TECHNICAL REVIEW COMMENT SHEET
Saltstone Facility

UNITED STATES DEPARTMENT OF ENERGY SAVANNAH RIVER SITE	Document Review Record SRR-CWDA-2009-00011 R0	
Document No./Title: **WSRC-STI-2008-00236, Thermodynamic and Mass Balance Analysis of Expansive Phase Precipitation in Saltstone**	Rev. No.: 0	Doc. Date: May. 2008
Reference: NRC Technical Inquiry, June 15, 2009		

No.	Comments	Comment Resolution
WSRC-STI-2008-00236, Thermodynamic and Mass Balance Analysis of Expansive Phase Precipitation in Saltstone		
1	What was the basis for choosing the solid phases included in the initial saltstone normative composition (Table 3) and the suite of minerals that were allowed to precipitate in the saltstone (Table 6)? Specifically, what was the basis for including gibbsite, quartz, and kaolinite in these sets of phases? Kaolinite was included in the allowed precipitates (Table 6) despite the report's argument (in the preceding paragraph) that clays should not be included. These phases are important to some of the report's modeled reactions that involve the precipitation or dissolution of expansive phases. For example, a reaction on page 14 suggests that ettringite (a high-molar-volume phase) is consumed by reaction with kaolinite. What effect does the inclusion of gibbsite, quartz, and kaolinite in the solid phases have on the results obtained?	The basis for including quartz, gibbsite, and kaolinite in the minerals allowed was to provide phases to accommodate the high concentrations of silica and aluminum relative to calcium present in the saltstone formula. It was assumed that these would have fewer kinetic barriers to precipitation than more complex clays and zeolites. In preparation of WSRC-STI-2008-00236 a run was done allowing more complex minerals to precipitate. The reaction path was more complex with several zeolites precipitating and re-dissolving. Only a very small amount of ettringite precipitated and the total mineral volume was dominated by CSH throughout the run. The conclusions of this run are the same as those discussed in WSRC-STI-2008-00236. An additional run was done in which kaolinite and gibbsite were suppressed and excess aluminum was put in mullite. Again this leads to no significant change in the total volume of minerals precipitated, and hence does not change the conclusions of the report.
2	What data and observations are available to compare to and constrain the modeling calculations?	WSRC-STI-2008-00236 was the initial step in trying to understand expansive phase precipitation during saltstone evolution. Further laboratory and modeling investigations into saltstone evolution under various exposure scenarios are ongoing.

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3	This study does not consider the effects of organic additives or pozzolanic replacement on the dissolution and precipitation of cement-related compounds. These components of concrete and grout may have an effect on the generation of expansive phases. For example, future studies could consider the effect that sulfide from the blast furnace slag might have on the phases and reactions present in this system.	WSRC-STI-2008-00236 was the initial step in trying to understand expansive phase precipitation during saltstone evolution. Further laboratory and modeling investigations into saltstone evolution under various exposure scenarios are ongoing.
4	Geochemical modeling seems to have many unknowns (initial conditions, phase selection or suppression, fundamental thermodynamic data, kinetics) that would impact the confidence in any particular result. Experiments that are designed to collect data on initial mineralogical conditions, fundamental thermodynamic data and reaction kinetics would provide much needed model support for this study	Geochemical modeling does have many unknowns and one of the purposes of WSRC-STI-2008-00236 was to take a broad look at sensitivity of saltstone evolution to some of these unknowns. It was the initial step in trying to understand expansive phase precipitation during saltstone evolution. Further laboratory and modeling investigations into saltstone evolution under various exposure scenarios are ongoing.
5	This study is a deterministic analysis. A probabilistic (stochastic) analysis would provide insights into the importance and sensitivity of the model results to certain thermodynamic or physical properties.	Agree. Once the results of further laboratory and modeling investigations are completed the need for future work will be evaluated.

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6	Geochemists Workbench is based on an equilibrium reaction model. However, reaction kinetics could result in metastable products that are often associated with an increase in volume. Follow on studies might consider expansive phases produced by intermediate or metastable reaction products.	Agree. The modeling in WSRC-STI-2008-00236 was equilibrium modeling. The uncertainty section acknowledges the role kinetics may play: "This analysis is for the equilibrium case only. If kinetics cause different phases to precipitate at different times, the reaction paths could be different. Likewise, if original minerals become coated by precipitating phases, they may become unreactive and reaction paths could change. Kinetic controls or coating of solid phases could change reaction paths to cause precipitation of either more or less expansive phases, depending upon which reactions are kinetically controlled or which solid phases are coated. Useful simulation of these controls is not possible without additional experimental information. Nevertheless, the equilibrium case provides the starting point for any analysis of potential fracturing due to expansive phases." Further laboratory and modeling investigations into Saltstone evolution under various exposure scenarios are ongoing.
7	The staff observes that the conclusions reached in this study area could be integrated with other ongoing or recently completed studies. Dixon (2008) recently completed a study on the physical properties of grout, which included bulk porosity measurements. Updated measurements of the bulk porosity of saltstone grout may be useful in assessing whether expansive phase precipitation is likely to result in grout degradation.	Agree. It is anticipated that the relevance of WSRC-STI-2008-00236 will be superseded by the results of ongoing laboratory and modeling studies of Saltstone under various exposure scenarios. WSRC-STI-2008-00236 was just the initial step in trying to understand expansive phase precipitation during Saltstone evolution.