Melter Technology Evaluation for Vitrification of Hanford Site Low-Level Waste

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MELTER TECHNOLOGY EVALUATION FOR VITRIFICATION OF HANFORD SITE LOW-LEVEL WASTE

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ABSTRACT

The current plan at the Hanford Site, in accordance with the Tri-Party Agreement among Washington State, the U.S. Environmental Protection Agency, and the U.S. Department of Energy, is to convert the low-level tank waste fraction into a silicate glass. The low-level waste will be composed primarily of sodium nitrate and nitrite salts concentrated in a highly alkaline aqueous solution. The capability to process up to 200 metric tons/day of glass will be established to produce an estimated 210,000 m$^3$ for onsite disposal. A program to test and evaluate high-capacity melter technologies is in progress. Testing performed by seven different industrial sources using Joule heating, combustion, plasma, and carbon arc melters is described.

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) and Westinghouse Hanford Company (WHC) plan to retrieve and vitrify approximately 230,000 m$^3$ of radioactive defense wastes stored in 177 underground tanks at the DOE Hanford Site in southeastern Washington State. A plan and schedule for disposal of Hanford Site tank wastes were agreed to in September 1993 by the DOE, the U.S. Environmental Protection Agency (EPA), and the Washington State Department of Ecology during renegotiation of the Hanford Federal Facility Agreement and Consent Order, also known as the Tri-Party Agreement. The Tri-Party Agreement milestones established for low-level waste (LLW) vitrification activities are as follows.
• Begin LLW melter testing with simulants (September 1994).

• Complete melter feasibility and system operability tests, select reference melter(s), and establish reference LLW glass formulation that meets complete systems requirements (June 1996).

• Submit conceptual design and initiate definitive design of the LLW vitrification facility (November 1996).

• Initiate construction of the LLW vitrification facility (December 1997).

• Complete construction of the LLW vitrification facility (December 2003).

• Initiate hot operations of the LLW vitrification facility (June 2005).

• Complete vitrification of Hanford Site low-level tank waste (December 2028).

In the planning case, the waste is retrieved from underground tanks and separated into a large-volume, liquid, LLW stream from which significant radionuclide removal has occurred, and a smaller volume high-level waste (HLW) stream (sludge) in which most of the radioactivity will be concentrated. The resulting LLW and HLW streams will be vitrified. For the LLW stream, it is estimated that a total vitrification capacity of 200 metric tons/day glass production would be required. Additional assumptions used in developing the planning case for LLW vitrification included the following.

• The LLW will be disposed of onsite, near the surface as glass.

• The LLW vitrification facility will have minimal radiation shielding, predicated on removal of Cs and Sr from the waste during pretreatment.

• The LLW vitrification facility will contain two parallel lines to be constructed and started in a phased manner.

• The LLW vitrification facility will use standard glass industry high-throughput melters.
Hot startup of the LLW vitrification facility will be in 2005 using pretreated double-shell slurry feed (DSSF) as initial feed.

This paper describes the LLW melter testing program initiated to meet the Tri-Party Agreement milestones to begin melter testing by September 1994, and to complete the initial testing program and select reference melter(s) systems by June 1996.

2.0 LLW MELTER TESTING PROGRAM

A multiphase program was initiated to test and evaluate commercially available candidate melter system technologies using nonradioactive LLW simulants. Seven melter system technologies were selected for Phase 1 testing. The vendor contracts will be extended at WHC's option after Phase 1 testing to include Phase 2 testing. It is anticipated that a reference melter system technology and a first-alternative technology will be selected by June 1996 following Phase 2 testing. The goal of the program is to select a melter system technology, not a melter vendor.

Phase 1 is a "proof of principle" test to demonstrate that a melter system technology can process a simulated highly alkaline, high nitrate/nitrite content aqueous LLW feed and produce a glass product of consistent quality. Phase 1 provides vendors with an opportunity to become familiar with the requirements and processing issues associated with vitrification of a Hanford Site LLW stream, and identifies specific issues associated with each technology. For Phase 2 testing, equipment and procedures for selected promising technologies will be optimized based on lessons learned during Phase 1 to provide data needed for selection of a reference melter(s) system.

2.1 Testing Objectives

The primary objective of the LLW melter testing program is to identify the best overall melter system technology available for vitrification of Hanford Site low-level tank waste on the schedule established by the Tri-Party Agreement. Another objective of the testing is to provide technical information on the most promising melter systems to support conceptual design of the LLW vitrification plant.

For this testing program, a melter system technology is defined to include the melter, melter feed preparation and melter feeding system, and any additional subsystems considered to be unique to the melter and feed systems. The primary testing considerations are performance of the melter and its feed processing system,
quality of the glass product, and characteristics of the offgas
and any other secondary waste streams. Performance of the
vendor's offgas and waste treatment systems is not a primary
consideration because these systems would likely be designed by
the architect-engineer to meet the plant design requirements for
these effluent streams. Maturity of the technology, adaptability
to a nuclear processing facility, and cost will also be important
considerations.

The following types of data are being collected and evaluated to
meet specific objectives, establish a basis for selecting a
reference vitrification technology, and provide preliminary data
to support the LLW vitrification plant conceptual design.

- Processing throughput and efficiency of operation.

- Demonstration of a practical and reliable feed system
compatible with the melter requirements and capable of
providing control of product glass composition.

- Product quality: ability to produce a durable, consistent,
homogeneous glass with a target composition.

- Mass balance data across the melter for potentially volatile
components such as Cs, Na, B, Mo, SO₄, F, I, and Cl to
determine partitioning of these components between the glass,
condensed deposits, offgas entrained particulates, and scrub
solutions. Mass balance data also are needed for elements of
radiological interest, including Cs, Sr, I, and Tc (Mo and/or
Re to be used as a surrogate for Tc).

- Offgas measurements for NOₓ and SOₓ concentrations, flow
rates, and quantities and composition of entrained
particulates.

- Determination of requirements for feed processing, secondary
waste, and offgas treatment systems.

- Observation and sampling of any apparent melt phase
separation and assessment of the PO₄, SO₄, F, and Cl
concentration limits that can be processed. These data will
identify melter systems with the greatest flexibility to
process feeds with these components, and provide data on
concentration limits for these components that can be
realistically processed by vitrification.
• Ability to idle the melter for extended periods, or shut down and restart, and the consequences of idling (including waste component volatility) and/or shutdown and restart cycles.

• Obtaining information on the melter system technology to support engineering studies, technology evaluation, and life-cycle cost analysis.

• Evaluation of life expectancy, reliability, and maintenance requirements for melter system major components.

Other observations, measurements, or samples may be taken for specific melter technologies, for example, measurement of wear on specific parts or components such as electrodes, refractories, and/or feed injectors.

2.2 LLW and Simulant Characteristics

Hanford Site tank waste was generated by several different chemical processing facilities and is stored in large underground tanks. The older single-shell tanks (SST) hold mostly precipitated sludges and salt cake. The newer double-shell tanks (DST) hold liquid wastes.

In the reference tank waste retrieval and pretreatment process, the sludges (low solubility) and salt cake (high solubility) wastes will be washed, producing a relatively large-volume liquid waste stream and a smaller volume of washed solids that contains most of the radioactive waste components. Most of the radioactive Cs in the liquid waste stream will be removed by an ion-exchange process to produce the liquid LLW stream to be sent to the LLW vitrification facility. The Cs removed from the liquid LLW stream will be combined with the washed solids HLW fraction. Because the waste generation history of the DSTs and SSTs is not identical, the LLW that will be obtained from the DSTs will differ from the LLW obtained from SSTs. Although wastes will be blended to the extent practical to minimize variability of the waste constituents, it is anticipated that at least two LLW types will need to be vitrified. These LLW types are identified as DSSF and a larger quantity of "remaining inventory" LLW derived primarily from the SSTs.

A DSSF simulant composition was chosen for Phase 1 testing. The DSSF simulant composition is based on a weighted average of analyses from six DSTs plus analyses of samples of dilute DST wastes intended for evaporator/crystallizer operations. A remaining inventory simulant that is expected to be the basis of one of two or more simulants run during Phase 2 testing has also
been formulated. Calcined solids compositions (assuming no halide or metal oxide volatility) and the relative quantities of volatile components for these two LLW simulants are given in Table I.

Many minor elements or species (mostly those contributing <0.02 wt%) analyzed in these tanks have not been included in the two simulants. Elements and species chosen to be included in these simulants are the major constituents plus those that may be potentially volatile during vitrification (Cs, I, Cl, and Mo), and those that may be present at concentrations exceeding their solubility in silicate glasses (PO₄, SO₄, Cl, and F). Strontium is included because ⁹⁰Sr will be the highest-activity radionuclide present in the LLW. Concentrations of Cs, Sr, I, and Mo have been spiked to 0.017 M concentration to provide sufficient amounts of these elements to allow a mass balance to be determined across the melter.

2.3 Glass Formulation

Durability and performance requirements for Hanford Site LLW glasses have not yet been established. Therefore, flexibility in melting temperature and the ability to process a range of glass compositions will be factors in melter system technology selection. Preliminary performance assessment work suggests that a highly durable glass may be needed if additional engineered barriers are not designed into the disposal system. However, optimization of glass compositions to meet specific durability and waste loading requirements is not a primary objective for the melter technology testing program. Vendors were required to use a "reasonable" LLW glass formulation for melter testing. Two criteria for the glass formulation were given in the Statement of Work (SOW) for a reasonable glass: (1) that waste loading (the weight fraction of the glass derived from the LLW simulant) be approximately 25%, and (2) the glass should have a normalized Na release rate of 1 g/m²/day or less measured by the product consistency test (PCT) method at 90 °C. This is the approximate durability of the Savannah River Environmental Assessment glass that is used as a minimum durability benchmark for HLW glass waste acceptance.

Soda-lime-boro-alumina-silicate systems encompass candidate glass compositions for Hanford Site LLW. Typical composition ranges are 15 to 25 wt% Na₂O, 0 to 12 wt% CaO, 5 to 12 wt% Al₂O₃, 0 to 12 wt% B₂O₃, 1 to 5 wt% other LLW components, and the balance (40 to 60 wt%) SiO₂. Five compositions from within this composition envelope that met the waste loading and durability requirements given in the SOW were developed by Pacific Northwest Laboratories (PNL) and offered to the vendors as acceptable glasses for
<table>
<thead>
<tr>
<th>Component</th>
<th>Double-shell slurry feed</th>
<th>Remaining inventory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na₂O</td>
<td>72.61</td>
<td>85.31</td>
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<tr>
<td>K₂O</td>
<td>5.76</td>
<td>0.13</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>12.73</td>
<td>3.84</td>
</tr>
<tr>
<td>CaO</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Cr₂O₃</td>
<td>0.16</td>
<td>0.15</td>
</tr>
<tr>
<td>Cs₂O</td>
<td>0.59</td>
<td>0.68</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>MgO</td>
<td>0.01</td>
<td>0.00</td>
</tr>
<tr>
<td>MnO₂</td>
<td>0.01</td>
<td>0.04</td>
</tr>
<tr>
<td>MoO₃</td>
<td>0.60</td>
<td>0.69</td>
</tr>
<tr>
<td>SrO</td>
<td>0.43</td>
<td>0.50</td>
</tr>
<tr>
<td>P₂O₅</td>
<td>0.75</td>
<td>3.67</td>
</tr>
<tr>
<td>SO₃</td>
<td>0.84</td>
<td>1.43</td>
</tr>
<tr>
<td>NaCl</td>
<td>2.29</td>
<td>0.25</td>
</tr>
<tr>
<td>NaF</td>
<td>2.57</td>
<td>2.57</td>
</tr>
<tr>
<td>NaI</td>
<td>0.62</td>
<td>0.72</td>
</tr>
<tr>
<td>Total solids</td>
<td>408.7</td>
<td>354.3</td>
</tr>
</tbody>
</table>

Volatiles as g/100 g calcined solids (10.0 M Na⁺)

<table>
<thead>
<tr>
<th>Component</th>
<th>Double-shell slurry feed</th>
<th>Remaining inventory</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₂O (estimated)</td>
<td>165</td>
<td>175</td>
</tr>
<tr>
<td>NO₃⁻</td>
<td>47.0</td>
<td>105</td>
</tr>
<tr>
<td>NO₂⁻</td>
<td>19.1</td>
<td>5.6</td>
</tr>
<tr>
<td>OH⁻</td>
<td>15.8</td>
<td>11.2</td>
</tr>
<tr>
<td>CO₃⁻</td>
<td>34.0</td>
<td>4.6</td>
</tr>
<tr>
<td>Organic carbon</td>
<td>4.1</td>
<td>0.6</td>
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</tbody>
</table>
Four of the vendors chose to formulate their own glasses for testing. The durability and melt viscosity were measured on the vendor-formulated glasses to verify their acceptability. Characteristics of the glasses used for Phase 1 testing by the seven vendors are given in Table II.

2.4 Test Monitoring Sample Analyses

Independent laboratories were selected to perform sample analyses for the melter testing program. Analyses of glass, feed materials, other solids samples, and PCT durability measurements were performed by CELS-Corning Laboratory Services, Corning, New York; and by U.S. Geological Survey Analytical Services Group, Denver, Colorado. Liquid LLW simulants, offgas scrub solutions, and other liquid samples were analyzed by Quanterra Environmental Services, Saint Louis, Missouri. Backup analyses on selected samples were performed by PNL as a check. These laboratories were contracted directly by WHC.

Offgas measurements, including entrained particulate analyses and continuous emissions monitoring for selected offgas components such as NOx and SOx, were conducted by qualified air quality laboratories using established EPA methods. Qualified laboratories providing offgas measurements were contracted by the melter test vendors. Various additional test monitoring measurements, such as material flow rates and temperatures, were also monitored by the vendors.

2.5 Testing Documentation

Each vendor prepared a project-specific quality assurance plan and a test plan to be approved by WHC prior to actual melter testing operations. Following testing, vendors prepared preliminary and full reports on Phase 1 test results. Each vendor also prepared a technical information report describing the full-scale melter system technology concept proposed for implementation in the Hanford Site LLW vitrification plant. In addition, each vendor prepared a report that provided available information on expected life and reliability of the proposed equipment. Vendor test plans and final test reports will be cleared for public release.

*Corning is a trademark of Corning Glass Works.
### Table II. Vendor Target Glass Compositions

<table>
<thead>
<tr>
<th>Target glass compositions (wt%)</th>
<th>Envitco</th>
<th>B&amp;W</th>
<th>USBM</th>
<th>Duratek</th>
<th>PEI</th>
<th>WSTC</th>
<th>Vectra</th>
</tr>
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<tbody>
<tr>
<td>Na&lt;sub&gt;2&lt;/sub&gt;O</td>
<td>20.00</td>
<td>20.00</td>
<td>20.00</td>
<td>18.82</td>
<td>18.82</td>
<td>18.82</td>
<td>20.00</td>
</tr>
<tr>
<td>K&lt;sub&gt;2&lt;/sub&gt;O</td>
<td>1.52</td>
<td>1.52</td>
<td>1.52</td>
<td>3.68</td>
<td>1.43</td>
<td>1.43</td>
<td>1.52</td>
</tr>
<tr>
<td>Al&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;3&lt;/sub&gt;</td>
<td>12.00</td>
<td>10.00</td>
<td>10.00</td>
<td>6.14</td>
<td>6.00</td>
<td>18.22</td>
<td>10.00</td>
</tr>
<tr>
<td>B&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;3&lt;/sub&gt;</td>
<td>9.00</td>
<td>5.00</td>
<td>5.00</td>
<td>6.15</td>
<td>--</td>
<td>9.45</td>
<td>8.00</td>
</tr>
<tr>
<td>CaO</td>
<td>--</td>
<td>5.00</td>
<td>5.00</td>
<td>7.80</td>
<td>9.77</td>
<td>4.65</td>
<td>2.90</td>
</tr>
<tr>
<td>MgO</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>2.10</td>
</tr>
<tr>
<td>Fe&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;3&lt;/sub&gt;</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>7.50</td>
<td>1.00</td>
<td>--</td>
<td>1.00</td>
</tr>
<tr>
<td>Li&lt;sub&gt;2&lt;/sub&gt;O</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>0.83</td>
<td>--</td>
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<tr>
<td>TiO&lt;sub&gt;2&lt;/sub&gt;</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>1.00</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>ZrO&lt;sub&gt;2&lt;/sub&gt;</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>5.09</td>
<td>2.00</td>
<td>2.10</td>
<td>--</td>
</tr>
<tr>
<td>SiO&lt;sub&gt;2&lt;/sub&gt;</td>
<td>55.78</td>
<td>56.78</td>
<td>56.78</td>
<td>42.22</td>
<td>59.23</td>
<td>42.90</td>
<td>52.78</td>
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<tr>
<td>Other</td>
<td>1.70</td>
<td>1.70</td>
<td>1.70</td>
<td>1.60</td>
<td>1.75</td>
<td>1.60</td>
<td>1.70</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
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<tr>
<td>Waste loading</td>
<td>26.3</td>
<td>26.3</td>
<td>26.3</td>
<td>25.0</td>
<td>25.0</td>
<td>25.0</td>
<td>26.3</td>
</tr>
<tr>
<td>PNL glass</td>
<td>LD4-912</td>
<td>LD6-5510</td>
<td>LD6-5510</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>T-100 (°C)*</td>
<td>1325</td>
<td>1296</td>
<td>1296</td>
<td>1096</td>
<td>1327</td>
<td>1215</td>
<td>1224</td>
</tr>
<tr>
<td>PCT Na g/m&lt;sup&gt;2&lt;/sup&gt;/d</td>
<td>0.046</td>
<td>0.074</td>
<td>0.074</td>
<td>0.102</td>
<td>0.242</td>
<td>0.034</td>
<td>0.078</td>
</tr>
</tbody>
</table>

*T-100 = Melt temperature at 100 poise viscosity.

B&W = Babcock & Wilcox
Duratek = GTS Duratek, Incorporated
Envitco = Envitco, Incorporated
PCT = Product consistency test
PEI = Penberthy Electromelt International, Incorporated
PNL = Pacific Northwest Laboratory
USBM = U.S. Bureau of Mines
Vectra = Vetra Technologies, Incorporated
WSTC = Westinghouse Science and Technology Center
3.0 MELTER TECHNOLOGIES AND TESTING DESCRIPTIONS

The request for proposals for the LLW melter technology demonstration was issued by WHC on February 25, 1994. Sixteen vendors responded with proposals. Proposals were evaluated by a source evaluation board supported by a Hanford Site technical panel and an external panel that included experts from industry, academia, and other DOE sites. Melter technologies and testing descriptions are summarized below for the seven vendors selected for Phase 1 testing.

3.1 GTS Duratek, Incorporated

GTS Duratek, Incorporated, of Columbia, Maryland, proposed Phase 1 melter demonstrations in its research- and pilot-scale melters at Catholic University of America's Vitreous State Laboratory in Washington, D.C. The Duratek melter is a ceramic, refractory-lined, Joule-heated melter that uses Inconel\textsuperscript{*} plate electrodes. Slurry feeding a mixture of the LLW simulant plus glass former materials and reductant additives to one or more of three available melters was proposed. The testing option that was selected involved smaller-scale testing in the DuraMelter\textsuperscript{**}-100 (100 kg/day) melter followed by larger-scale testing in the DuraMelter-1000 (1,000 kg/day) melter. The DuraMelter-100 test was conducted in late September 1994 and the DuraMelter-1000 test was conducted during January 1995. Both tests were run essentially as planned without significant problems. Steady-state processing rates approximately twice that of the conservative melter ratings were achieved in both melters.

3.2 Envitco, Incorporated

Envitco, Incorporated, of Toledo, Ohio, proposed Phase 1 melter demonstration testing in its EV-16 test melter located at Clemson University. The Envitco melter is a ceramic-lined, Joule-heated melter that uses molybdenum rod electrodes. The EV-16 test melter uses side wall horizontal electrodes and has a glass production capacity of approximately 600 kg/day. A top-entering, tilted, molybdenum electrode design is currently proposed by Envitco for the full-scale melter design of the LLW vitrification plant. The baseline Envitco Phase 1 test used dried feed and complete cold-top batch blanket operation. Slurry feeding was also demonstrated following 1 week of dry feed operation. To prepare the dry feed,

\begin{itemize}
\item [*Inconel is a trademark of Inco Alloys International, Inc.]
\item [**DuraMelter is a trademark of GTS Duratek, Inc.]
\end{itemize}
a slurry of LLW, glass former materials, and a reductant additive were spray dried by Hosokawa Bepex Corporation, Minneapolis, Minnesota, using the Unison” drying system. The drying process produced a fine, low-density powder that was compacted and granulated to form the final dried melter feed. The dry feed was prepared during September 1994 and the melter test run was conducted during October 1994.

3.3 Babcock & Wilcox

Babcock & Wilcox, Research and Development Division, Alliance, Ohio, proposed Phase 1 testing in its small boiler simulator cyclone furnace. A slurry composed of the LLW simulant plus glass formers is injected into a horizontal, gas-fired cyclone burner. The cyclone shell is water cooled and lined with a thin layer of refractory cement. The slurry is blown onto the cyclone wall where initial melting occurs. The melt flows from the cyclone burner to a drain tap in the bottom of the adjacent furnace/"boiler" section. A glass-refining tank section would likely follow the cyclone burner in a full-scale LLW vitrification unit. During Phase 1, glass was produced at a conservative rate of about 600 kg/day. Babcock & Wilcox cyclone furnaces fired with crushed coal have been in commercial steam generation service since the 1940's. During commercial boiler service, mineral impurities in the coal are melted in the cyclone burner and tapped off as a slag in a manner similar to the glass melted during Phase 1 testing.

3.4 Westinghouse Science and Technology Center

Westinghouse Science and Technology Center,** Pittsburgh, Pennsylvania, proposed demonstration of LLW vitrification in a plasma torch-fired, cupola furnace. A premelted glass former frit was used for the Phase 1 test. A metered mixture of the LLW simulant and frit was injected above the plasma plume in the tuyere channel between the plasma torch and the cupola furnace crucible. A series of scoping tests were conducted leading to the Phase 1 demonstration test run in December 1994. The glass processing rate was approximately 7,000 kg/day.

*Unison is a trademark of Hosokawa Bepex Corporation.

**Westinghouse Science and Technology Center is a division of Westinghouse Electric Corporation.
3.5 Penberthy Electromelt, Incorporated

Penberthy Electromelt International, Incorporated, Seattle, Washington, proposed Phase 1 testing in a ceramic refractory-lined, cold-top, Joule-heated melter with side wall molybdenum electrodes. Absorbent glass former materials were batched and fed to the melter using screw chargers. The liquid LLW simulant was injected directly into the screw chargers where it was mixed with, and absorbed by, the glass former batch. Drying and nitrate/nitrite reduction reactions with reductant additives occurred in the melter batch blanket. The feed system concept requires minimal processing or handling of radioactively contaminated materials in front of the melter. The test melter had approximately 0.5 m² of melt surface area.

3.6 U.S. Bureau of Mines

The U.S. Bureau of Mines, Albany, Oregon, Research Center proposed demonstration of an electric arc furnace with top-entering vertical carbon electrodes. The test furnace design was similar to that of larger commercial units used in steel production and other processes such as melting of fused cast ceramic refractory materials. A granular pre-reacted dry feed was prepared by heating a blended mixture of LLW simulant, glass former materials, and reductant additives to a temperature sufficient (~200°C) to initiate reaction between nitrate/nitrite and reductant additives. Two demonstration runs were held, the first at a melting rate of approximately 7,200 kg/day and a second at approximately 4,400 kg/day. Feed drying was performed during January 1995 and the two melter runs were conducted during March and April 1995.

3.7 Vectra Technologies, Incorporated

Vectra Technologies, Incorporated, proposed vitrification of the simulated LLW using its Ve-Skull* melter system developed for commercial vitrification of LLW. Testing was conducted at Vectra's facility in Richland, Washington. The Ve-Skull melter is water jacketed and Joule heated with vertical top-entering molybdenum electrodes. The inner vessel of the test melter is refractory lined. Operation with a frozen glass skull is proposed for the full-scale melter. Three approaches to feed preparation and melter feeding were investigated: slurry feeding, feed drying, and calcination. Approximately 500 kg of calcined melter feed was prepared by Procedyne, New Brunswick, New Jersey, using a fluidized bed calciner. A limited amount of dried melter feed was

*Ve-Skull is a trademark of Vectra Technologies Inc.
also prepared by Vectra using a liquid-heated, mechanical, mixer-dryer system. The drying process was abandoned after producing a limited quantity of dried feed due to feed caking problems in the dryer. The melter test included processing of slurry feed, calciner product, and dry feed batched from glass former materials and dry chemicals. The Phase 1 Vectra test was conducted during April 1995 with a glass processing rate of approximately 1,500 kg/day.

4.0 SUMMARY

A multiphase program was initiated to test and evaluate commercially available technologies for potential vitrification of Hanford Site low-level tank waste streams. A primary objective of the program is to provide a technical basis for recommendation of melter system technologies for Hanford Site LLW by June 1996. The program will also provide data to support conceptual design for the LLW vitrification facility. Details of the LLW melter system technology testing program have been discussed.

Seven vendors proposing various melter technologies and melter feed preparation approaches were selected for Phase 1 testing. Four vendors (GTS Duratek, Envitco, Penberthy Electromelt International, and Vectra) are demonstrating various Joule-heated melter technologies with different melter feeding approaches, including slurry feed, blended and dried feed, calcined feed, and nozzle mixing of liquid LLW and absorbent glass former materials. The Westinghouse Science and Technology Center is demonstrating a slurry-fed plasma torch-fired melter system. Babcock & Wilcox is demonstrating a slurry-fed cyclone combustion-fired melter system. The U.S. Bureau of Mines is demonstrating preparation of dried granulated melter feed and melting in a carbon electrode electric arc furnace.

Phase 1 testing is scheduled for completion in May 1995 and results from Phase 1 testing are currently being evaluated. For technologies where additional testing is judged to provide the greatest benefit for meeting program objectives, the vendor contracts will be extended for additional Phase 2 testing. Vendor test plans and final test reports will be cleared for public release. Evaluation of the melter system technologies and testing results, lessons learned, and the vitrification technology down-selection process are expected to be documented in WHC reports.
5.0 REFERENCES


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