WPO 30795

DR-6: BRINE PUDDLING IN THE REPOSITORY DUE TO HETEROGENEITIES
Summary Memo of Record

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Subject: FEP Screening Issue DR-6

STATEMENT OF SCREENING DECISION

FEP Screening Issue DR-6 need not be included in future system-level performance assessment calculations.

STATEMENT OF SCREENING ISSUE

This screening effort evaluates the need for including heterogeneity of disposal room contents in in future system-level performance assessment calculations. Previous modeling of flow within the repository is based on homogenizing the room contents into large computational volumes. However, heterogeneity of room contents may influence gas and brine behavior in the room by causing fluid flow among channels or preferential paths in the waste, bypassing entire regions. This bypassing of entire regions may leave large volumes of brine immobile and available to react with the waste producing significant volumes of gas. Isolated regions could exist because (1) they may be isolated by low permeability waste barriers, 2) because connectivity with the interbeds may occur only at particular locations within the repository, or 3) the repository dip may promote preferential gas flow in the upper regions of the waste.

The impact of puddling on direct releases to the surface during a drilling intrusion into the repository is also considered. Direct releases to the surface may occur during drilling due to cuttings and spallings in the drilling fluid and brine circulation from the repository to the surface in the wellbore. These releases are controlled by the prevailing pressure, permeability, and saturation conditions in the disposal room at the time of intrusion. The effect of puddling on these conditions may be important and needs to be evaluated.

APPROACH

To address room heterogeneity issues and resulting impact of immobile brine, an additional parameter has been implemented in BRAGFLO to specify the minimum active (mobile) brine flow saturation (pseudo-residual brine saturation). Above this saturation, the normal descriptions of two-phase flow apply (i.e., either the Brooks/Corey or VanGenuchten/Parker relative permeability models). Below this minimum, brine is immobile, although it is available for reaction and it may still be consumed during the gas generation reactions. Justification for the saturation limit assumption is based on the presumed heterogeneity of the waste and the fact that the repository dips slightly. The saturation limit (puddling parameter) is applied uniformly throughout the disposal room in order to bound the impact of puddling. Implementation of the puddling parameter is described in Appendix 2 of the records package entitled "FEPs Screening Analysis for FEPs DR2, DR3, DR6, DR7, and S6".

A series of BRAGFLO simulations were performed to determine if puddling has the potential to enhance contaminant migration to the accessible environment. Effects of all other FEP issues were disabled in the simulations. Two basic scenarios were considered in the screening analysis, undisturbed performance and disturbed performance. Both scenarios included a 1.0 degree formation dip downward to the south. Intrusion event E1 is considered in the disturbed scenario and consists of a borehole that penetrates the repository and pressurized brine in the underlying

Castile Formation. Two variations of intrusion event E1 are examined, E1 Up-Dip and E1 Down-Dip. In the E1 Up-Dip event the intruded panel region is located on the up-dip (north) end of the repository, whereas in the E1 Down-Dip event the intruded panel region is located on the down-dip (south) end of the repository. These two E1 events permit evaluation of the possiblity of increased brine flow into the panel region due to higher brine saturations down-dip of the borehole and the potential for subsequent impacts on contaminant migration. To incorporate the effects of uncertainty in each case (E1 Up-Dip, E1 Down-Dip, and undisturbed), a Latin hypercube sample size of 20 was used resulting in a total of sixty simulations. To assess the sensitivity of system performance on puddling, conditional complementary cumulative distribution functions (CCDFs) of normalized contaminated brine releases to the Culebra via human intrusion and shaft system, as well as releases to the subsurface boundary of the accessible environment, were constructed and compared to the corresponding baseline model CCDFs. In the baseline model calculations, the effects of all FEP issues were disabled. These comparisons provide direct information about how the inclusion of puddling may influence repository performance. In addition, performance measures are examined for direct releases during drilling due to cuttings and spallings and brine circulation from the repository to the surface. Potential releases to the surface during drilling are strongly influenced by three drivers: brine pressures, brine saturations, and permeability in the waste disposal area. Spallings, cuttings, and brine releases tend to increase with an increase in each of these drivers. The exception to this trend is that at high brine saturations (or low gas saturations) brine releases tend to decrease because gas volumes become to small to maintain an appreciable gas drive (gas expansion).

RESULTS AND DISCUSSION

CCDFs for releases to the Culebra and subsurface boundary of the accessible environment for E1 Up-Dip, E1 Down-Dip, and undisturbed cases are provided in Figure 6 of Appendix 1. Each figure compares CCDFs of normalized releases predicted by the baseline model and normalized releases predicted with puddling. Note that releases to the Culebra via the shaft and intrusion borehole are shown on the left side of the figure whereas releases to the subsurface boundary of the accessible environment are presented on the right side of the figure. In all three cases (E1 Up-Dip, E1 Down-Dip, and undisturbed), the puddling curves for releases to the Culebra are very close to the baseline curves for most of their lengths. In addtion, CCDFs for releases to the subsurface boundary via the marker beds show that the baseline CCDF is consistently above and to the right of the puddling CCDF. In summary, differences in releases between the baseline and puddling results are minor with the baseline model predicting consistently higher releases.

Performance measures for direct releases during drilling, which include maximum, mean, medium, and minimum values of volume averaged brine pressures, brine saturations, porosity, and permeability in the waste region for undisturbed conditions at 100, 1000, and 10000 years, are given in Table 5 of Appendix 1. Comparison of these values with the baseline values given in Table 2 indicate that puddling produces slightly larger maximum, mean, and median brine saturations at 100, 1000, and 10000 years. All other performance measures are nearly equal between the baseline and puddling cases. The higher brine saturations, however, with the exception of the maximum values at 1000 and 10000 years, are small and the brine will not be sufficiently mobile for releases to be significant. Further, although the maximum brine saturation values at 1000 and 10000 years exceed the corresponding baseline values, they are too high to allow enough gas to be present to provide the gas drive needed to exceed baseline model releases. As a consequence, the corresponding maximum baseline saturations result in slightly larger releases with respect to direct releases due to a drilling intrusion. In summary, the baseline case is sufficiently conservative with respect to direct releases due to a drilling intrusion.

BASIS FOR RECOMMENDED SCREENING DECISION

Based on the CCDFs, the inclusion of puddling in BRAGFLO results in overall lower computed releases to the accessible environment than the baseline case. In addition, puddling has an insignificant effect on waste room conditions relevant to releases due to a drilling intrusion. As a result, the baseline model appears is conservative in its

approach to homogenizing waste panel contents into large computational volumes and puddling can be eliminated from consideration in system-level PA calculations. It is emphasized that a separate screening analysis of direct releases due to brine circulation from the repository to the surface is currently underway and the impact of puddling on this phenomena will be examined in additional detail. This screening decision will be reevaluated once the separate screening analysis is completed and the impact of puddling on releases due to a drilling intrusion are further evaluated.