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High Aluminum HLW Glasses for Hanford's WTP

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Office of River Protection

P.O. Box 450
Richland, Washington 99352

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High Aluminum HLW Glasses for Hanford's WTP

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The world's largest radioactive waste vitrification facility is now under construction at the United State Department of Energy's (DOE's) Hanford site. The Hanford Tank Waste Treatment and Immobilization Plant (WTP) is designed to treat nearly 53 million gallons of mixed hazardous and radioactive waste now residing in 177 underground storage tanks. This multi-decade processing campaign will be one of the most complex ever undertaken because of the wide chemical and physical variability of the waste compositions generated during the cold war era that are stored at Hanford. The DOE Office of River Protection (ORP) has initiated a program to improve the long-term operating efficiency of the WTP vitrification plants with the objective of reducing the overall cost of tank waste treatment and disposal and shortening the duration of plant operations.

Due to the size, complexity and duration of the WTP mission, the lifecycle operating and waste disposal costs are substantial. As a result, gains in High Level Waste (HLW) and Low Activity Waste (LAW) waste loadings, as well as increases in glass production rate, which can reduce mission duration and glass volumes for disposal, can yield substantial overall cost savings. Energy*Solutions* and its long-term research partner, the Vitreous State Laboratory (VSL) of the Catholic University of America, have been involved in a multi-year ORP program directed at optimizing various aspects of the HLW and LAW vitrification flow sheets. A number of Hanford HLW streams contain high concentrations of aluminum, which is challenging with respect to both waste loading and

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processing rate. Therefore, a key focus area of the ORP vitrification process optimization program at Energy*Solutions* and VSL has been development of HLW glass compositions that can accommodate high Al_2O_3 concentrations while maintaining high processing rates in the Joule Heated Ceramic Melters (JHCMs) used for waste vitrification at the WTP. This paper, reviews the achievements of this program with emphasis on the recent enhancements in Al_2O_3 loadings in HLW glass and its processing characteristics. Glass formulation development included crucible-scale preparation and characterization of glass samples to assess compliance with all melt processing and product quality requirements, followed by small-scale screening tests to estimate processing rates. These results were used to down-select formulations for subsequent engineering-scale melter testing. Finally, further testing was performed on the DM1200 vitrification system installed at VSL, which is a one-third scale (1.20 m^2) pilot melter for the WTP HLW melters and which is fitted with a fully prototypical off-gas treatment system. These tests employed glass formulations with high waste loadings and Al_2O_3 contents of ~ 25 wt%, which represents a near-doubling of the present WTP baseline maximum Al_2O_3 loading. In addition, these formulations were processed successfully at glass production rates that exceeded the present requirements for WTP HLW vitrification by up to 88%. The higher aluminum loading in the HLW glass has an added benefit in that the aluminum leaching requirements in pretreatment are reduced, thus allowing less sodium addition in pretreatment, which in turn reduces the amount of LAW glass to be produced at the WTP. The impact of the results from this ORP program in reducing the overall cost and schedule for the Hanford waste treatment mission will be discussed.