U.S. Department of Energy
Office of River Protection
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

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Mr. Richard Albright, Director
Waste and Chemicals Management
U.S. Environmental Protection Agency
Region 10
Office of Waste and Chemicals Management (WCM-127)
1200 Sixth Avenue
Seattle, Washington 98101

Dear Mr. Albright:

PERFORMANCE CRITERIA TO SUPPORT A DETERMINATION OF EQUIVALENT TREATMENT (DET) FOR BULK VITRIFICATION (BV) OF HANFORD TANK WASTE

The purpose of this letter is to submit to your office for written concurrence the performance criteria that will be used to support the development of a DET Petition to be submitted pursuant to 40 Code of Federal Regulations 268.42(b). The DET will support Hanford Federal Facility Agreement and Consent Order (HFFACO) M-62-08, "Submittal of Hanford Tank Waste Supplemental Treatment Technologies Report, Draft Hanford Tank Waste Treatment Baseline, and Draft Negotiations Agreement in Principle (AIP)," due June 30, 2006. The M-62-08 report includes the results of waste form performance data for all treatment technologies being considered such that the performance data will be adequate to make decisions as to the acceptability of any proposed waste form.

The U.S. Department of Energy, Office of River Protection (ORP) has been participating in a number of workshops with Dr. David Bartus of your staff and the State of Washington Department of Ecology. The objective of these workshops is to develop performance criteria that will be used to support a Land Disposal Restriction (LDR) DET Petition. The purpose of the DET Petition is to demonstrate that the supplemental treatment technology, BV, achieves a level of performance equivalent to that of the LDR treatment standard of high-level vitrification (HLVIT) for the waste numbers D002 and D004 through D011. The DET is needed to support the HFFACO M-62-08 Milestone.

The workshops have culminated in the identification of the performance criteria contained in the Attachment. ORP anticipates that data from ongoing testing activities will be sufficient to measure the performance of BV by these criteria and determine whether this technology is equivalent to the HLVIT treatment technology for mixed radioactive waste. To optimize meeting the HFFACO M-62-08 Milestone, ORP is requesting written concurrence from your office by June 2, 2005, that these criteria are anticipated to be sufficient to meet the data needs necessary for completion of a DET Petition.

If you have any questions, please contact me, or your staff may contact Woody Russell, Environmental Division, (509) 373-5227 or Billie Mauss, Tank Farms Engineering Division, (509) 373-5113.

Sincerely,

Roy J. Schepens
Manager

ED:RWR

Attachment

cc w/attach:
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CH2M Correspondence Control

BULK VITRIFICATION (BV) DETERMINATION OF EQUIVALENT TREATMENT PERFORMANCE CRITERIA

QUANTITATIVE CRITERIA STUDY QUESTIONS

1. **Does the BV glass meet the High-Level Waste (HLW) reference environmental assessment (EA) glass performance requirements for waste numbers D004-D011?**

Glasses upon which the high level vitrification (HLVIT) treatment standard was promulgated are required to demonstrate consistent performance using the Product Consistency Test (PCT) (ASTM 2002). Waste acceptance criteria require waste form producers such as the Defense Waste Processing Facility in South Carolina, the West Valley Demonstration Project in New York, and the Waste Treatment and Immobilization Plant (WTP) in Washington to:

"1. ... demonstrate control of waste form production by comparing production samples or process control information, separately or in combination to the Environmental Assessment [EA] benchmark glass using the Product Consistency Test or equivalent."

"2. For acceptance, the mean concentrations of lithium, sodium, and boron in the leachate, after normalization for the concentrations in the glass, shall be less than those of the benchmark glass." (DOE-RW 2002)

Furthermore,

> "One acceptable method of demonstrating that the acceptance criteria is met, would be to ensure that the mean PCT results for each waste type are at least two standard deviations below the mean PCT results of the EA glass." (DOE-EM 1997)

This last criterion is statistically ambiguous, and, for the purposes of the determination of equivalent treatment performance criteria will be restated as:

> At the 95% confidence level, the estimates indicate the true PCT means for lithium, sodium, and boron are less than the corresponding PCT means for the EA glass.

The lithium, sodium, and boron PCT responses of the EA glass are described by Jantzen, et. al. (1993, 1994) and are summarized in Table 1. The concentrations of the individual elements in the PCT leachate solution are a function of their concentration in the glass. Therefore, the responses are "normalized" by dividing the leachate concentration, C_i, by the mass fraction of the element, x_i, in the glass to give the normalized response, NC_i.

$$NC_i = C_i / x_i$$

Unlike HLW glasses, lithium is not added to the wastes as part of the bulk vitrification glass forming process. Its measured concentrations would be very small with large uncertainties. Therefore, it will not be included as part of the quantitative performance criteria.

Table 1 also shows the results of application of the two standard deviations in the PCT response to define the final U.S. Department of Energy (DOE) PCT acceptance criteria for the waste glasses. This then leads to the decision rule described below.

Table 1. PCT Response for Environmental Assessment Benchmark Glass

	Boron	Lithium	Sodium
Mean Normalized Leachate Concentration	16.695 g/L	9.565 g/L	13.346 g/L
Standard Deviation	1.222 g/L	0.735 g/L	0.902 g/l
Relative Percent Standard Deviation	7.31%	7.68%	6.76%

Decision Rule:
The decision rule for the PCT response for the BV glasses will be the same as that used by DOE for the glasses upon which the HLVIT treatment standard is established.

"If, at the 95% confidence level, the estimates indicate the true PCT means for sodium and boron are less than the corresponding PCT means for the EA glass, then there is sufficient evidence to reject the assumption that the true PCT means are equal to or greater than the corresponding PCT means for the EA glass and to conclude with high confidence that the true PCT means for sodium and boron are below the corresponding PCT means for the EA benchmark glass."

2. **Does the BV product sufficiently reduce the toxicity of the waste and the likelihood of migration underlying hazardous constituents (Sb, Be, Ni, Tl) from the waste? (organics and cyanide to be addressed later) (TV Question)**

To be acceptable for land disposal, the wastes must be treated to meet treatment standards. In the case of the inorganic underlying hazardous constituents antimony, beryllium, nickel, and thallium in the Hanford tank wastes, an extract of the treated waste using the Toxicity Characteristic Leaching Procedure (TCLP, Environmental Protection Agency [EPA] method 1311) must be shown to be less than the universal treatment standards in 40 CFR 268.48. These concentration limits are listed in Table 2.

Table 2. Universal Treatment Standards for Sb, Be, Ni, and Tl

Regulated Constituent	**Concentration in TCLP Leachate, mg/L**
Antimony	1.15
Beryllium	1.22
Nickel	11
Thallium	0.20

The WTP has completed the Data Quality Objectives (DQO) process to support a treatability variance petition (Cook and Blumenkranz 2003). Similarly, a DQO process has been completed for the Demonstration Bulk Vitrification System (DBVS) (Banning, May, and Bagaasen 2005). The decision rule for BV will be derived from the WTP and DBVS DQOs.

Sections 5 and 6 of the WTP DQO describe the development of the decision rules and decision errors for the WTP glass waste form. The final decision criterion is:

> "If the 90% UCL [upper confidence level] estimate of the true mean TCLP leachate is less than the AL [action level], then there is sufficient evidence to reject the initial assumption and conclude with high confidence that the true mean TCLP leachate concentration is below the AL."

The initial assumption or null hypothesis is that the true mean TCLP leachate concentration is equal to or greater than the action level. For Sb, Be, Ni, and Tl, the action levels are the Universal Treatment Standard (UTS) concentration limits given in Table 2.

The DBVS DQO (Section 4.9) discusses demonstrating compliance with Land Disposal Restrictions (LDR) treatment requirements using TCLP leachates of composite samples composed of the BV glass plus the package refractory, sand, and insulation board. For the purposes of the BV treatability variance, the same composite configuration will be used to show compliance with the UTS.

Decision Rule:
The decision rule for the inorganic underlying hazardous constituents treated by BV is derived from similar decision rules developed for the WTP glass waste form and the DBVS waste package.

"If the 90% upper confidence level estimate of the true mean TCLP leachate from the bulk vitrification package composite sample is less than the Universal Treatment Standard concentrations for Sb, Be, Ni, and Tl, then there is sufficient evidence to reject the initial assumption that the true mean TCLP leachate is equal to or greater than the UTS limits and to conclude with high confidence that the true mean TCLP leachate concentration is below the UTS limits."

QUALITATIVE DISCUSSION STUDY QUESTIONS

1. Consistently Produce a Compliant Waste Form

1.1. Demonstrate that the BV glass product is well mixed and compliant with requirements.

Testing to date at the engineering and large scale have demonstrated that the glass from the BV process is relatively uniform in composition and easily complies with performance requirements associated with the PCT, Vapor Hydration Test, and TCLP (Hrma et al., 2005). To confirm the earlier Findings, a full-scale BV box will be filled with non-radioactive simulant glass using typical processing parameters. After cooling, the glass will be sampled at various locations in the box including edges, corners, and center. The samples will be chemically analyzed and will be tested using the PCT. Results from the chemical analyses and PCT will be statistically evaluated to determine the degree of uniformity in the composition and performance. The PCT response will be compared to the performance of the EA benchmark glass.

1.2. Determine extent that hazardous materials migrate from the BV glass into the other components of the engineered waste package.

There is some evidence of migration of species from the waste/glass into the engineered components of the BV waste package during the melting process. The engineered components include the refractory in immediate contact with the wastes/glass, sand, and insulation board. Engineering-scale tests will be conducted with simulants containing inorganic hazardous constituents of concern. Chemical analyses will be conducted on samples of the individual system components to determine the extent to which migration into the engineered components has occurred. TCLP tests will be conducted on the individual package engineered components to evaluate the extent to which the migrated species may be leachable from the package components. Migration of hazardous constituents into the engineered waste package components is expected to be low such that the concentrations are very low. Therefore, comparing TCLP response to health-based standards provides an indication of waste form performance. TCLP tests on composite samples as described by Banning, May, and Bagaasen (2005) will be conducted to demonstrate that the BV waste form package meets UTS concentrations in 40 CFR 268.48.

1.3. Determine extent that hazardous materials segregate in non-glass materials that may form during the BV melting process.

There is some evidence that small amounts of non-glass materials may form during the BV melting process. BV boxes from engineering- and full-scale tests with simulants will be examined for the formation and segregation of these non-glass materials. Chemical analyses will be conducted to determine what, if any, hazardous constituents are associating with the non-glass materials. TCLP tests will be conducted on the non-glass materials to evaluate the extent to which the hazardous constituents are immobilized or may be leachable. The concentrations of hazardous constituents in non-glass materials are expected to be very low. Therefore comparing TCLP response to health-based standards provides an indication of waste form performance. The impacts of any leachable materials will be evaluated relative to protection of human health and the environment based on disposal in Integrated Disposal Facility.

2. Appropriately Manage Hazardous Waste Components

2.1. Determine the extent to which hazardous constituents are retained in the BV waste package.

Some hazardous waste constituents may leave the BV box as vapors or particulates to be captured in the gaseous effluent treatment system. Engineering evaluations will be conducted to describe where and how the constituents are captured in the off-gas treatment system and how the constituents are recycled back into the vitrification process or exit the system for treatment and disposal as a secondary waste stream.

2.2. Quantify secondary waste streams.

Most of the hazardous waste constituents in the Hanford tank wastes will be immobilized in the BV waste package. A small fraction may leave through secondary waste streams generated during the BV processing. The BV flow sheet will be examined to determine the path of the hazardous waste constituents through the process and where they exit the process. The quantities of secondary wastes to be generated will be estimated.

3. Non-Corrosive Final BV Product

The BV product will be a solid waste form. Deactivation of the corrosivity characteristic (D002) of the Hanford tank waste through the BV process will be described in terms of a solid waste form that is not aqueous or liquid per the definition of the corrosivity characteristic in 40 CFR 261.22. Washington State Dangerous Waste Regulations include a corrosivity characteristic for solids and semisolids (Washington Administrative Code [WAC] 173-303-090 (6)(a)(iii)):

> "It is a solid or semisolid which, upon testing using Method 9045 in 'Test Methods for Evaluating Solid Waste, Physical/Chemical Methods' (SW 846), results in a pH less than or equal to 2, or greater than or equal to 12.5."

A solid waste that exhibits only this corrosivity characteristic is assigned the dangerous waste Number WSC2. The BV waste form is not expected to exhibit this characteristic. This will be addressed in the land disposal treatability variance petition.

REFERENCES

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