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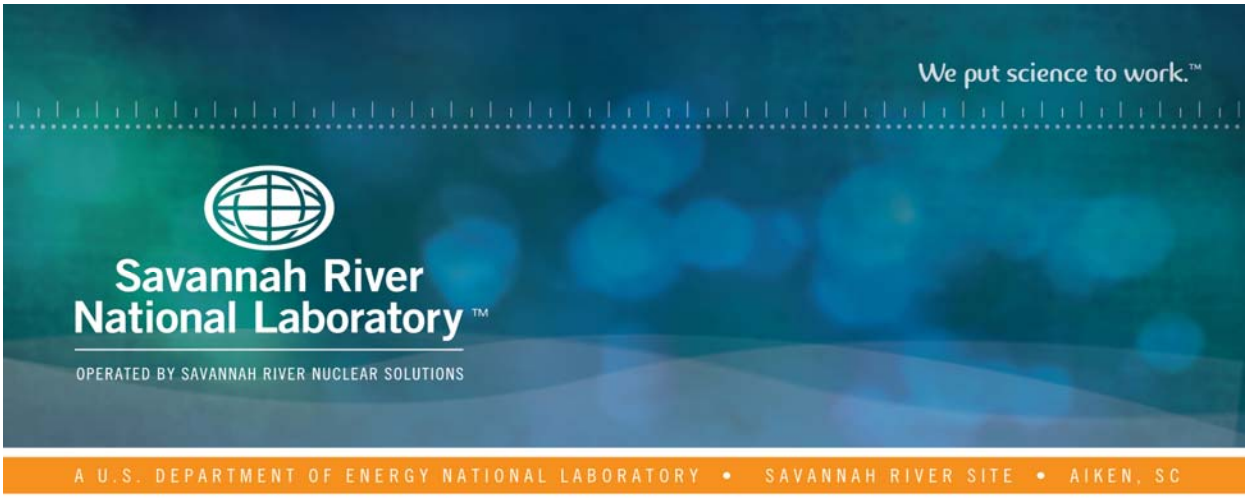

Evaluation of the Sludge Batch 9 - Frit 803 Variability Study Glasses with the Revised Defense Waste Processing Facility Product Composition Control System

F.C. Johnson

T.B. Edwards

June 2018

SRNL-STI-2018-00189, Revision 0

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EXECUTIVE SUMMARY

Compositionally, Sludge Batch 8 (SB8) and Sludge Batch 9 (SB9) are similar. Frit 803 was developed for SB8, and was subsequently confirmed for SB9 processing at a waste loading target of 36% ± 4 percentage points. The SB9 – Frit 803 experimental variability study was issued in 2016. Durability measurements from these glasses were assessed to demonstrate the applicability of the Defense Waste Processing Facility (DWPF) Product Composition Control System (PCCS) durability models for the SB9 – Frit 803 glass system, and the acceptability of the glasses with respect to the Environmental Assessment glass in terms of durability, as defined by Product Consistency Test (PCT).

Recently, the technical basis document for PCCS was revised to allow for coupled processing with the Salt Waste Processing Facility. The revision of that document includes modifications to the durability models. A task is currently underway at DWPF to revise and align PCCS with the updated models and logic from the new technical basis document. Prior to the implementation of the revised PCCS for SB9 – Frit 803 processing at DWPF, the applicability of the new durability models must be demonstrated. This document provides the assessment of durability measurements from the SB9 - Frit 803 variability study glasses to demonstrate the applicability of the revised durability models to this glass system.

Almost all the PCT results are well predicted by the revised durability models (i.e., fall within the 95% confidence band). Five out of the thirty variability study glasses exhibit some normalized concentrations (NC_B and/or NC_{Li}) that fall slightly outside of the lower 95% confidence band, which indicates that the models conservatively predicted the durability results. Similar trends were observed for glasses VSL-SB8-22, SB9VS05, and SB9VS08 in the SB8 and SB9 variability studies. Therefore, the revised PCCS durability models are deemed applicable to the SB9 – Frit 803 glass system.

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LIST OF ABBREVIATIONS

CCC	Centerline canister cooling
DWPF	Defense Waste Processing Facility
EA	Environmental Assessment
HLW	High Level Waste
NC_i	normalized concentration of element *i*
PCCS	Product Composition Control System
PCT	Product Consistency Test
SB8	Sludge Batch 8
SB9	Sludge Batch 9
SRNL	Savannah River National Laboratory
SWPF	Salt Waste Processing Facility

1.0 Introduction

Compositionally, Sludge Batch 8 (SB8) and Sludge Batch 9 (SB9) are similar.[1-3] Frit 803 was developed for SB8,[1] and was subsequently confirmed[2,4-6] for SB9 processing at a waste loading target of 36% ± 4 percentage points. Due to the similarities between the SB9 – Frit 803 and SB8 – Frit 803 glass systems, only eight glasses were recommended[3] for the SB9 variability study, which supplemented the existing durability data, as measured by the Product Consistency Test (PCT)[7], from twenty-two glasses that were generated during the SB8 variability study.[8] These thirty glasses were assessed by the Savannah River National Laboratory (SRNL) to demonstrate that their PCT responses were predictable by the Defense Waste Processing Facility (DWPF) Product Composition Control System (PCCS) durability models[9] and acceptable relative to the durability of the Environmental Assessment (EA) glass.[10]

Since the completion of the SB9 – Frit 803 variability study in 2016, the technical basis document[11] for PCCS has been revised to allow for coupled processing with the Salt Waste Processing Facility (SWPF). The revised technical basis document for PCCS includes modifications to the durability models.[12] A task is currently underway at DWPF to revise and align the facility PCCS software with the updated models and logic from the new technical basis document.[11] Prior to the implementation of the revised PCCS for SB9 – Frit 803 processing at DWPF, the applicability of the new durability models[12] must be demonstrated. This document provides the assessment of the variability study durability measurements to demonstrate the applicability of the modified durability models to this glass system.

2.0 Quality Assurance

This work was supported using JMP® Pro Version 11.2.1.[13] Requirements for performing reviews of technical reports and the extent of review are established in Manual E7, Procedure 2.60.[14] SRNL documents the extent and type of review using the SRNL Technical Report Design Checklist contained in WSRC-IM-2002-00011, Rev. 2.[15]

3.0 Results and Discussion

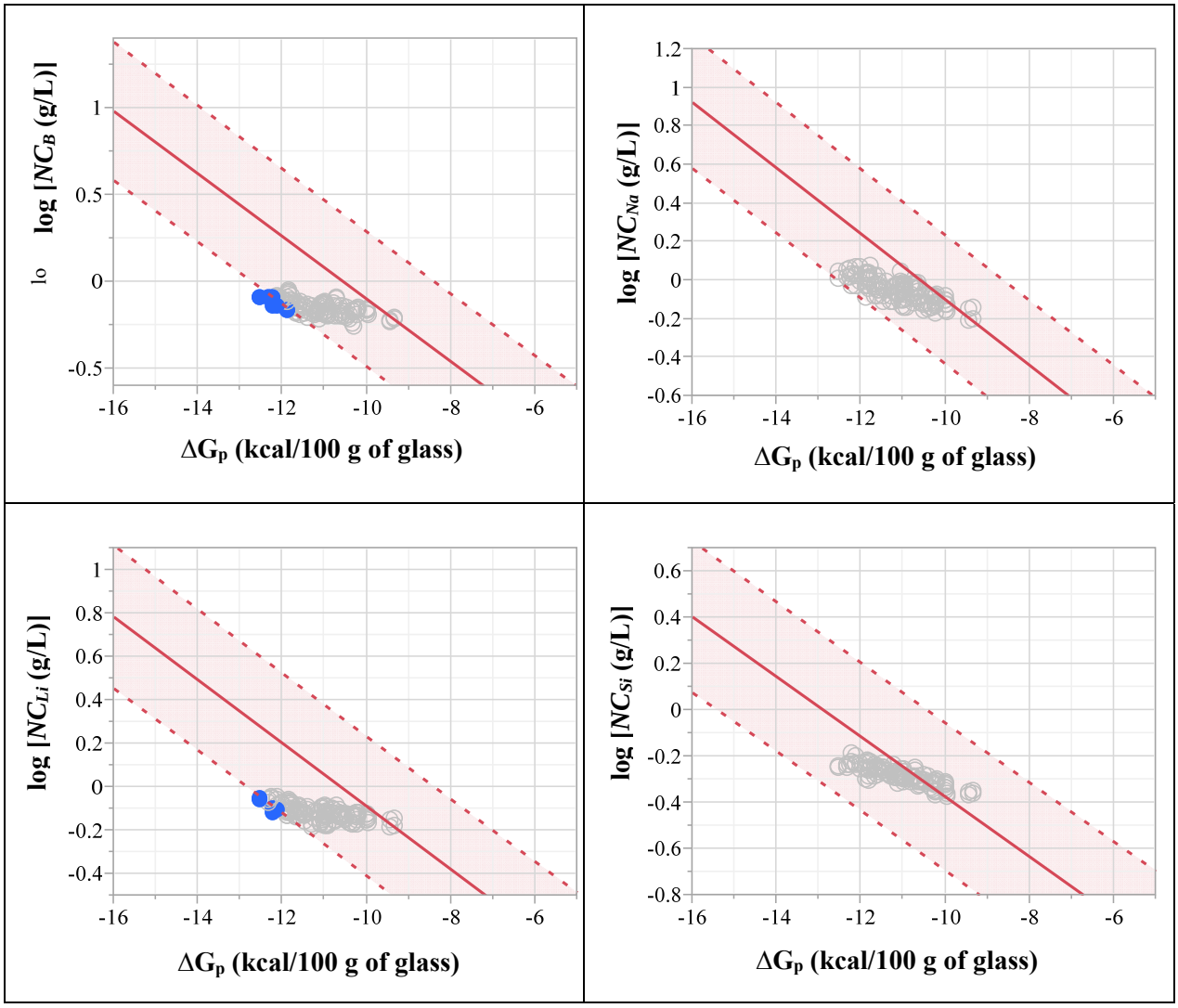
Each of the glasses from the SB8[8] and SB9[10] variability studies underwent a heat treatment representing canister centerline cooling (CCC). For each composition, samples of both the quenched glass (cooled in air) and glass subjected to the CCC were evaluated with the PCT. The normalized concentrations (NC_i) of B, Li, Na, and Si were calculated utilizing both the targeted and measured compositions. These results were provided previously[8,10] and will not be repeated in this report.

Figure 3-1 provides plots of the revised DWPF durability models that relate the normalized concentrations for each element of interest to a linear function of a free energy of hydration term (ΔG_p, kcal/100g glass).[16] Prediction limits at a 95% confidence for an individual PCT result (_ _ _ _) are plotted along with the linear fit (____).

All the variability study glasses are predictable with respect to the revised PCCS models for durability except for the following (shown by a ● in Figure 3-1), which are slightly outside of the lower 95% confidence band.

- NC_B for glasses VSL-SB8-19 (targeted-CCC and targeted-quenched), VSL-SB8-22 (measured-CCC, measured-quenched, targeted-CCC, and targeted-quenched), SB9VS05 (measured-CCC and measured-quenched), and SB9VS08 (measured-CCC, measured-quenched, and targeted-CCC).
- NC_{Li} for glasses VSL-SB8-22 (targeted-CCC and targeted-quenched), and SB9VS08 (measured-CCC, measured-quenched, and targeted-CCC).

The durability models are conservative for these PCT responses since the actual results indicate better durability values than predicted by the models. Similar trends were observed for glasses VSL-SB8-22, SB9VS05, and SB9VS08 in the SB8[8] and SB9[10] variability studies.



○	**SB8 and SB9 glasses within the 95% confidence bands**
●	SB8 and SB9 glasses outside the 95% confidence bands

Figure 3-1. ΔG_p predictions (kcal/100 g of glass) versus the log of the normalized concentrations (g/L) of B, Li, Na, and Si.

4.0 Conclusions

Almost all the PCT results are well predicted by the revised durability models (i.e., fall within the 95% confidence band). Five out of the thirty variability study glasses exhibit some normalized concentrations (NC_B and/or NC_{Li}) that fall slightly outside of the lower 95% confidence band, which indicates that the models conservatively predicted the durability results. Therefore, the revised PCCS durability models are deemed applicable to the SB9 – Frit 803 glass system.

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