the canistered waste form shall be 61.0 cm (+ 1.5 cm, - 1.0 cm). The minimum wall thickness of the empty canister shall be 0.85 cm. The producer shall state in the WCP the minimum canister wall thickness of the filled canister, and the thickness of any secondary canisters, along with their technical bases.

3.11.4 Specification for Overall Dimensions

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

3.12 DROP TEST SPECIFICATION

The canistered waste form at time of shipment shall be capable of withstanding a drop of 7 m onto a flat, essentially unyielding surface without breaching. The producer shall describe the method of compliance in the WCP and present the supporting documentation of analysis and test results in the WQR. The test results shall include information on measured canister leak rates and canister deformation after the drop test.

3.13 HANDLING FEATURES SPECIFICATION

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

The producer shall design the lifting flange and a suitable grapple, which could be used at the repository, that meets applicable codes and standards for use at the repository. The grapple and the flange shall be designed to satisfy 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 (to be supplied by the repository), and when engaged with the flange, shall be capable of raising and lowering a canistered waste form in a vertical direction.
- (c) The grapple, in the disengaged position, shall be capable of being inserted into and withdrawn in a vertical direction from a right-circular cylindrical cavity with a diameter equal to that of the canistered waste form.

The design of the flange and grapple shall be capable of fulfilling the requirements of Specification 3.13(a) through 3.13(c) without contacting or penetrating the walls of an imaginary right-circular, cylindrical cavity with a diameter equal to that of the canistered waste form, coaxial with the canistered waste form, and extending for a height of 0.7 m above the highest point on the canistered waste form. The design of the grapple shall include features that will prevent an inadvertent release of a suspended canistered waste form when the grapple is engaged with the flange. The producer shall describe the grapple and the flange design concepts in the WCP and provide the designs in the WQR.

4. QUALITY ASSURANCE SPECIFICATION

The producer shall establish, maintain, and execute a quality assurance program for waste form production, canisterizing the waste form, and preparing it for shipment to the repository. The quality assurance program shall be established in accordance with the Office of Civilian Radioactive Waste Management, as quality assurance management policies and requirements of the DOE/RW-0032, October 1985. The producer shall document the method of compliance with this specification in the WCP and provide supporting documentation in the WQR.

GLOSSARY FOR WASTE ACCEPTANCE PRELIMINARY SPECIFICATION

Borosilicate glass - glass typically containing approximately 20 to 35 wt% waste oxides, 40 to 50 wt% silicas, 5 to 10 wt% boron oxides, and 10 to 20 wt% alkali oxides, plus additives.

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

Canister breach - loss of canister leaktightness.

Canistered waste form - the waste form and the surrounding canister as well as any secondary canisters applied by the producer.

Combustible material - any material that can be ignited readily, and, when ignited, burns rapidly, and is therefore liable to cause fires.

Corrosiveness - the tendency of a substance to wear away or alter a material by a chemical or electrochemical (essentially, oxidizing) process.

Explosive material - a substance that, in its normal condition, is characterized by chemical stability, 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 40 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 the canister at temperatures below the glass transition temperature. This includes gases mechanically trapped in the waste form and those generated by chemical reaction and radiolytic decomposition.

Free-liquid - liquid that could be drained or evaporated from the canistered waste form at temperatures below the glass transition temperature; free-liquid includes liquid that is mechanically trapped in the waste form.

Free-volume - volume inside the sealed canister that is not occupied by the borosilicate glass, including voids within the glass itself.

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.

Leaktightness - a leakage rate of 10^{-7} atm-cm³/s or less based on dry air at 25°C and for a pressure differential of 1 atm against a vacuum of 10^{-2} atm or less (ANSI N14.5-1977, "American National Standard for Leakage Tests on Packages for Shipment of Radioactive Materials.").

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

Organic material - any material based on carbon chains or rings, generally containing hydrogen with or without oxygen, nitrogen, or other elements, whether or not derived from living organisms.

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 processes such as fission, fusion, neutron capture, or 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 cm² with an absorbent material, using moderate pressure, and measuring the activity on the wiping material.

Secondary canister - a sealed metal vessel that is applied by the producer and completely surrounds the waste form and its canister.

Transition temperature - the dilatometric softening point where the slope of the thermal expansion versus temperature curve shows a sharp increase.

Waste form - the radioactive waste materials and any encapsulating or stabilizing matrix (10 CFR 60.2).

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 producer.

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.

APPENDIX A

**RATIONALE FOR DEFENSE WASTE PROCESSING FACILITY HIGH-LEVEL WASTE FORM
WASTE ACCEPTANCE PRELIMINARY SPECIFICATIONS**

1. WASTE FORM SPECIFICATIONS

1.1 RATIONALE FOR THE CHEMICAL SPECIFICATION

The regulatory requirements outlined in 10 CFR 60.135(c)(1) state that, "All such radioactive wastes shall be in solid form and placed in sealed containers". The chemical specification addresses two repository information needs. Information on the planned production is required to allow testing of material that is representative of what is to be produced. Secondly, information on production waste forms confirms that actual product is within the range of materials tested.

Expected accuracy of measurement of production waste form compositions is necessary to allow adequate evaluation of uncertainties in waste form composition for repository performance assessment.

1.2 RATIONALE FOR THE RADIONUCLIDE INVENTORY SPECIFICATION

The total radionuclide inventory is required for a determination of the producer's contribution to the repository source term for calculations to show compliance with 40 CFR 191 total release standards. A year was needed for indexing radionuclide inventory values. The year 2025 was chosen as a reasonable date for completion of emplacement operations in the first repository. Inventory estimates for canistered waste forms are required to confirm that canistered waste forms fall within ranges considered in licensing, safety, and isolation assessments, and for estimates of releases under unanticipated processes and events, and accident scenario conditions. Expected variations in radionuclide inventories are necessary to adequately quantify uncertainties in radionuclide release estimates for repository performance assessments. The minimum concentration of 0.05% [R]* is needed to ensure that all isotopes of possible consequence to safety and isolation analyses are included, assuming that congruent dissolution of all nuclides occurs upon contact with an aqueous environment. It provides a factor of 2 reduction with respect to the 0.1% limit on isotopes which must be considered in meeting the 10 CFR 60.113 release rate criterion; it also provides a reasonable lower bound for assessment of releases during accidents. The half-life criterion needs to be as low as 10 years so that "pre-closure" exposure and accident concerns can be addressed.

The 1100 years is based on 1000 year containment period plus 100 years after production for storage, transportation, and operation prior to repository closure, and will be used as the basis for calculating the inventory for the 10 CFR 60.113 release rate criterion.

1.3 RATIONALE FOR THE SPECIFICATION FOR RADIONUCLIDE RELEASE PROPERTIES

The justification for this specification is based on the need of the repository for information concerning the release of radionuclides from the waste form. The test procedures and correlation of these data with release properties under repository conditions are being developed by the repository projects to satisfy regulatory criteria. Both the NRC criteria (10 CFR 60)

*[R] - denotes a value which has been reserved for final determination.

and the EPA criteria (40 CFR 191) have defined long-term radionuclide release in terms of the engineered barrier system and the mined geologic disposal system respectively. As a component part of these systems, the waste form may be required to contribute to the compliance with these requirements. The preliminary allocation of performance requirements among the various components of the engineered barrier system and the repository system is to be described in the Site Characterization Plans being developed for each candidate repository site. Therefore, site-specific tests and acceptance specifications are required.

1.4 RATIONALE FOR THE SPECIFICATION FOR CHEMICAL AND PHASE STABILITY

The borosilicate glass waste forms will retain release properties similar to those obtained under Specification 1.3 so long as the phase structures and compositions of the glass are unchanged from those provided under Specification 1.1.

The waste form temperature exceeding the transition temperature is the only process which can result in significant changes in the phase structures and compositions; thus, ensuring that significant change in the phase structure does not occur ensures that waste form release properties will be unchanged from those obtained under Specification 1.3.

Specifications 1.4.(a) and 1.4.(b) will provide data useful to the repository project for establishment of repository and waste package design limits. The certifications required will provide assurance that producers and transporters have not handled or stored the wastes in such a way as to cause significant changes in the phase structure, as well.

At the time of publication of the WAPS, the organizational responsibility for transportation of the wastes from the production facility has not been established. The requirement for certification of conditions during transportation has been included herein to identify the need for consideration of these requirements during design of the transportation system.

2. CANISTER SPECIFICATIONS

2.1 RATIONALE FOR THE MATERIAL SPECIFICATION

The repository must have a complete materials inventory to evaluate long term performance under repository conditions. Austenitic stainless steel has been selected as the container material for DWPF. This specification acknowledges that fact and establishes the repository's interest in this interface. Additionally, identification of the materials is necessary to assure that the canister material, and the material of any other component present in significant quantities (i.e., secondary canisters and welding fillers), are compatible with other materials in the repository.

2.2 RATIONALE FOR THE FABRICATION AND CLOSURE SPECIFICATION

The canister is designed to provide containment of the waste during handling up to packaging in a repository container to prevent escape of waste, liquids, gases, and particulates. Additionally, the canister must provide protection of the waste form from contact with externally derived liquids and gases until the canister is sealed in a repository container.

2.3 RATIONALE FOR THE IDENTIFICATION AND LABELING SPECIFICATIONS

The regulatory requirements in 10 CFR 60.135(b)(4) state that "A label or other means of identification shall be provided for each waste package. The identification shall not impair the integrity of the waste package and shall be applied in such a way that the information shall be legible at least to the end of the period of retrievability. Each waste package identification shall be consistent with the waste package's permanent written records."

This specification provides a means of tying the waste package and the waste form together through the retrievability period. The 92 point sans serif type face (Megaron Bold Condensed or equivalent) results in a letter height of approximately 3 cm and width of approximately 2 cm which has been judged to be adequate dimensions for visibility.

3. CANISTERED WASTE FORM SPECIFICATIONS

3.1 RATIONALE FOR THE FREE-LIQUID SPECIFICATION

The regulatory requirements outlined in 10 CFR 60.135(b)(2) state that, "The waste package shall not contain free-liquids in an amount that could compromise the ability of the waste package to achieve the performance objectives relating to containment of HLW (because of chemical interactions or formation of pressurized vapor) or result in spillage and spread of contamination in the event of waste package perforation during the period through permanent closure."

3.2 RATIONALE FOR THE GAS SPECIFICATION

The regulatory requirements in 10 CFR 60.135(a) require that "packages for HLW shall be designed so that in-situ chemical, physical, and nuclear properties of the waste package...do not compromise the function of the waste package... "and "The design shall include...consideration of...oxidation/reduction reactions, corrosion, hydriding, gas generation, thermal effects...mechanical stress, radiolysis radiation damage...." In order to demonstrate compliance with the regulations, waste package designers require information on gas generation potential of the waste form.

The intent of this specification is to ensure that gas pressure will not build up inside the container and contribute to loss of containment and dispersion of radionuclides. This specification provides a limit to initial gas pressure and information to index calculation of gas pressure build-up with time due to nuclear decay and temperature changes.

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

This specification is needed to ensure that after closure, the canistered waste form does not explode or burn during normal repository operations and accident conditions.

The regulatory requirements as outlined in 10 CFR 60.135(b)(1) state that, "The waste package shall not contain explosive or pyrophoric materials in an amount that could compromise the ability of the underground facility to contribute to waste isolation or the ability of the geologic repository to satisfy the performance objectives."

The regulatory requirements on the waste package as outlined in 10 CFR 60.135(a)(2) state that, "The design shall include but not be limited to consideration of...fire and explosion hazards." The waste form, as a component of the waste packages must comply with this requirement.

3.4 RATIONALE FOR THE ORGANIC MATERIALS SPECIFICATION

This specification is needed to ensure that organic materials that tend to mobilize radionuclides by formation of complexes, etc., or generate gases due to radiolysis are not present in the canistered waste form.

The regulatory requirements on the waste package as outlined in 10 CFR 60.135(2) state that, "The design shall include but not be limited to consideration of the following factors: ...gas generation, radiolysis, radionuclide retardation, leaching...." The waste form, as a component of the waste package must be assessed for compliance.

3.5 RATIONALE FOR THE FREE-VOLUME SPECIFICATION

In general, free-volume is to be minimized for the following reasons: 1) repository design; 2) economical use of repository space; and 3) less volume of water in contact with waste form after breach of containment. Specifically, BWIP has a concern about collapse of the packing into the void, resulting in less than desired density and creating preferential flow paths for radionuclide release. The value of 20% [R3] free-volume has been chosen as the best estimate for repository design requirements and is achievable by the producer under normal operating conditions.

Although it is desirable to have the vast majority of canistered waste forms to have free-volume less than 20 percent [R3], it is recognized that a small fraction of canisters may have free-volumes in excess of this due to operational occurrences at the producer's facility. The specification, as drafted, is intended to allow for these cases, to provide the information necessary for assessment of their impact on performance, and to provide the canister-by-canister certifications necessary to demonstrate compliance with likely repository license conditions.

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

This specification is necessary to protect personnel, prevent uncontrolled spread of contamination in repository facilities, minimize need for remote maintenance of facility equipment, and minimize need for cleanup of contamination during normal operations.

The specification limits chosen are used extensively in the nuclear industry practice and regulations to indicate surfaces are free of removable contamination.

3.7 RATIONALE FOR THE HEAT GENERATION SPECIFICATION

A heat generation rate limit must be set to ensure that the temperatures reached in other disposal package components or the host rock do not significantly reduce their performance capabilities.

Repository designers need a number with which to work to ensure that repository thermal load limits are not violated. The value of 800 watts was chosen as an expected upper bound for production from DWPF facilities. An accuracy of $\pm 15\%$ is judged to be a reasonable working value, acceptable to both repositories and to DWPF. The variation in normal expected heat generation rates is necessary to allow assessment of uncertainties in repository performance.

3.8 RATIONALE FOR THE SPECIFICATION FOR MAXIMUM DOSE RATES

The repository projects need the maximum gamma and neutron dose rates in order to design shielding for the receipt and handling facilities. The value of 10^5 rem/hr for maximum gamma dose rate and 10^3 rem/hr for maximum neutron dose rate provide a reasonable basis for repository design and operation and are judged to be sufficiently above the expected dose rates for DWPF wastes to provide reasonable flexibility for normal operations.

3.9 RATIONALE FOR THE CHEMICAL COMPATIBILITY SPECIFICATION

The specification is required to assure that the canister can be safely handled during storage, transportation, and repository operational periods, and to provide needed data for assessment of long term performance of the waste package components.

3.10 RATIONALE FOR THE SUBCRITICALITY SPECIFICATION

The regulatory requirements as outlined in 10 CFR 60.134(b)(7) state that, "The calculated effective multiplication factor k_{eff} must be sufficiently below unity, to show at least a 5% margin, after allowance for the bias in the method of calculation and the uncertainty in the experiments used to evaluate the method of calculation."

Subcriticality of multiple canister arrays at the repository is the responsibility of the repository designer.

3.11 RATIONALE FOR THE SPECIFICATIONS FOR WEIGHT, LENGTH, DIAMETER, AND OVERALL DIMENSIONS

The specifications on weight, length, diameter and wall thickness of the canistered waste form are needed for the repository design of handling requirements and waste packages. The overall dimensions of the canistered waste form must be such that (1) no forcing is required to place it in the disposal package container to prevent damage to the inside of the container and (2) there is compatibility with container geometry.

3.12 RATIONALE FOR THE DROP TEST SPECIFICATION

This specification is necessary to ensure that the canistered waste form is not breached after a drop. The height of 7 m was chosen as representative of the maximum drop height under normal operating conditions. Repository facilities will be designed to ensure that larger drops of bare canisters are not possible. The surface which is characteristic of repository conditions has been defined as a "flat, essentially unyielding" surface.

3.13 RATIONALE FOR THE HANDLING FEATURES SPECIFICATION

This specification reflects the lifting and handling requirements necessary for compatibility with current waste package concepts. The specification is drafted to allow the waste producer maximum flexibility in design of the canister handling arrangements.

4.0 RATIONALE FOR THE QUALITY ASSURANCE SPECIFICATION

All activities relevant to licensing of a repository must be conducted in accordance with appropriate Quality Assurance controls. OCRWM quality assurance policies and requirements are described in the referenced document. Producer activities must be conducted to comply with the program established by OCRWM.

APPENDIX B
EXPLANATION OF RESERVED ITEMS

R1 - Radionuclide Inventory Specification

Specification 1.2 establishes a numerical concentration of 0.05% (curies) of the total inventory for the reporting of radionuclides. This value is considered to be adequate based on a preliminary analysis by one of the repository projects alone; consequently, 0.05% is being held on reserve pending final analysis by repository projects.

R2 - Specification for Radionuclide Release Properties

At the time of publication of the WAPS, the test procedures and acceptance criteria for Specification 1.3, Specification for Radionuclide Release Properties, are not available. These procedures and criteria are being developed along with each project's Site Characterization Plan and depend upon site-specific performance allocations for the waste form. These procedures and acceptance criteria will be added to the specifications when they become available.

R3 - Free-Volume Specification

Specification 3.5 allows 20% free-volume within the canistered waste forms. 20% is being held in reserve pending a final analysis by the repository projects.

R4 - Time of Compliance

The time for compliance for the specification remains reserved pending further discussions within the DOE.

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OGR/B-9

Comments from Tom Jungling
4-30-86

**WASTE ACCEPTANCE
PRELIMINARY SPECIFICATIONS
for the
West Valley Demonstration Project
High Level Waste Form**

Draft for Concurrence

April, 1986

**U.S. Department of Energy
Office of Civilian Radioactive Waste Management
Washington, D.C. 20585**

DRAFT

3.9 CHEMICAL COMPATIBILITY SPECIFICATION

The contents of the canistered waste form shall not lead to internal corrosion of the canister such that there will be an adverse effect on normal handling during storage, transportation, and repository operation. The producer shall describe the method of compliance in the WCP and document in the WQR the extent of corrosiveness and chemical reactivity among the waste form, the canister, and any filler materials. Corrosion, chemical interactions, and any reaction products generated within the canistered waste forms after exposure to temperatures up to the transition temperature of Specification 1.4(a) shall be evaluated in the WQR.

3.10 SUBCRITICALITY SPECIFICATION

The producer shall ensure that the canistered waste form will remain subcritical under all credible conditions likely to be encountered from production through receipt at the repository. The calculated effective neutron multiplication factor, k_{eff} , shall be sufficiently below unity to show at least a 5% margin after allowance 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 compliance in the WCP and provide supporting documentation in the WQR. The WQR shall also include sufficient information on the nuclear characteristics of the canistered waste forms to enable the repository designer to confirm subcriticality under repository storage and disposal conditions.

3.11 SPECIFICATIONS FOR WEIGHT, LENGTH, DIAMETER, AND OVERALL DIMENSIONS

The configuration, dimensions, and weights of the canistered waste form shall be controlled as indicated below, and the following parameters of the canistered waste form shall be documented at the time of shipment.

3.11.1 Weight Specification

The weight of the canistered waste form shall not exceed 3,000 kg. The measured weight shall be specified in the production records, accurate to within $\pm 5\%$.

3.11.2 Length Specification

The overall length of the final canistered waste form at the time of shipment shall be 3.000 m (+ 0.005 m, - 0.020 m)

3.11.3 Diameter Specification

The outer diameter of the canistered waste form shall be 61.0 cm (+ 1.5 cm, - 1.0 cm). The minimum wall thickness of the empty canister shall be TBD [R6]. The producer shall state in the WCP the minimum canister wall thickness of the filled canister, and the thickness of any secondary canisters, along with their technical bases.

*LLNL had specified
CWH to be packed
w/ a diameter of 32 cm
UCID
19926
Dec 1993
Should not be a problem*

3.11.4 Specification for Overall Dimensions

The dimensions of the canistered waste form shall be controlled so that, at the time of shipment to a repository, the canister will stand upright

without support on a flat horizontal surface and will fit without forcing when lowered vertically into a right-circular, cylindrical cavity 64.0 cm in diameter and 3.01 m in length.

3.12 DROP TEST SPECIFICATION

The canistered waste form at time of shipment shall be capable of withstanding a drop of 7 m [R4] onto a flat essentially unyielding surface without breaching. The producer shall describe the method of compliance in the WCP and present the supporting documentation of analysis and test results in the WQR. The test results shall include information on measured canister leak rates and canister deformation after the drop test.

3.13 HANDLING FEATURES SPECIFICATION

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

The producer shall design the lifting flange and a suitable grapple, which could be used at the repository, that meets applicable codes and standards for use at the repository. The grapple and the flange shall be designed to satisfy 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 (to be supplied by the repository), and when engaged with the flange, shall be capable of raising and lowering a canistered waste form in a vertical direction.
- (c) The grapple, in the disengaged position, shall be capable of being inserted into and withdrawn in a vertical direction from a right-circular, cylindrical cavity with a diameter equal to that of the canistered waste form. *larger*

The design of the flange and the grapple shall be capable of fulfilling the requirements of Specifications 3.13(a) through 3.13(c) without contacting or penetrating the walls of an imaginary right-circular, cylindrical cavity with a diameter equal to that of the canistered waste form, coaxial with the canistered waste form, and extending for a height of 0.7 m above the highest point on the canistered waste form. The design of the grapple shall include features that will prevent an inadvertent release of a suspended canistered waste form when the grapple is engaged with the flange. The producer shall describe the grapple and the flange design concepts in the WCP and provide the detailed designs in the WQR.

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**WASTE ACCEPTANCE
PRELIMINARY SPECIFICATIONS
for the
West Valley Demonstration Project
High Level Waste Form**

Draft for Concurrence

April, 1986

**U.S. Department of Energy
Office of Civilian Radioactive Waste Management
Washington, D.C. 20585**

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WASTE ACCEPTANCE
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Waste Form and Waste Acceptance Preliminary
Specifications"

Appendix B - "Explanation of Reserved Items"

WASTE ACCEPTANCE
PRELIMINARY SPECIFICATIONS
for the
West Valley Demonstration Project
High-Level Waste Form

Introduction

These Waste Acceptance Preliminary Specifications (WAPS) specify the properties and requirements for the high-level waste (HLW) forms to be produced by the West Valley Demonstration Project (WVDP) at West Valley, New York. The WAPS establish the minimum requirements that the WVDP waste form must meet in order to be compatible with any of the three geologic media (i.e., basalt, salt, or tuff) under consideration for the first geologic repository.

The WAPS has been developed by the Waste Acceptance Committee (WAC), which is responsible for the preparation of the various site-specific and generic documents identified in the Waste Acceptance Process (WAP). The development and the approval of the WAPS have been carried out in accordance with procedures outlined in the WAC charter. The WAPS specify technical requirements that the waste form must meet and documentation that the producer must provide in order to fulfill the producer's role in the repository licensing process. The WAPS also provide the bases for developing design specifications for the repository and the waste package design. The rationale for each specification is presented in Appendix A.

It is recognized that some individual canistered waste forms may not comply in every respect with these specifications. For these cases, the producer will identify nonconformities and propose a remedy for evaluation by the receiving repository on a case-by-case basis. The repository will evaluate the proposed remedy, and a final disposition of the nonconforming waste form will be determined in accordance with the repository license.

Within the waste acceptance process, the WAPS follow the repository-site-specific, waste-form-specific Waste Acceptance Specifications. Where possible, the WAPS reflect generic requirements; however, in one case (i.e., Specification 1.3, Specification for Radionuclide Release Properties), it is not possible to set a single specification that is adequate for all repositories. In this case, producers must demonstrate compliance with repository-specific requirements, at least until the site for the first repository is chosen. The required release properties for the waste form will be based on the overall performance allocation for different parts of the engineered barrier system since containment and isolation requirements are to be met by the total engineered barrier system and not necessarily by the waste form alone. The WAPS require demonstration of compliance via three different documents, each prepared by the producer and concurred with by the repository projects through the waste acceptance process: (1) the Waste Form Compliance Plan (WCP), (2) the Waste Form Qualification Report (WQR), and (3) Production Records.

The Waste Form Compliance Plan (WCP) is the producer's plan for demonstrating compliance with each specification in the WAPS. The WCP is to

include detailed descriptions of the testing (including detailed test procedures), analyses, and process controls to be performed by the waste producer, including the identification of production records to be provided to demonstrate compliance with the specifications. The plan for compliance with each specification is to be concurred with by each of the repository projects. To meet schedule demands, it may be necessary for WCP preparation and concurrence to proceed specification by specification, and such an approach is permissible, with the agreement of the WAC Chairman. Concurrence by repository projects means that the producer's proposed method of compliance will satisfactorily meet the intent of the specification, acceptance criteria (as applicable), and support requirements for licensing arguments.

The WQR is a compilation of all results from testing and analysis that presents detailed evidence of compliance with each specification. This document is also prepared by the producer and concurred with by each repository project. Concurrence by the repository projects will be required for each specification and will mean that the testing and analysis as described and documented provide a satisfactory demonstration of compliance with the specification and are adequate for the intended use in repository licensing. Again, consideration of the basis of individual specifications is permissible if the WAC Chairman concurs.

Production Records refers to documentation, provided by the producer, that describes the actual canistered waste forms for review by the repository operator before the waste is shipped. The format and the content of the production records will be specified in the WCP. Concurrence means that the canistered waste forms described are in compliance with the specifications and are therefore acceptable for disposal.

The WAPS are based on the best available information current as of the date of issue. They are likely to be revised as the repository program proceeds through design and licensing. Eventually the WAPS will evolve into the Updated Waste Acceptance Specifications (WAS), which will be used for the License Application, and ultimately into the Final WAS, after the incorporation of applicable NRC licensing technical specifications. All changes will be made in accordance with the Waste Acceptance Process through the WAC.

When these WAPS were prepared, there was insufficient information available to firmly fix several of the specifications. These specifications remain reserved and are denoted by [R#] in the text of the specification. An explanation of all reserved items is found in Appendix B.

1. WASTE FORM SPECIFICATIONS

1.1 CHEMICAL SPECIFICATION

The waste form for WVDP is borosilicate glass.

1.1.1 Chemical Composition Projections

The producer shall include in the Waste Form Qualification Report (WQR), sufficient chemical and microstructural data to characterize the elemental composition and crystalline phases for the product of the waste production facility and expected variations in the product due to process variations during the life of the facility. The method used to make these projections shall be described by the producer in the Waste Form Compliance Plan (WCP).

1.1.2 Chemical Composition During Production

For the production waste forms, the producer shall include in the production records ^{why?} the elemental composition of the glass waste form for all elements, excluding oxygen, present in concentrations greater than 0.5 percent by weight with a precision and an accuracy to be reported in the WCP. The producer shall describe the method to be used for compliance in WCP.

1.2 RADIONUCLIDE INVENTORY SPECIFICATION

For all radionuclide inventory estimates required by this specification, the producer shall report all radioisotopes that have half-lives longer than 10 years and are present in concentrations greater than 0.05% (curies) [R1] of the total radioactivity inventory (aggregate or canistered waste form, as applicable) at any time up to 1100 years after production.

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 and of the uncertainties in the expected values. The producer shall also provide in the WQR estimates of the inventories of individual radionuclides expected to be present in canistered waste forms produced at the facility and the expected range of variations due to process variations during the life of the facility. These estimates shall be calculated for the year 2025. The method used to make these projections shall be described by the producer in the WCP.

1.2.2 Radionuclide Inventory During Production

At the time of shipment the producer shall provide in the production records estimates of inventories of individual radionuclides in the canistered waste forms. The producer shall also report the expected precision and accuracy of these estimates in the WCP.

1.3 SPECIFICATION FOR RADIONUCLIDE RELEASE PROPERTIES

The producer shall document that the radionuclide release properties of the waste form have been controlled so that the production waste glass can

meet the limits specified in repository-specified tests (TBD*) [R2]. Before shipment the producer shall document that the waste forms at time of (TBD*) [R5] are in compliance with the radionuclide release specification for the receiving repository. The producer shall describe the intended method for demonstrating compliance with each repository-site-specific requirement in the WCP. Supporting technical documentation for the selected method of compliance shall be included in the WQR.

1.4 SPECIFICATION FOR CHEMICAL AND PHASE STABILITY

The producer shall provide the following data on the borosilicate glass waste form:

- (a) The transition temperature where the slope of the thermal expansion vs. temperature curve shows a sharp increase.
- (b) A time-temperature-transformation (TTT) diagram that identifies temperatures and the duration of exposure at the temperature that causes significant changes in either the phase structure or the phase compositions of the borosilicate glass waste form. The producer shall provide TTT diagrams characteristic of the expected range of waste form composition. The waste form radionuclide release properties called for under Specification 1.3 shall also be provided for representative samples covering the same ranges of temperature, duration of exposure, and waste form composition.

The requested data, analysis, and appropriate technical support shall be provided in the WQR. The method used to produce these data shall be described in the WCP.

At the time of shipment, the producer shall certify that the maximum waste form temperature is at least 100°C below the transition temperature of 1.4(a) above. In addition, the producer shall certify that after the initial cooldown, the waste forms to be shipped have been handled and stored in a manner such that the maximum temperature of the waste form has not exceeded the transition temperature specified in Specification 1.4(a). Waste forms shall be transported under conditions that ensure that the transition temperature of Specification 1.4(a) above is not exceeded; certification that this has been accomplished will be required on receipt at the repository.

*TBD - to be determined

2. CANISTER SPECIFICATIONS

2.1 MATERIAL SPECIFICATION

The waste form canister and any secondary canisters to be applied by the producer shall be fabricated from austenitic stainless steel. The ASTM alloy specification and the composition of the canister material, the secondary canister material, and any filler material used in welding shall be included in the WCP.

2.2 FABRICATION AND CLOSURE SPECIFICATION

The canister fabrication methods, as well as those for any secondary canisters applied by the producer, shall be identified in the WCP and documented in the WQR. The outermost closure shall be leaktight in accordance with the definition of "leaktightness" in ANSI 14.5-1977, "American National Standard for Leakage Testing on Packages for Shipment of Radioactive Materials." The method for demonstrating compliance shall be described by the producer in the WCP and documented in the WQR.

2.3 IDENTIFICATION AND LABELING SPECIFICATIONS

2.3.1 Identification

The producer shall assign an alphanumeric code to each canister or secondary canister, if one is used, that is produced. This alphanumeric code shall appear on the labels of the canistered waste form and on all documentation pertinent to that particular canistered waste form.

2.3.2 Labeling

Each canister shall be labeled with the identification code specified above. Two labels shall be firmly affixed, with 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 (Megaron Bold Condensed or equivalent). A proposed layout shall be provided in the WCP. Labels meeting the requirements above shall be applied to the exterior of the outermost canister. Labels affixed to the outside of the outermost canister shall not cause the dimensional limits of Specification 3.11 to be exceeded.

3. CANISTERED WASTE FORM SPECIFICATIONS

3.1 FREE-LIQUID SPECIFICATION

After closure the canistered waste form shall not contain free-liquids that could be drained from the canister either initially or after having been subjected to the transition temperature of Specification 1.4(a). The producer shall describe the method of compliance in the WCP and provide documentation in the WQR.

3.2 GAS SPECIFICATION

After closure the canistered waste form shall not contain free gases, other than cover and radiogenic gases. Cover gases shall be helium, argon, other inert gases, or air or combinations thereof. The maximum internal gas pressure immediately after closure shall be 7 psig at 25°C. The producer shall describe the method of compliance in the WCP and shall document in the WQR the quantities and compositions of any gases that might accumulate inside the canister after the canister has been subjected to temperatures up to the transition temperature of Specification 1.4(a).

The producer shall also document in the WQR the quantities and compositions of any gases that might accumulate inside the canisters as a result of radioactive decay.

3.3 SPECIFICATION FOR EXPLOSIVENESS, PYROPHORICITY, AND COMBUSTIBILITY

After closure the canistered waste form shall not contain explosive, pyrophoric, and combustible materials. The producer shall describe in the WCP those administrative controls and other factors that prevent the introduction of explosive, pyrophoric, or combustible materials into canistered waste forms. The producer shall present in the WQR an evaluation of the canistered waste form to demonstrate that, for the range of material compositions, it remains nonexplosive, nonpyrophoric, and noncombustible after having been subjected to the temperatures up to the transition temperature of Specification 1.4(a).

3.4 ORGANIC MATERIALS SPECIFICATION

After closure the canistered waste form shall not contain organic materials. The producer shall describe the method for complying with this specification in the WCP and document the detection limit for organic materials in the WQR.

3.5 FREE-VOLUME SPECIFICATION

After closure, the free-volume within the canistered waste form shall not exceed 20 percent [R3] of the total internal volume of an empty canister. The producer shall identify the nominal free-volume and expected range of variation in the WCP and describe the method of compliance in the WCP. The producer shall provide in the WCP the expected frequency distribution of free-volumes in canistered waste forms.

3.6 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:

Alpha radiation: 220 dpm/100 cm²

Beta and Gamma radiation: 2200 dpm/100 cm²

In addition, the producer shall visually inspect the canistered waste forms, and remove visible waste glass on the exterior of the canistered waste form before shipment. The producer shall describe the method of compliance in the WCP and provide supporting documentation in the WQR.

3.7 HEAT GENERATION SPECIFICATION

The canistered waste form shall not exceed a total heat generation rate of 800 watts per canister at the time of shipment to the repository.

3.7.1 Heat Generation Projections

The producer shall document in the WQR the expected thermal output and the range of expected variation due to process variations during the life of the production facility. The method to be used in making these projections shall be described by the producer in the WCP.

3.7.2 Heat Generation During Production

The producer shall specify ^{or report?} in the production records the heat generation rate and its accuracy for canistered waste forms at time of shipment. The expected accuracy of the heat generation rates shall be supplied in the WCP. The producer shall describe the plan for compliance in the WCP.

3.8 SPECIFICATION FOR MAXIMUM DOSE RATES

At the time of shipment, the canistered waste form shall not exceed a maximum surface gamma dose rate of 10⁵rem/hr and a maximum neutron dose rate of 10³rem/hr.

3.8.1 Projections of Maximum Dose Rates

The producer shall specify in the WQR the expected values and the range of expected variation for both gamma and neutron dose rates. The producer shall describe in the WCP the method to be used in making these projections.

3.8.2 Maximum Dose Rates at Time of Shipment

The producer shall provide in the production records the gamma and neutron dose rates for the canistered waste forms at the time of shipment. The producer shall describe the method of compliance in the WCP.

It is not clear how these are different.

3.9 CHEMICAL COMPATIBILITY SPECIFICATION

The contents of the canistered waste form shall not lead to internal corrosion of the canister such that there will be an adverse effect on normal handling during storage, transportation, and repository operation. The producer shall describe the method of compliance in the WCP and document in the WQR the extent of corrosiveness and chemical reactivity among the waste form, the canister, and any filler materials. Corrosion, chemical interactions, and any reaction products generated within the canistered waste forms after exposure to temperatures up to the transition temperature of Specification 1.4(a) shall be evaluated in the WQR.

3.10 SUBCRITICALITY SPECIFICATION

The producer shall ensure that the canistered waste form will remain subcritical under all credible conditions likely to be encountered from production through receipt at the repository. The calculated effective neutron multiplication factor, k_{eff} , shall be sufficiently below unity to show at least a 5% margin after allowance 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 compliance in the WCP and provide supporting documentation in the WQR. The WQR shall also include sufficient information on the nuclear characteristics of the canistered waste forms to enable the repository designer to confirm subcriticality under repository storage and disposal conditions.

3.11 SPECIFICATIONS FOR WEIGHT, LENGTH, DIAMETER, AND OVERALL DIMENSIONS

The configuration, dimensions, and weights of the canistered waste form shall be controlled as indicated below, and the following parameters of the canistered waste form shall be documented at the time of shipment.

3.11.1 Weight Specification

The weight of the canistered waste form shall not exceed 3,000 kg. The measured weight shall be specified in the production records, accurate to within $\pm 5\%$. *reported?*

3.11.2 Length Specification

The overall length of the final canistered waste form at the time of shipment shall be 3.000 m (+ 0.005 m, - 0.020 m)

3.11.3 Diameter Specification

The outer diameter of the canistered waste form shall be 61.0 cm (+ 1.5 cm, - 1.0 cm). The minimum wall thickness of the empty canister shall be TBD [R6]. The producer shall state in the WCP the minimum canister wall thickness of the filled canister, and the thickness of any secondary canisters, along with their technical bases. *24 in.*

3.11.4 Specification for Overall Dimensions

The dimensions of the canistered waste form shall be controlled so that, at the time of shipment to a repository, the canister will stand upright

without support on a flat horizontal surface and will fit without forcing when lowered vertically into a right-circular, cylindrical cavity 64.0 cm in diameter and 3.01 m in length.

3.12 DROP TEST SPECIFICATION

The canistered waste form at time of shipment shall be capable of withstanding a drop of 7 m [R4] onto a flat essentially unyielding surface without breaching. The producer shall describe the method of compliance in the WCP and present the supporting documentation of analysis and test results in the WQR. The test results shall include information on measured canister leak rates and canister deformation after the drop test.

3 cm seal area over 10 ft length
Does it still have to go into 64cm dia. cavity?

3.13 HANDLING FEATURES SPECIFICATION

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

The producer shall design the lifting flange and a suitable grapple, which could be used at the repository, that meets applicable codes and standards for use at the repository. The grapple and the flange shall be designed to satisfy 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 (to be supplied by the repository), and when engaged with the flange, shall be capable of raising and lowering a canistered waste form in a vertical direction.
- (c) The grapple, in the disengaged position, shall be capable of being inserted into and withdrawn in a vertical direction from a right-circular, cylindrical cavity with a diameter equal to that of the canistered waste form.

The design of the flange and the grapple shall be capable of fulfilling the requirements of Specifications 3.13(a) through 3.13(c) without contacting or penetrating the walls of an imaginary right-circular, cylindrical cavity with a diameter equal to that of the canistered waste form, coaxial with the canistered waste form, and extending for a height of 0.7 m above the highest point on the canistered waste form. The design of the grapple shall include features that will prevent an inadvertent release of a suspended canistered waste form when the grapple is engaged with the flange. The producer shall describe the grapple and the flange design concepts in the WCP and provide the detailed designs in the WQR.

4. QUALITY ASSURANCE SPECIFICATION

The producer shall establish, maintain, and execute a quality assurance program for waste form production, canisterizing the waste form, and preparing it for shipment to the repository. The quality assurance program shall be established in accordance with the Office of Civilian Radioactive Waste Management, as quality assurance management policies and requirements of the DOE/RW-0032, October 1985. The producer shall document the method of compliance with this specification in the WCP and provide supporting documentation in the WQR.

need comment for QA Section in WMRP.

GLOSSARY FOR WASTE ACCEPTANCE PRELIMINARY SPECIFICATION

Borosilicate glass - glass typically containing approximately 20 to 35 wt% waste oxides, 40 to 50 wt% silicas, 5 to 10 wt% boron oxides, and 10 to 20 wt% alkali oxides, plus additives.

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

Canister breach - loss of canister leaktightness.

Canistered waste form - the waste form and the surrounding canister as well as any secondary canisters applied by the producer.

Combustible material - any material that can be ignited readily, and, when ignited, burns rapidly, and is therefore liable to cause fires.

Corrosiveness - the tendency of a substance to wear away or alter a material by a chemical or electrochemical (essentially oxidizing) process.

Explosive material - a substance that, in its normal condition, is characterized by chemical stability, 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 40 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 the canister at temperatures below the glass transition temperature. This includes gases mechanically trapped in the waste form and those generated by chemical reaction and radiolytic decomposition.

Free-liquid - liquid that could be drained or evaporated from the canistered waste form at temperatures below the glass transition temperature; free-liquid includes liquid that is mechanically trapped in the waste form.

Free-volume - volume inside the sealed canister that is not occupied by the borosilicate glass, including voids within the glass itself.

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.

Leaktightness - a leakage rate of 10^{-7} atm-cm³/s or less based on dry air at 25°C and for a pressure differential of 1 atm against a vacuum of 10^{-2} atm or less (ANSI N14.5-1977, "American National Standard for Leakage Tests on Packages for Shipment of Radioactive Materials.").

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

Organic material - any material based on carbon chains or rings, generally containing hydrogen with or without oxygen, nitrogen, or other elements, whether or not derived from living organisms.

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 processes such as fission, fusion, neutron capture, or 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 cm² with an absorbent material, using moderate pressure, and measuring the activity on the wiping material.

Secondary canister - a sealed metal vessel that is applied by the producer and completely surrounds the waste form and its canister.

Transition temperature - the dilatometric softening point where the slope of the thermal expansion versus temperature curve shows a sharp increase.

Waste form - the radioactive waste materials and any encapsulating or stabilizing matrix (10 CFR 60.2).

Waste Acceptance Preliminary Specification
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 producer.

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.

APPENDIX A

**RATIONALE FOR WEST VALLEY DEMONSTRATION PROJECT HIGH-LEVEL WASTE FORM
WASTE ACCEPTANCE PRELIMINARY SPECIFICATIONS**

1. WASTE FORM SPECIFICATIONS

1.1 RATIONALE FOR THE CHEMICAL SPECIFICATION

The regulatory requirements outlined in 10 CFR 60.135(c)(1) state that, "All such radioactive wastes shall be in solid form and placed in sealed containers". The chemical specification addresses two repository information needs. Information on the planned production is required to allow testing of material that is representative of what is to be produced. Secondly, information on production waste forms confirms that actual product material is within the range of materials tested.

Expected accuracy of measurement of production waste form compositions is necessary to allow adequate evaluation of uncertainties in waste form composition for repository performance assessment.

1.2 RATIONALE FOR THE RADIONUCLIDE INVENTORY SPECIFICATION

The total radionuclide inventory is required for a determination of the producer's contribution to the repository source term for calculations to show compliance with 40 CFR 191 total release standards. A year was needed for indexing radionuclide inventory values. The year 2025 was chosen as a reasonable date for completion of emplacement operations in the first repository. Inventory estimates for canistered waste forms are required to confirm that canistered waste forms fall within ranges considered in licensing, safety, and isolation assessments, and for estimates of releases under unanticipated processes and events, and accident scenario conditions. Expected variations in radionuclide inventories are necessary to adequately quantify uncertainties in radionuclide release estimates for repository performance assessments. The minimum concentration of 0.05% [R]* is needed to ensure that all isotopes of possible consequence to safety and isolation analyses are included, assuming that congruent dissolution of all nuclides occurs upon contact with an aqueous environment. It provides a factor of 2 reduction with respect to the 0.1% limit on isotopes which must be considered in meeting the 10 CFR 60.113 release rate criterion; it also provides a reasonable lower bound for assessment of releases during accidents. The half-life criterion needs to be as low as 10 years so that "pre-closure" exposure and accident concerns can be addressed.

The 1100 years is based on 1000 year containment period plus 100 years after production for storage, transportation, and operation prior to repository closure, and will be used as the basis for calculating the inventory for the 10 CFR 60.113 release rate criterion.

1.3 RATIONALE FOR THE SPECIFICATION FOR RADIONUCLIDE RELEASE PROPERTIES

The justification for this specification is based on the need of the repository for information concerning the release of radionuclides from the waste form. The test procedures and correlation of these data with release properties under repository conditions are being developed by the repository projects to satisfy regulatory criteria. Both the NRC criteria (10 CFR 60) and the EPA criteria (40 CFR 191) have defined long-term radionuclide release in terms of the engineered barrier system and the mined geologic disposal

*[R] - denotes a value which has been reserved for final determination.

We can only assume this means that the canistered waste form must be capable of meeting containment and release reqts without assistance from any other waste pkg components or engineered barriers.
DRAFT

Performance Allocation will be revealed in SCPN, which are probably at least a year away. EAW 4/30/86

system respectively. As a component part of these systems, the waste form may be required to contribute to the compliance with these requirements. The preliminary allocation of performance requirements among the various components of the engineered barrier system and the repository system is to be described in the Site Characterization Plans being developed for each candidate repository site. Therefore, site-specific tests and acceptance specifications are required.

Radionuclide Release Properties

1.4 RATIONALE FOR THE SPECIFICATION FOR CHEMICAL AND PHASE STABILITY

The borosilicate glass waste forms will retain release properties similar to those obtained under Specification 1.3 so long as the phase structures and compositions of the glass are unchanged from those provided under Specification 1.1.

The waste form temperature exceeding the transition temperature is the only process which can result in significant changes in the phase structures and compositions; thus, ensuring that significant change in the phase structure does not occur ensures that waste form release properties will be unchanged from those obtained under Specification 1.3.

Transition Temp. TTT diagram

Specifications 1.4(a) and 1.4(b) will provide data useful to the repository project for establishment of repository and waste package design limits. The certifications required will provide assurance that producers and transporters have not handled or stored the wastes in such a way as to cause significant changes in the phase structure, as well.

At the time of publication of the WAPS, the organizational responsibility for transportation of the wastes from the production facility has not been established. The requirement for certification of conditions during transportation has been included herein to identify the need for consideration of these requirements during design of the transportation system.

2. CANISTER SPECIFICATIONS

canister?

very general

2.1 RATIONALE FOR THE MATERIAL SPECIFICATION

The repository must have a complete materials inventory to evaluate long term performance under repository conditions. Austenitic stainless steel has been selected as the container material for WVDP. This specification acknowledges that fact and establishes the repository's interest in this interface. Additionally, identification of the materials is necessary to assure that the canister material, and the material of any other component present in significant quantities (i.e., secondary canisters and welding fillers), are compatible with other materials in the repository.

2.2 RATIONALE FOR THE FABRICATION AND CLOSURE SPECIFICATION

The canister is designed to provide containment of the waste during handling up to packaging in a repository container to prevent escape of waste, liquids, gases, and particulates. Additionally, the canister must provide protection of the waste form from contact with externally derived liquids and gases until the canister is sealed in a repository container.

2.3 RATIONALE FOR THE IDENTIFICATION AND LABELING SPECIFICATIONS

The regulatory requirements in 10 CFR 60.135(b)(4) state that "A label or other means of identification shall be provided for each waste package. The identification shall not impair the integrity of the waste package and shall be applied in such a way that the information shall be legible at least to the end of the period of retrievability. Each waste package identification shall be consistent with the waste package's permanent written records."

This specification provides a means of tying the waste package and the waste form together through the retrievability period. The 92 point sans serif type face (Megaron Bold Condensed or equivalent) results in a letter height of approximately 3 cm and width of approximately 2 cm which has been judged to be adequate dimensions for visibility.

3. CANISTERED WASTE FORM SPECIFICATIONS

3.1 RATIONALE FOR THE FREE-LIQUID SPECIFICATION

The regulatory requirements outlined in 10 CFR 60.135(b)(2) state that, "The waste package shall not contain free-liquids in an amount that could compromise the ability of the waste package to achieve the performance objectives relating to containment of HLW (because of chemical interactions or formation of pressurized vapor) or result in spillage and spread of contamination in the event of waste package perforation during the period through permanent closure."

3.2 RATIONALE FOR THE GAS SPECIFICATION

The regulatory requirements in 10 CFR 60.135(a) require that "packages for HLW shall be designed so that in-situ chemical, physical, and nuclear properties of the waste package...do not compromise the function of the waste package... "and "The design shall include...consideration of...oxidation/reduction reactions, corrosion, hydriding, gas generation, thermal effects...mechanical stress, radiolysis radiation damage...." In order to demonstrate compliance with the regulations, waste package designers require information on gas generation potential of the waste form.

The intent of this specification is to ensure that gas pressure will not build up inside the container and contribute to loss of containment and dispersion of radionuclides. This specification provides a limit to initial gas pressure and information to index calculation of gas pressure build-up with time due to nuclear decay and temperature changes.

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

This specification is needed to ensure that after closure the canistered waste form does not explode or burn during normal repository operations and accident conditions.

The regulatory requirements as outlined in 10 CFR 60.135(b)(1) state that, "The waste package shall not contain explosive or pyrophoric materials in an amount that could compromise the ability of the underground facility to contribute to waste isolation or the ability of the geologic repository to satisfy the performance objectives."

The regulatory requirements on the waste package as outlined in 10 CFR 60.135(a)(2) state that, "The design shall include but not be limited to consideration of...fire and explosion hazards." The waste form, as a component of the waste packages must comply with this requirement.

3.4 RATIONALE FOR THE ORGANIC MATERIALS SPECIFICATION

This specification is needed to ensure that organic materials that tend to mobilize radionuclides by formation of complexes, etc., or generate gases due to radiolysis are not present in the canistered after closure.

The regulatory requirements on the waste package as outlined in 10 CFR 60.135(2) state that, "The design shall include but not be limited to consideration of the following factors: ...gas generation, radiolysis, radionuclide retardation, leaching...." The waste form, as a component of the waste package must be assessed for compliance.

3.5 RATIONALE FOR THE FREE-VOLUME SPECIFICATION

In general, free-volume is to be minimized for the following reasons: 1) repository design; 2) economical use of repository space; and 3) less volume of water in contact with waste form after breach of containment. Specifically, BWIP has a concern about collapse of the packing into the void, resulting in less than desired density and creating preferential flow paths for radionuclide release. The value of 20% [R3] free-volume has been chosen as the best estimate for repository design requirements and is achievable by the producers under normal operating conditions.

Although it is desirable to have the vast majority of canistered waste forms to have free-volume less than 20 percent [R3], it is recognized that a small fraction of canisters may have free-volumes in excess of this due to operational occurrences at the producer's facility. The specification, as drafted, is intended to allow for these cases, to provide the information necessary for assessment of their impact on performance, and to provide the canister-by-canister certifications necessary to demonstrate compliance with likely repository license conditions.

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

This specification is necessary to protect personnel, prevent uncontrolled spread of contamination in repository facilities, minimize need for remote maintenance of facility equipment, and minimize need for cleanup of contamination during normal operations.

The specification limits chosen are used extensively in the nuclear industry practice and regulations to indicate surfaces are free of removable contamination.

3.7 RATIONALE FOR THE HEAT GENERATION SPECIFICATION

A heat generation rate limit must be set to ensure that the temperatures reached in other disposal package components or the host rock do not significantly reduce their performance capabilities.

Repository designers need a number with which to work to ensure that repository thermal load limits are not violated. The value of 800 watts was chosen as an expected upper bound for production from the WVDP facility. WVDP will determine the attainable accuracy in planned testing and report it for evaluation by repositories in the WCP. The variation in normal expected heat generation rates is necessary to allow assessment of uncertainties in repository performance.

3.8 RATIONALE FOR THE SPECIFICATION FOR MAXIMUM DOSE RATES

The repository projects need the maximum gamma and neutron dose rates in order to design shielding for the receipt and handling facilities. The value of 10^5 rem/hr for maximum gamma dose rate and 10^3 rem/hr for maximum neutron dose rate provide a reasonable basis for repository design and operation and are judged to be sufficiently above the expected dose rates for WVDP wastes to provide reasonable flexibility for normal operations.

3.9 RATIONALE FOR THE CHEMICAL COMPATIBILITY SPECIFICATION

The specification is required to assure that the canister can be safely handled during storage, transportation, and repository operational periods, and to provide needed data for assessment of long term performance of the waste package components.

3.10 RATIONALE FOR THE SUBCRITICALITY SPECIFICATION

The regulatory requirements as outlined in 10 CFR 60.134(b)(7) state that, "The calculated effective multiplication factor k_{eff} must be sufficiently below unity, to show at least a 5% margin, after allowance for the bias in the method of calculation and the uncertainty in the experiments used to evaluate the method of calculation."

Subcriticality of multiple canister arrays at the repository is the responsibility of the repository designer.

3.11 RATIONALE FOR THE SPECIFICATIONS FOR WEIGHT, LENGTH, DIAMETER, AND OVERALL DIMENSIONS

The specifications on weight, length, diameter and wall thickness of the canistered waste form are needed for the repository design of handling requirements and waste packages. The overall dimensions of the canistered waste form must be such that (1) no forcing is required to place it in the disposal package container to prevent damage to the inside of the container and (2) there is compatibility with container geometry.

3.12 RATIONALE FOR THE DROP TEST SPECIFICATION

This specification is necessary to ensure that the canistered waste form is not breached after a drop. The height of 7 m [R4] was chosen as representative of the maximum drop height under normal operating conditions. Repository facilities will be designed to ensure that larger drops of bare canisters are not possible. The surface which is characteristic of repository conditions has been defined as a "flat, essentially unyielding" surface.

3.13 RATIONALE FOR THE HANDLING FEATURES SPECIFICATION

This specification reflects the lifting and handling requirements necessary for compatibility with current waste package concepts. The specification is drafted to allow the producer maximum flexibility in design of the canister handling arrangements.

4.0 RATIONALE FOR THE QUALITY ASSURANCE SPECIFICATION

All activities relevant to licensing of a repository must be conducted in accordance with appropriate Quality Assurance controls. OCRWM quality assurance policies and requirements are described in the referenced document. Producer activities must be conducted to comply with the program established by OCRWM.

APPENDIX B

EXPLANATION OF RESERVED ITEMS