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SANDIA NATIONAL LABORATORIES
WASTE ISOLATION PILOT PLANT

Impact Assessment of an Additional WIPP Shaft

Revision 0

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Executive Summary

The recent radiological release event at the WIPP site has temporarily halted waste emplacement activities at the facility. A modified ventilation system is envisioned that will provide sufficient airflow necessary for the resumption of full-rate disposal operations in the future. A primary component of the modified ventilation system is an additional exhaust shaft and two access drifts in the north end of the repository. The repository representation used in WIPP PA was modified to include the additional shaft and its drifts. The increased volume in the WIPP north end translated to a reduction in pressure (on average) in that region. Slight pressure reductions were also seen in repository waste regions, with reductions being less pronounced with increased distance from the north end. The slight pressure reductions in repository waste regions yielded very slightly increased brine saturations (on average) in those areas. Brine flows up the borehole during a hypothetical drilling intrusion were nearly identical to those found in the CRA-2014 PA. Brine flows up the composite repository shaft were decreased as compared to the CRA-2014 PA due to the pressure reduction in the north end of the repository. The combination of slightly reduced waste region pressure (on average) and very slightly increased brine saturation was also seen in the SDI impact assessment, where it was found that these slight changes have no impact on regulatory compliance. It is concluded that WIPP continues to satisfy regulatory compliance limits with the addition of an exhaust shaft and its access drifts, with compliance curves like those found in the CRA-2014 PA for total normalized releases.

1 Introduction

The Waste Isolation Pilot Plant (WIPP), located in southeastern New Mexico, has been developed by the U.S. Department of Energy (DOE) for the geologic (deep underground) disposal of transuranic (TRU) waste. Containment of TRU waste at the WIPP is regulated by the U.S. Environmental Protection Agency (EPA) according to the regulations set forth in Title 40 of the Code of Federal Regulations (CFR), Part 191. The DOE demonstrates compliance with the containment requirements according to the Certification Criteria in Title 40 CFR Part 194 by means of performance assessment (PA) calculations performed by Sandia National Laboratories (SNL). WIPP PA calculations estimate the probability and consequence of potential radionuclide releases from the repository to the accessible environment for a regulatory period of 10,000 years after facility closure. The models used in PA are maintained and updated with new information as part of an ongoing process. Improved information regarding important WIPP features, events, and processes typically results in refinements and modifications to PA models and the parameters used in them. Planned changes to the repository and/or the components therein also result in updates to WIPP PA models. WIPP PA models are used to support the repository recertification process that occurs at five-year intervals following the receipt of the first waste shipment at the site in 1999.

The recent radiological release event at the WIPP site has temporarily halted waste emplacement activities at the facility. A modified ventilation system is envisioned that will provide sufficient airflow necessary for the resumption of full-rate disposal operations in the future. A primary component of the modified ventilation system is an additional exhaust shaft in the north end of the repository. This analysis quantifies the impact of the additional shaft and its access drifts on long-term performance of the repository. The analysis undertaken herein is delineated in AP-169 (Camphouse 2014).

2 Approach

Repository shafts have been included in WIPP PA as a feature of the repository since the original Compliance Certification Application (DOE 1996). To date, repository shafts have yielded no releases that impact long-term performance of the facility when included in WIPP PA. To be clear, WIPP PA demonstrates repository performance from facility closure to 10,000 years after closure. The recent radiological release at the site impacts current operational aspects of the facility, but is outside the scope of WIPP PA. However, repository design changes made to allow for the resumption of waste disposal at the site potentially comprise features of the repository that must be included in PA. An additional exhaust shaft and its associated access drifts are such features.

There are four shafts currently in the repository north end, namely a salt handling shaft, an exhaust shaft, a waste shaft, and an air intake shaft. These shafts are combined into a single shaft in WIPP PA that captures the combined impacts of all of them. The proposed additional exhaust shaft is combined with the four existing shafts in this analysis to determine its impacts (if any) on long-term repository performance. Moreover, mined volume in the repository north end is modified in the repository representation so as to include additional drifts created to access the new shaft. The dimensions used for the additional shaft are a 14 foot diameter and a height of 2150 feet (see Attachments 1 and 2 of Camphouse (2014)). Two drifts will be used to access the new shaft. Each drift is modeled as being 42 feet wide, 13 feet high, and 2,640 feet (½ mile) long (see Attachment 2 of Camphouse (2014)). The additional shafts are assumed to connect to the current repository operations area. The proposed exhaust shaft and associated drifts are similar to those that currently exist in the repository.

The code BRAGFLO is the WIPP PA code used to model brine and gas flow in and around the repository. The current numerical grid and material map used to represent the WIPP in BRAGFLO are shown in Figure 2-1. As seen in that figure, the current base area of the shaft representation in BRAGFLO is $10.00 \text{ m} \times 9.50 \text{ m} = 95.0 \text{ m}^2$. The new exhaust shaft has a base area of $\pi (7 \text{ ft})^2 = 153.94 \text{ ft}^2 = 14.30 \text{ m}^2$. As a result, the combined area of the current shaft representation and the proposed exhaust shaft is $95.0 \text{ m}^2 + 14.30 \text{ m}^2 = 109.30 \text{ m}^2$. The same increase in length, denoted by D, is added to the x and z directions to attain the combined base area of all five shafts, i.e. $(10.0 + D)(9.5 + D) = 109.30$. The result is a quadratic equation of the form $D^2 + 19.5D - 14.3 = 0$, which has a positive root equaling 0.7075. Thus, the shaft representation is modified to have x and z cell widths of 10.7075 m and 10.2075 m, respectively, for the analysis undertaken herein.

The two drifts corresponding to the proposed exhaust shaft have a volume of $2(42 \text{ ft})(13 \text{ ft})(2{,}640 \text{ ft}) = 2{,}882{,}880 \text{ ft}^3$, which equals $81{,}634 \text{ m}^3$. This volume is added to the current representation of the operations area in the BRAGFLO numerical grid. As seen in Figure 2-1, the operations area is represented by three grid columns, each having a volume of $12{,}577.62 \text{ m}^3$. The new drifts do not alter the north-to-south extent of the repository operations area, nor its height. As a result, the increased volume is incorporated by increasing cell dimensions in the z-direction, with the increase being equal for the three grid columns representing the operations area. With D denoting the increased cell width in the z-direction, we have $(32.18 + D)(98.70)(3.96) = 12{,}577.62 + (81{,}634)/3$, which yields $D = 69.62$. Therefore, grid cells representing the operations area have their length in the z-direction increased by 69.62 m, yielding a total length of $32.18 \text{ m} + 69.62 \text{ m} = 101.80 \text{ m}$.

The BRAGFLO grid and material map that incorporates the proposed exhaust shaft and its associated access drifts are shown in Figure 2-2. Grid dimensions that have been changed in Figure 2-2 are in red font, as are their CRA-2014 PA counterparts in Figure 2-1. The impact assessment done herein consists of a BRAGFLO analysis. As will be seen in the results to follow, the addition of the proposed shaft and its access drifts results in slight changes to pressures and brine saturations in repository waste areas. These slight changes are not unlike those that have been seen in prior analyses, where it was shown that they have essentially no impact on regulatory compliance.

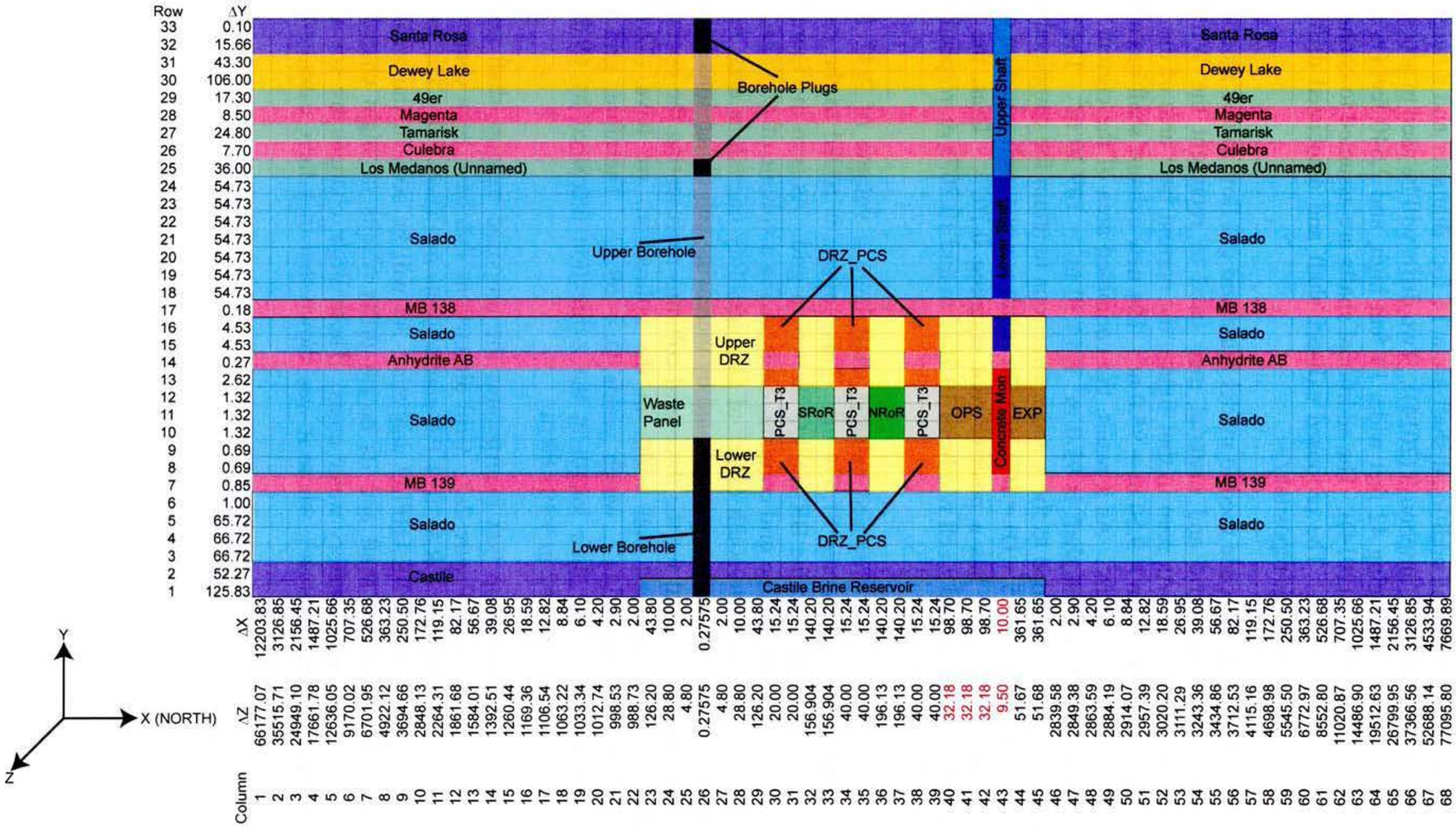

Figure 2-1: The CRA-2014 PA BRAGFLO Repository Representation

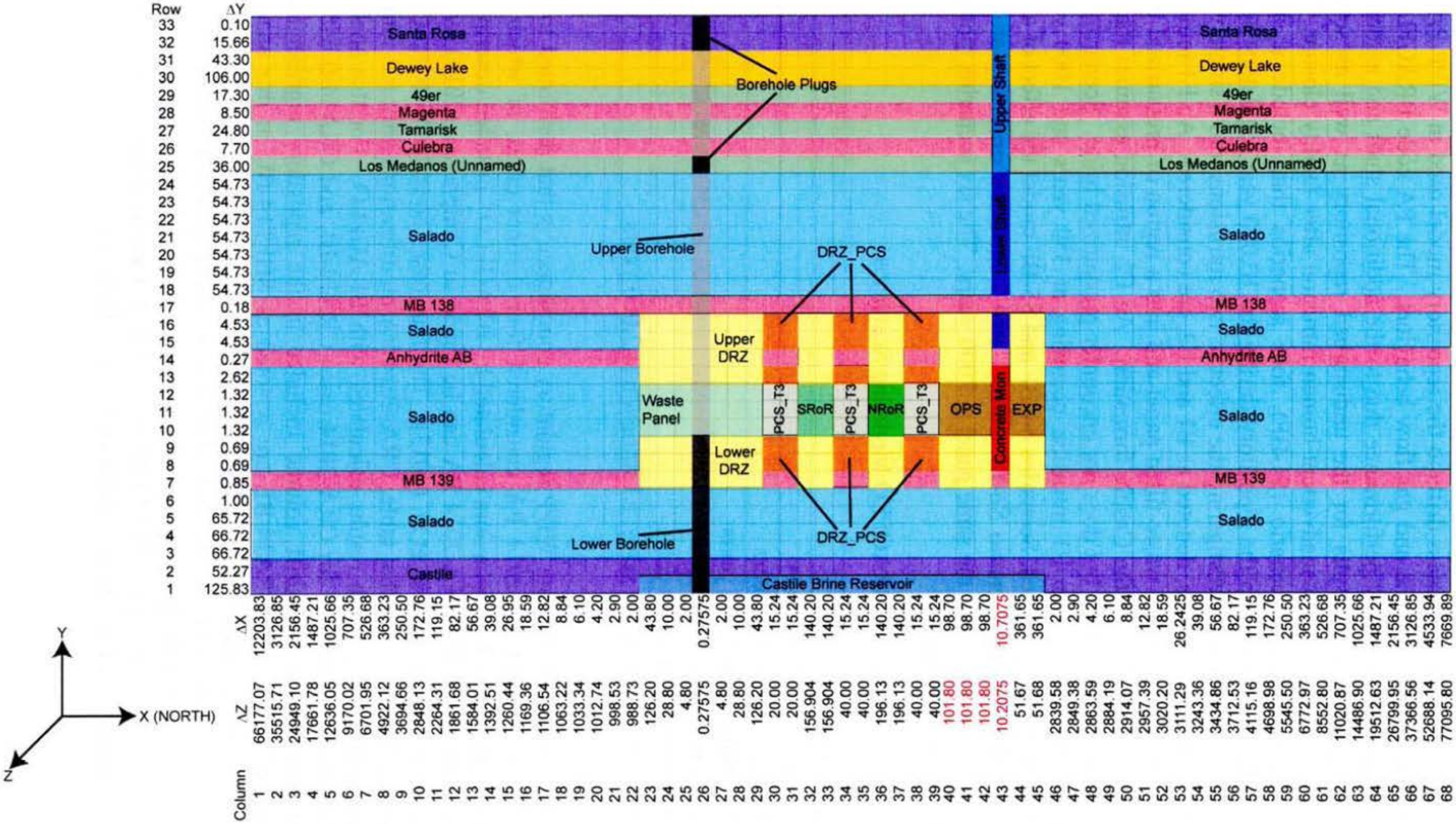

Figure 2-2: The BRAGFLO Repository Representation used in the Exhaust Shaft Impact Assessment

The addition of an exhaust shaft and access drifts to the repository model used in WIPP PA has the potential of altering calculated brine and gas flow behaviors. The PA code BRAGFLO is used to ascertain changes to repository performance due to the additional shaft and associated drifts. BRAGFLO provides flow results for the undisturbed repository as well as several disturbance scenarios used to represent inadvertent human intrusion after facility closure. The scenarios include one undisturbed scenario (S1-BF), four scenarios that include a single inadvertent future drilling intrusion into the repository during the 10,000 year regulatory period (S2-BF to S5-BF), and one scenario investigating the effect of two intrusions into a single waste panel (S6-BF). Two types of intrusions, denoted as E1 and E2, are considered. An E1 intrusion assumes the borehole passes through a waste-filled panel and into a region of pressurized brine that may exist under the repository in the Castile formation. An E2 intrusion assumes that the borehole passes through the repository but does not encounter pressurized brine. Scenarios S2-BF and S3-BF model the effect of an E1 intrusion occurring at 350 years and 1000 years, respectively, after the repository is closed. Scenarios S4-BF and S5-BF model the effect of an E2 intrusion at 350 and 1000 years. Scenario S6-BF models an E2 intrusion occurring at 1000 years, followed by an E1 intrusion into the same panel at 2000 years. The six scenarios modeled by BRAGFLO are shown in Table 2-1.

Table 2-1: BRAGFLO Modeling Scenarios

Scenario	**Description**
S1-BF	Undisturbed Repository
S2-BF	E1 intrusion at 350 years
S3-BF	E1 intrusion at 1,000 years
S4-BF	E2 intrusion at 350 years
S5-BF	E2 intrusion at 1,000 years
S6-BF	E2 intrusion at 1,000 years; E1 intrusion at 2,000 years.

The most recent PA done to demonstrate WIPP regulatory compliance is that performed for the CRA-2014 (DOE 2014). The CRA-2014 PA considered four distinct cases, of which two potentially impact gas and brine flow behaviors calculated by BRAGFLO. Detailed descriptions of the four cases considered in the CRA-2014 PA can be found in Camphouse (2013), with a summary of results given in Camphouse et al. (2013). The four cases considered in the CRA-2014 PA are shown in Table 2-2. In that table, CRA-2014 PA modifications with red font are those that can have a direct impact on results calculated with BRAGFLO. For this analysis, BRAGFLO calculations are performed for CRA-2014 cases CRA14-BL and CRA14-0 with the additional exhaust shaft and access drift volume included in the repository representation. Calculations corresponding to case CRA14-BL are denoted as SHFT14-BL in this analysis. Similarly, calculations corresponding to case CRA14-0 are denoted as SHFT14-0. In effect, case SHFT14-BL is case CRA14-BL with the proposed shaft and access drifts added. Similarly, case SHFT14-0 is case CRA14-0 with the proposed shaft and its drifts added. The number of calculations listed in Table 2-2 for cases CRA14-BL and CRA14-0 are used for cases SHFT14-BL and SHFT14-0, respectively, over the six scenarios listed in Table 2-1.

Table 2-2: Cases Considered in the CRA-2014 PA

	CRA-2014 PA Cases			
	Case CRA14-BL	Case CRA14-TP	Case CRA14-BV	Case CRA14-0
CRA-2014 PA changes included	**Replacement of Option D PCS with the ROMPCS** **Inclusion of additional mined volume in the WIPP experimental area** **Updated WIPP waste inventory parameters** Updated radionuclide solubilities and uncertainty, colloid parameters Updated drilling rate and plugging pattern parameters	Replacement of Option D PCS with the ROMPCS Inclusion of additional mined volume in the WIPP experimental area Updated WIPP waste inventory parameters Updated radionuclide solubilities and uncertainty, colloid parameters Updated drilling rate and plugging pattern parameters BOREHOLE:TAUFAIL and GLOBAL:PBRINE parameter distribution refinements	Replacement of Option D PCS with the ROMPCS Inclusion of additional mined volume in the WIPP experimental area Updated WIPP waste inventory parameters Updated radionuclide solubilities and uncertainty, colloid parameters Updated drilling rate and plugging pattern parameters BOREHOLE:TAUFAIL and GLOBAL:PBRINE parameter distribution refinements Variable Brine Volume Implementation	**Replacement of Option D PCS with the ROMPCS** **Inclusion of additional mined volume in the WIPP experimental area** **Updated WIPP waste inventory parameters** Updated radionuclide solubilities and uncertainty, colloid parameters Updated drilling rate and plugging pattern parameters BOREHOLE:TAUFAIL and GLOBAL:PBRINE parameter distribution refinements Variable Brine Volume Implementation **Update to parameter STEEL:CORRMCO2** **Refinement to Repository Water Balance Implementation**
Number of replicates	1	1	1	3

3 FEPs Re-Assessment

An assessment of the Features, Events, and Processes (FEPs) baseline was conducted to determine if the current FEPs basis remains valid in consideration of changes introduced by the proposed exhaust shaft and its drifts. The assessment was performed according to SP 9-4, *Performing FEPs Impact Assessment for Planned or Unplanned Changes*, and is provided in Kirkes (2014). The FEPs assessment was originally planned to be an attachment to this analysis report, but is instead a separate document. This is a deviation from the approach delineated in AP-169.

4 Code Execution

Run control documentation of codes executed in the exhaust shaft impact assessment is provided in Section Run Control of this report. This documentation contains:

1. A description of the hardware platform and operating system used to perform the calculations.
2. A listing of the codes and versions used to perform the calculations.
3. A listing of the scripts used to run each calculation.
4. A listing of the input and output files for each calculation.
5. A listing of the library and class where each file is stored.
6. File naming conventions.

Results obtained in this analysis are compared to those acquired in the CRA-2014 PA. Documentation of run control for results calculated in the CRA-2014 PA is provided in Long (2013).

5 Results

Salado flow results obtained after including the proposed shaft and its access drifts in the BRAGFLO repository representation are now presented, and compared to those obtained in the CRA-2014 PA. Results are discussed in terms of overall means. Overall means are obtained by forming the average of all realizations obtained for a given quantity and scenario. In WIPP PA, a replicate consists of 100 calculated realizations. As discussed in Section 2, and denoted in Table 2-2, replicate 1 results are generated for cases SHFT14-BL and CRA14-BL. Means and statistics presented for these two cases are generated over replicate 1. Three replicates are used to generate results for cases SHFT14-0 and CRA14-0. Means and statistics presented for these two cases are calculated over all three replicates.

Results are presented for undisturbed scenario S1-BF. Results associated with intrusions are presented for scenarios S2-BF and S4-BF, as these are representative of the intrusion types considered in scenarios S2-BF to S5-BF with the only differences being the timing of drilling intrusions. Results from BRAGFLO scenario S6-BF are also discussed. In the results that follow, summary statistics and plots were generated with Matlab, a commercial off-the-shelf software package.

5.1 Pressure

The two access drifts for the proposed exhaust shaft yield increased volume in the repository operations area. An expected outcome of increased volume is a reduction in pressure. Plots of mean pressure for the operations area are shown in Figure 5-1 to Figure 5-4. When compared to cases CRA14-BL and CRA14-0 from the CRA-2014 PA, the increase in volume yields a reduction in mean pressure in the operations area. Mean pressure is lower in case SHFT14-BL as compared to case CRA14-BL for all scenarios modeled in BRAGFLO. The same is also true for cases SHFT14-0 and CRA14-0. Similar trends are seen for the repository experimental region. As seen in Figure 5-5 to Figure 5-8, mean pressures are lower in cases SHFT14-BL and SHFT14-0 than their counterparts from the CRA-2014 PA.

Pressure reductions in the repository north end result in pressure reductions in repository waste regions, with these reductions being less pronounced with increasing distance from the operations area. Plots of mean pressure for the north rest-of-repository waste region are shown in Figure 5-9 to Figure 5-12. As seen in those figures, mean pressures are lower in the northern waste region when the additional shaft and access drifts are included in the BRAGFLO repository representation. Similar trends are evident for the south rest-of-repository waste region. As seen in Figure 5-13 to Figure 5-16, mean pressures are lower for this region in all scenarios modeled with BRAGFLO. Mean pressure reductions are less pronounced for the south rest-of-repository than for the north rest-of-repository.

Pressure reductions are much less pronounced for the southernmost waste panel, as it has the greatest distance (as well as the most intermittent panel closures) from the repository operations area in the BRAGFLO grid. As seen in Figure 5-17, slight reductions are seen in the mean waste panel pressure for undisturbed conditions. For scenarios in which the repository undergoes a drilling intrusion, reductions in mean pressure are very slight. The mean pressure curves shown in Figure 5-18 to Figure 5-20 for cases SHFT14-BL and SHFT14-0 are almost identical to their counterparts from the CRA-2014 PA.

Pressure statistics for case SHFT14-BL and SHFT14-0 are summarized in Table 5-1 and Table 5-2, respectively. In those tables, means are calculated at 10,000 years over all vectors obtained in each particular case. The addition of the shaft and its access drifts results in lower mean pressures as compared to the CRA-2014 PA. The trend for maximum pressure values is similar.

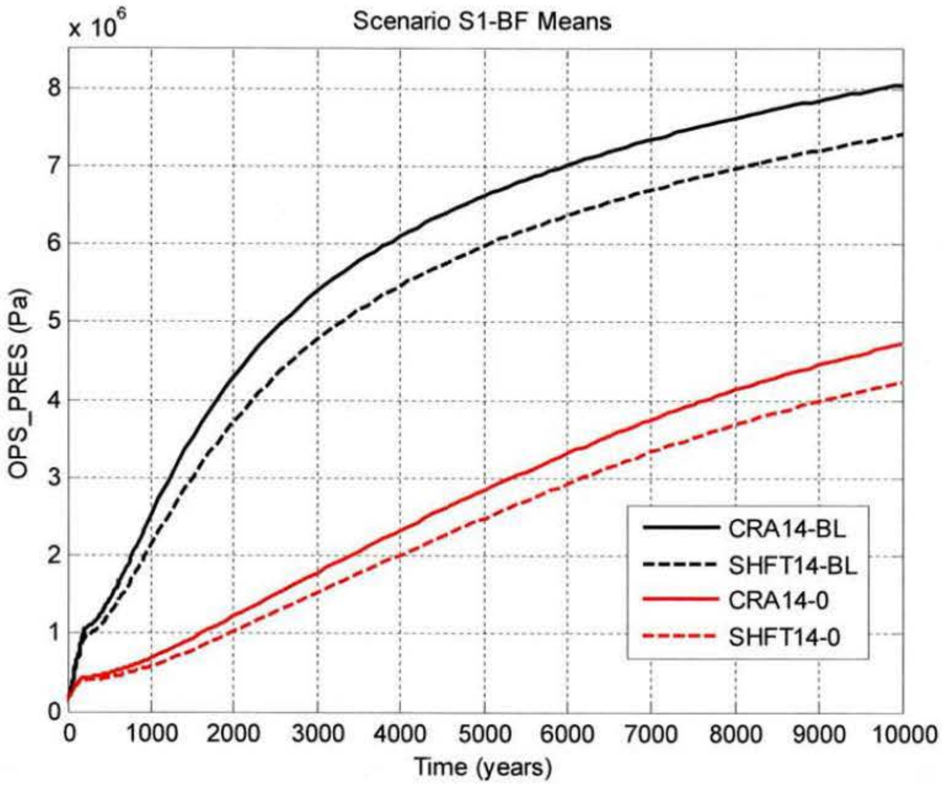

Figure 5-1: Pressure Means for the Operations Region, Scenario S1-BF

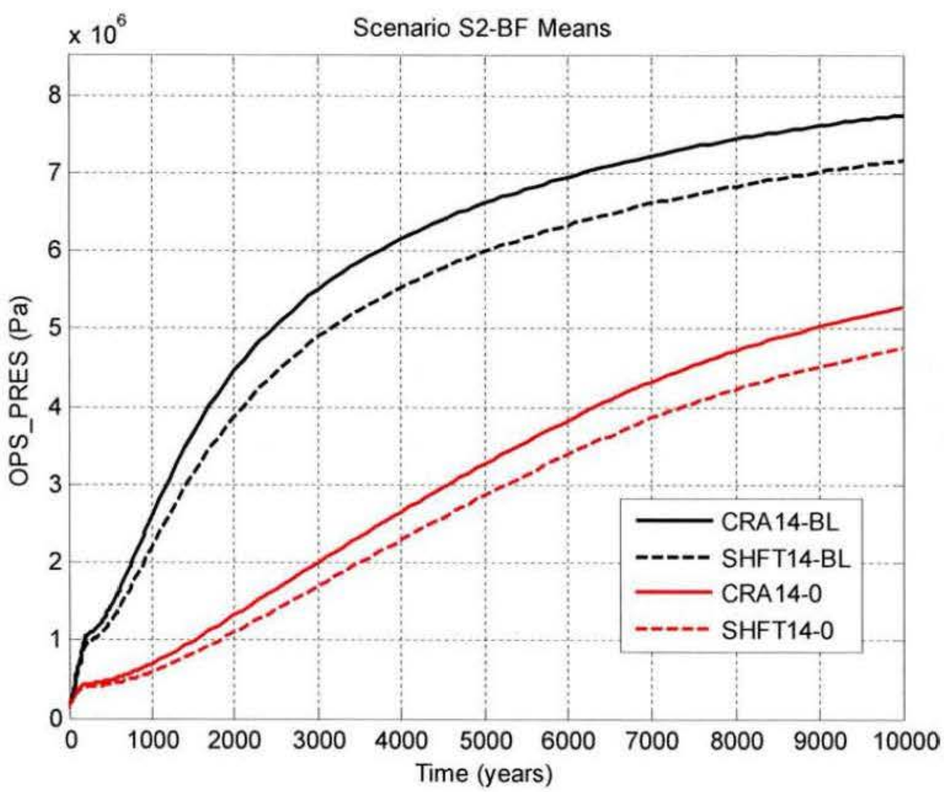

Figure 5-2: Pressure Means for the Operations Region, Scenario S2-BF

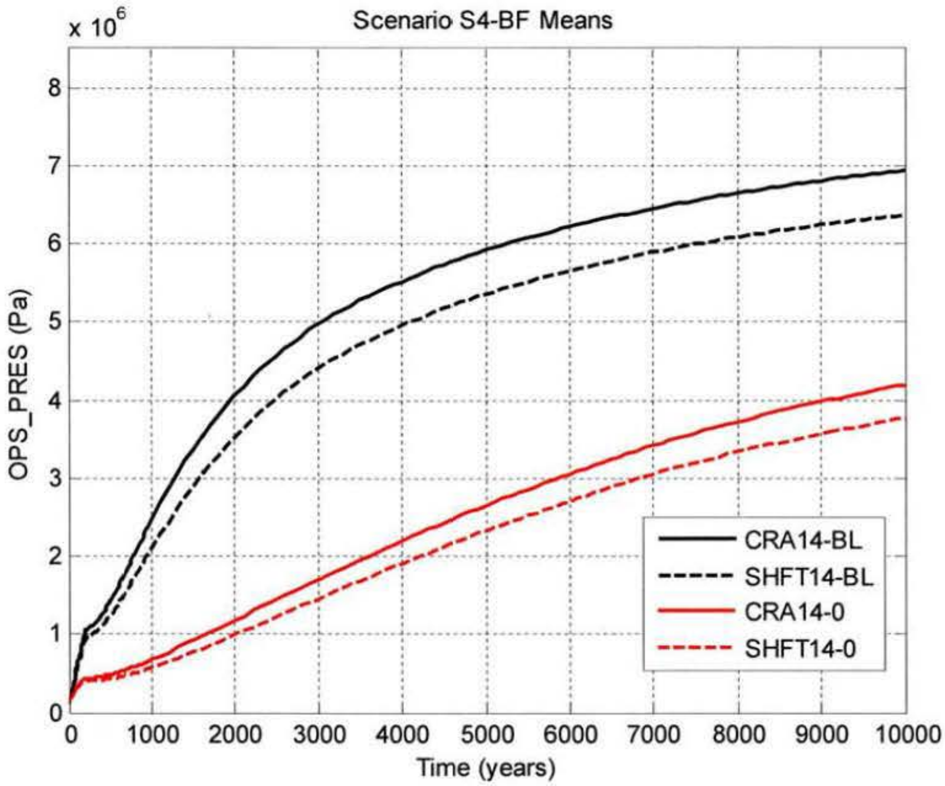

Figure 5-3: Pressure Means for the Operations Region, Scenario S4-BF

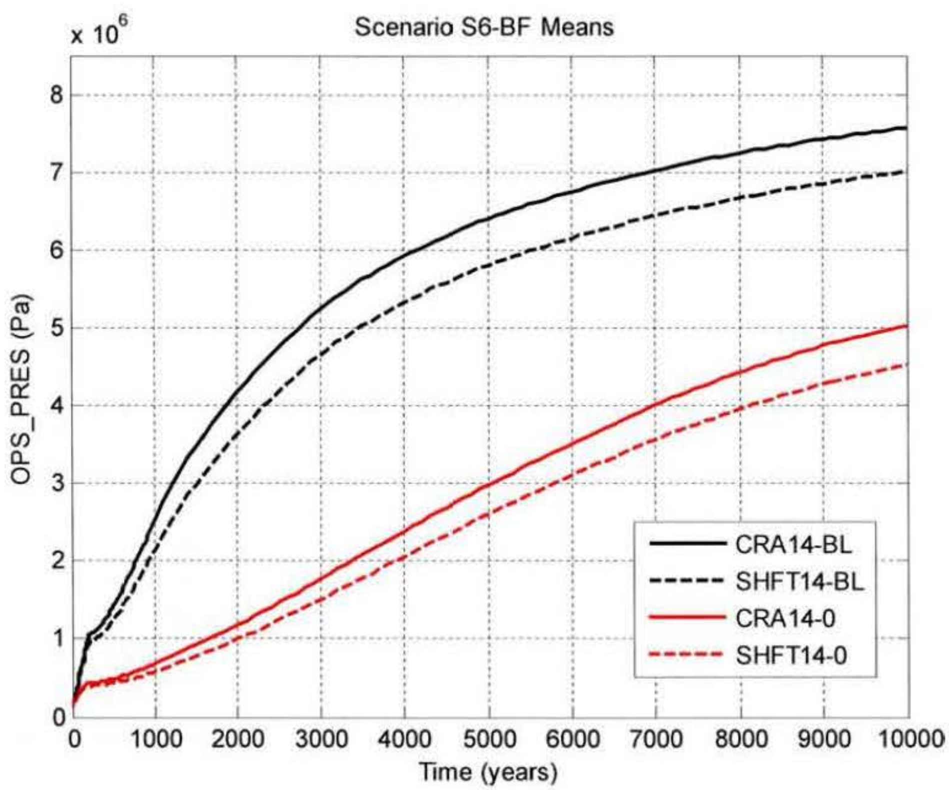

Figure 5-4: Pressure Means for the Operations Region, Scenario S6-BF

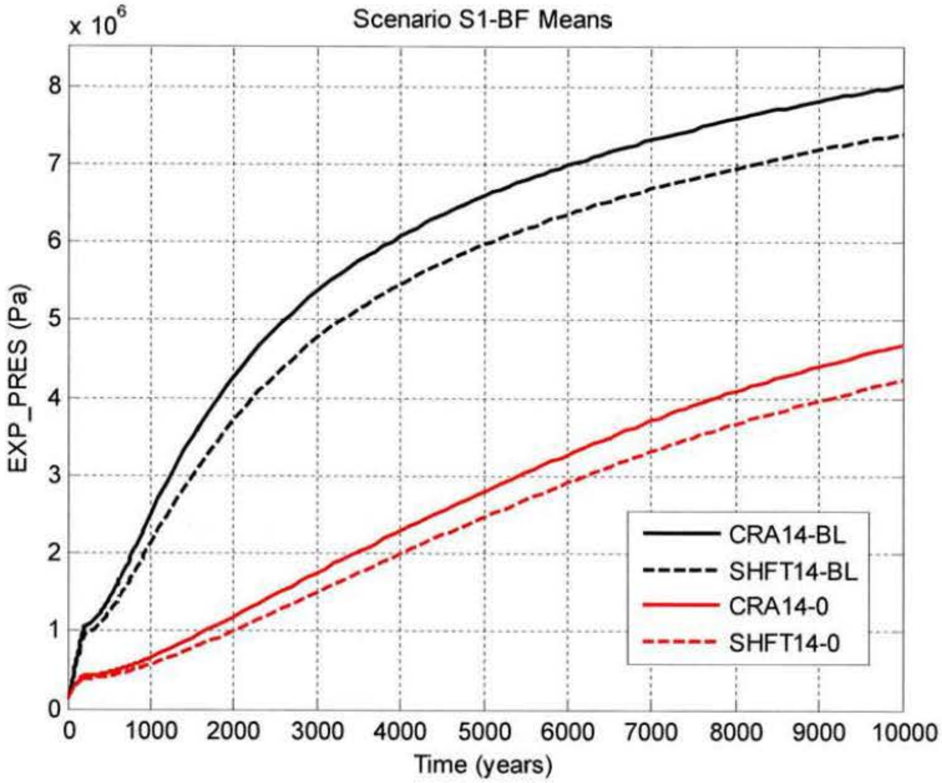

Figure 5-5: Pressure Means for the Experimental Region, Scenario S1-BF

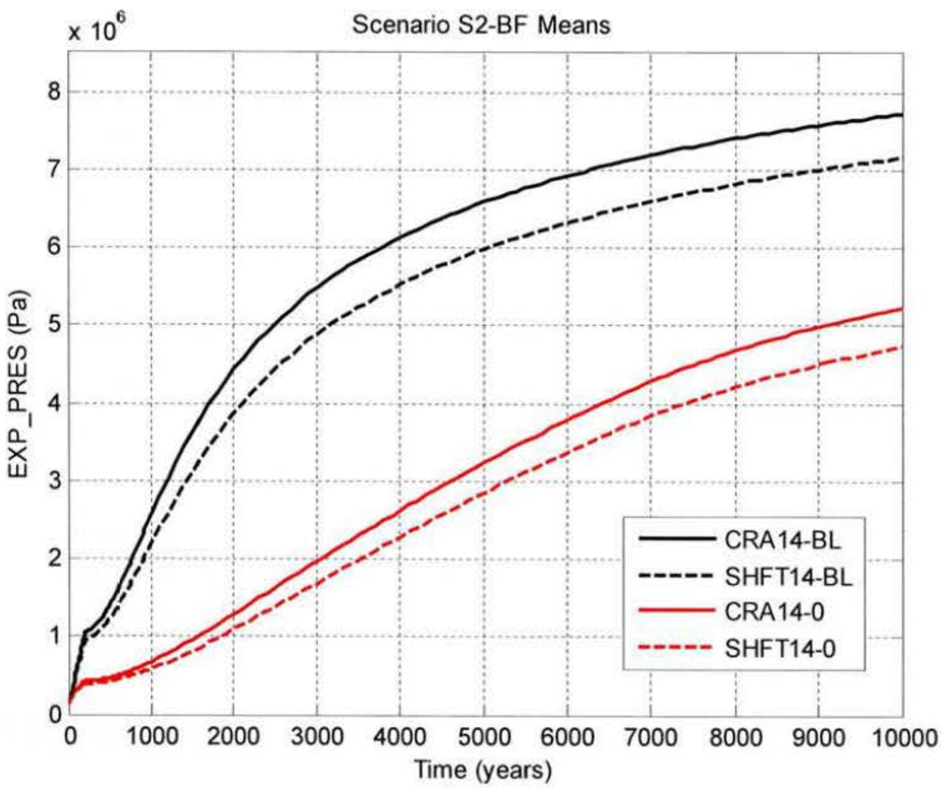

Figure 5-6: Pressure Means for the Experimental Region, Scenario S2-BF

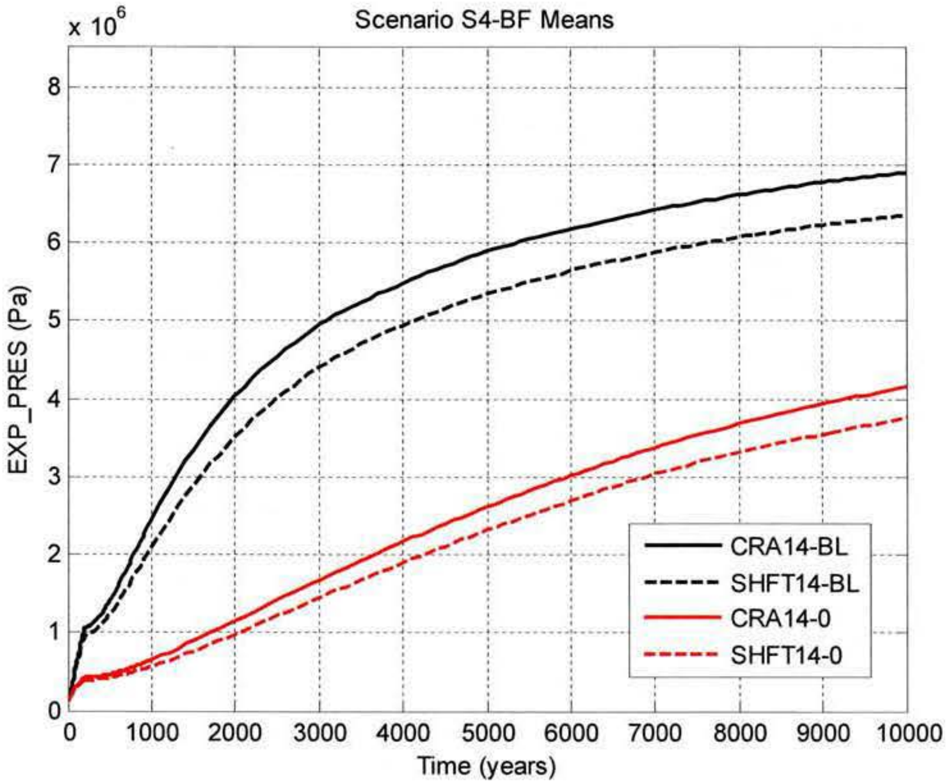

Figure 5-7: Pressure Means for the Experimental Region, Scenario S4-BF

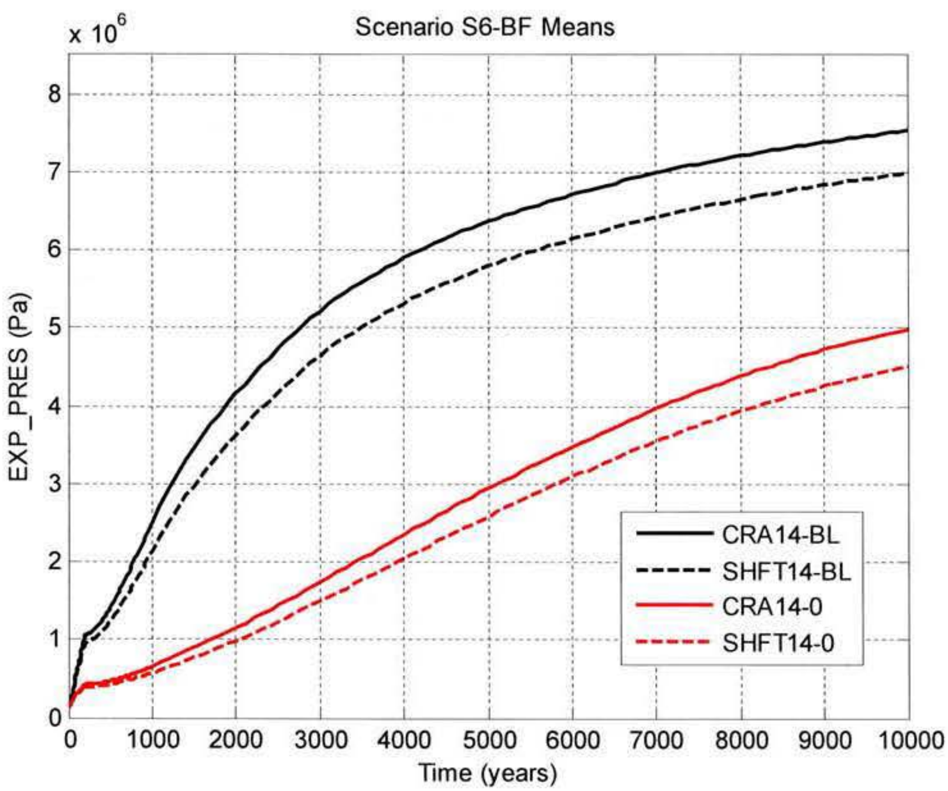

Figure 5-8: Pressure Means for the Experimental Region, Scenario S6-BF

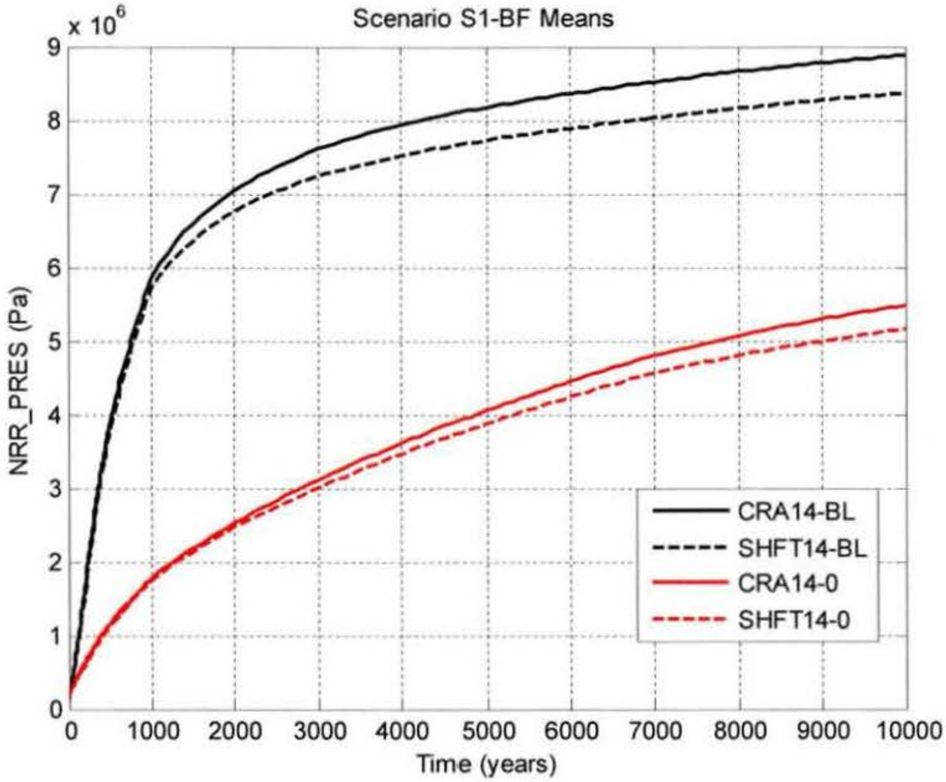

Figure 5-9: Pressure Means for the North Rest-of-Repository, Scenario S1-BF

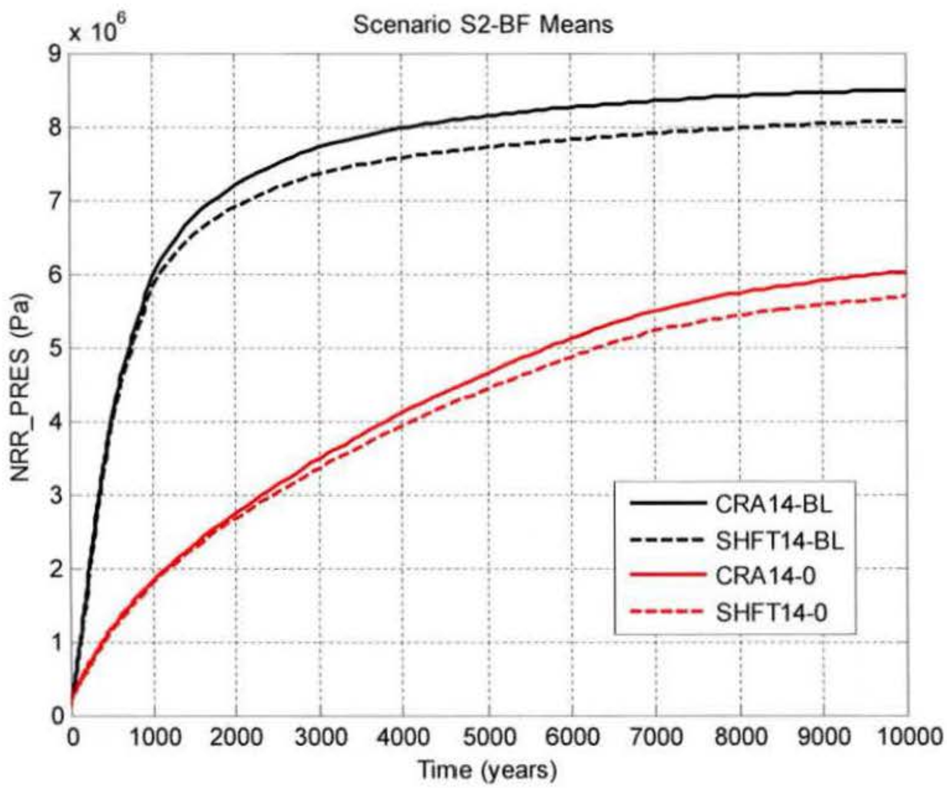

Figure 5-10: Pressure Means for the North Rest-of-Repository, Scenario S2-BF

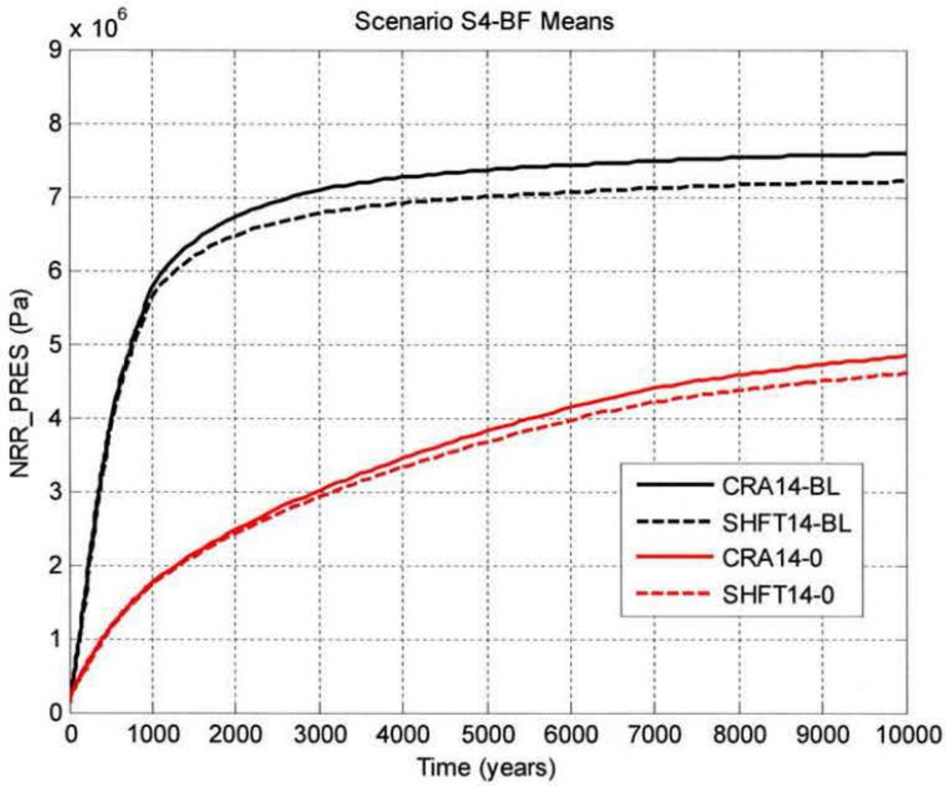

Figure 5-11: Pressure Means for the North Rest-of-Repository, Scenario S4-BF

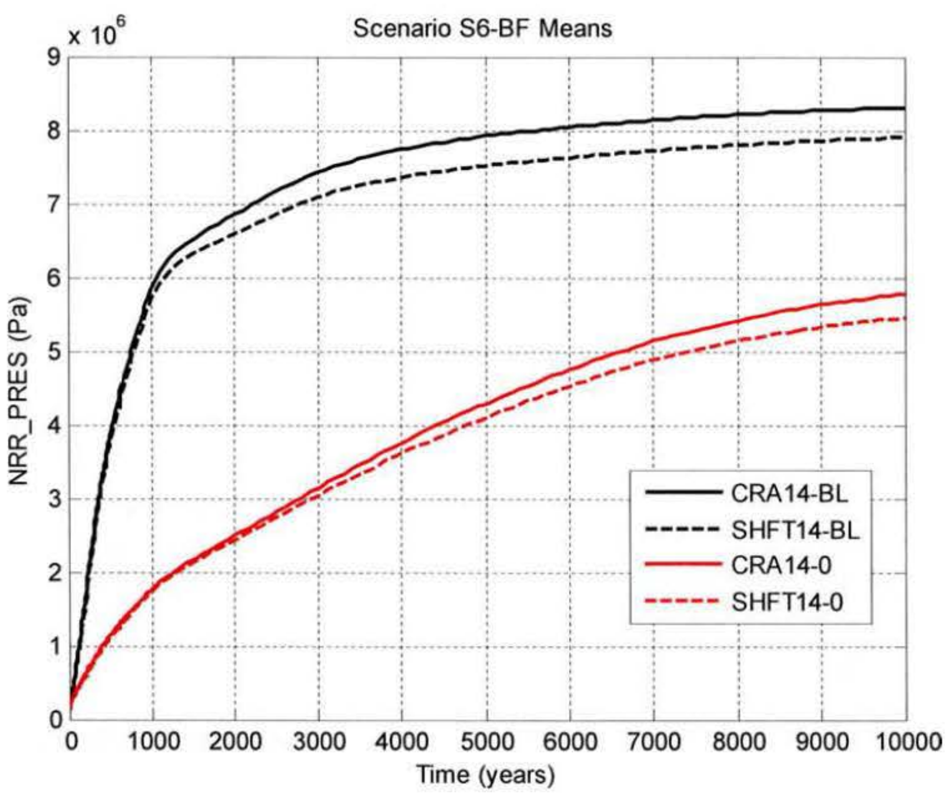

Figure 5-12: Pressure Means for the North Rest-of-Repository, Scenario S6-BF

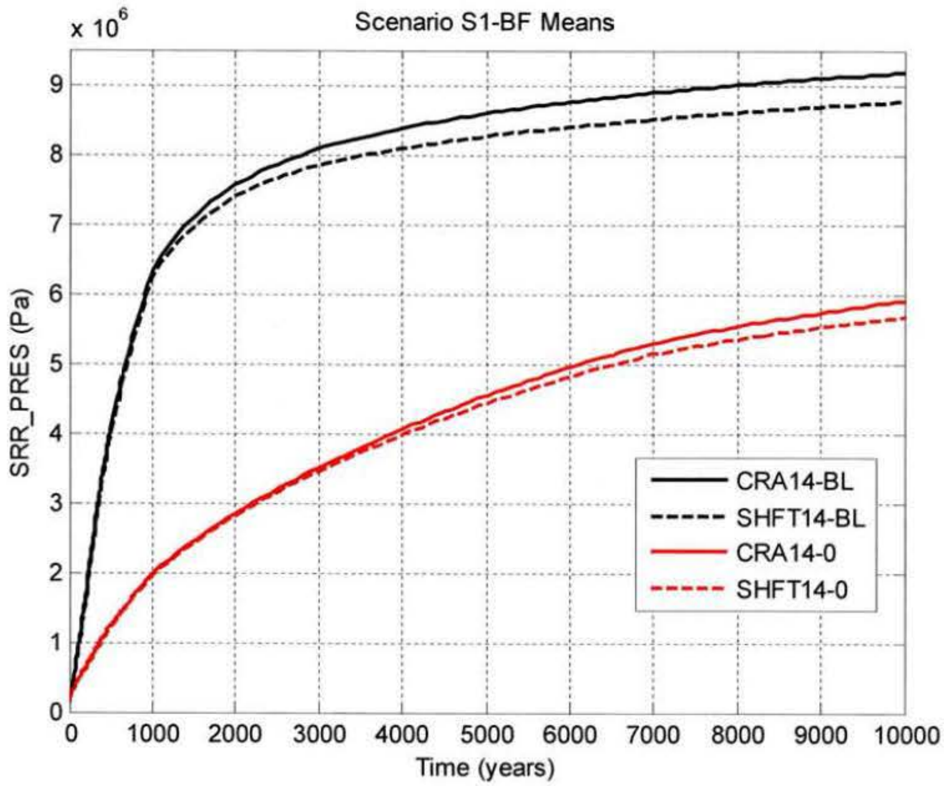

Figure 5-13: Pressure Means for the South Rest-of-Repository, Scenario S1-BF

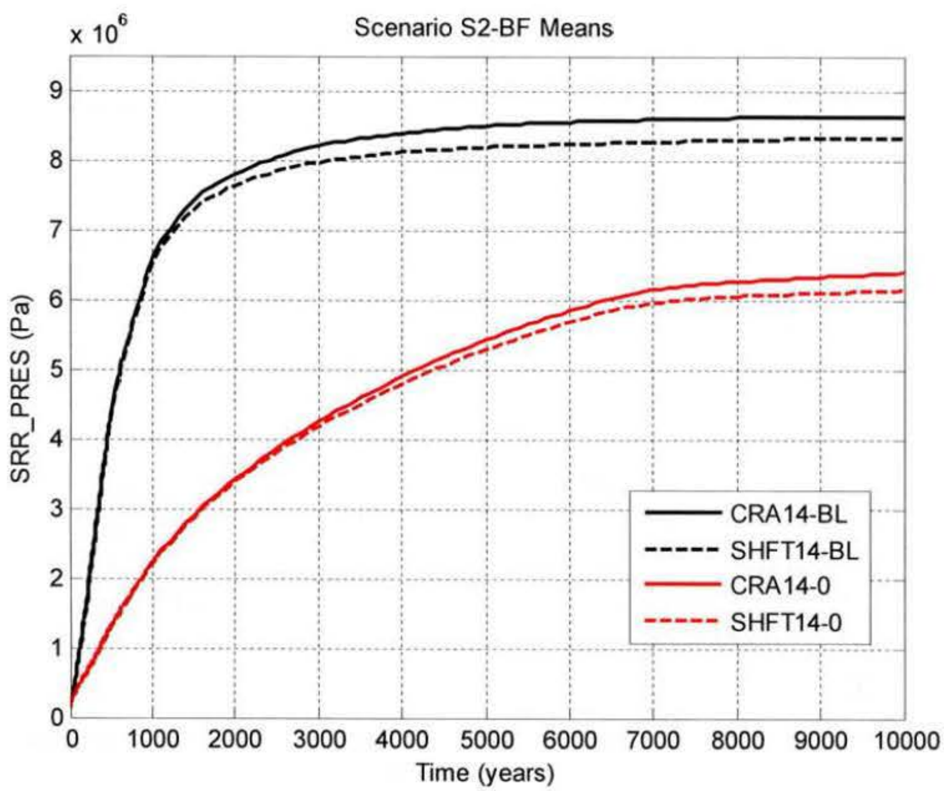

Figure 5-14: Pressure Means for the South Rest-of-Repository, Scenario S2-BF

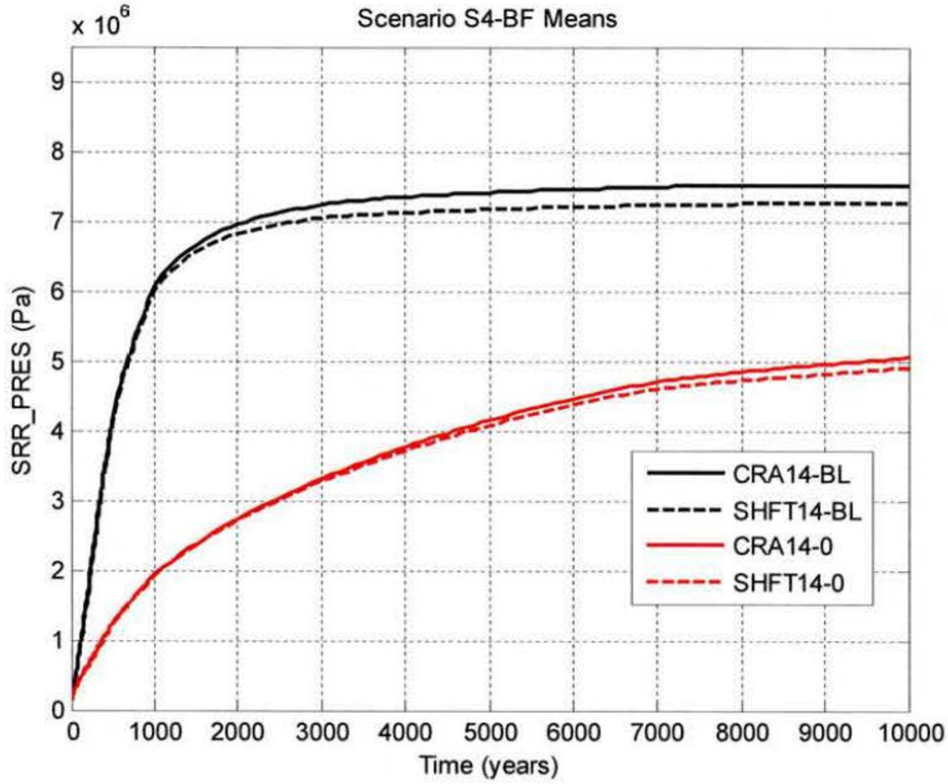

Figure 5-15: Pressure Means for the South Rest-of-Repository, Scenario S4-BF

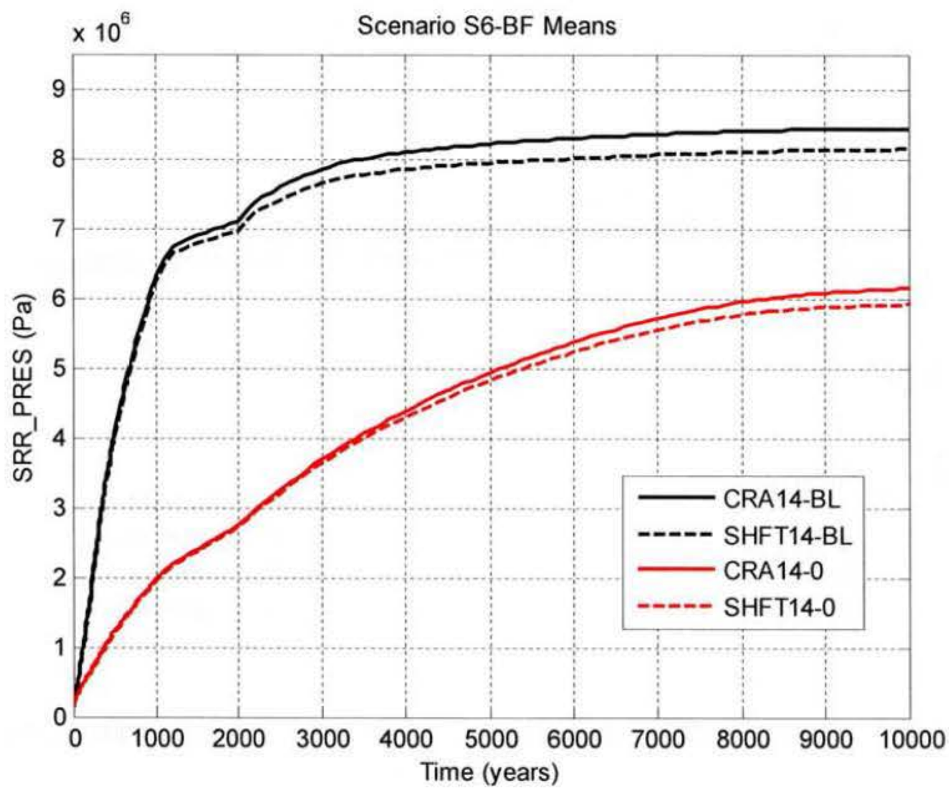

Figure 5-16: Pressure Means for the South Rest-of-Repository, Scenario S6-BF

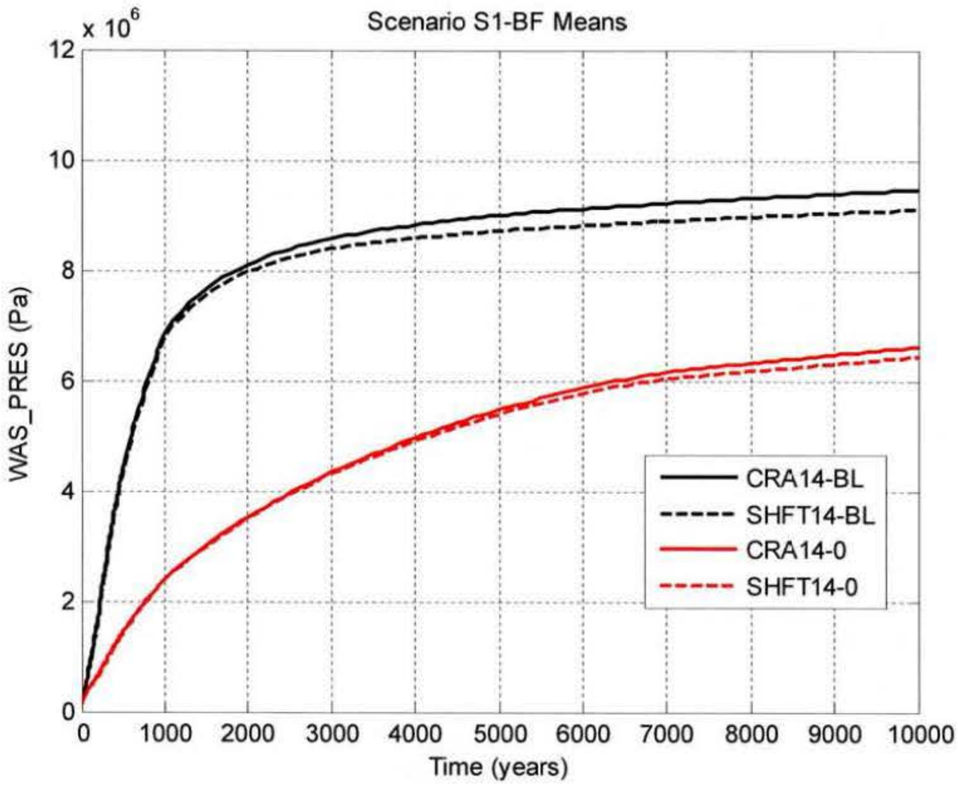

Figure 5-17: Pressure Means for the Waste Panel, Scenario S1-BF

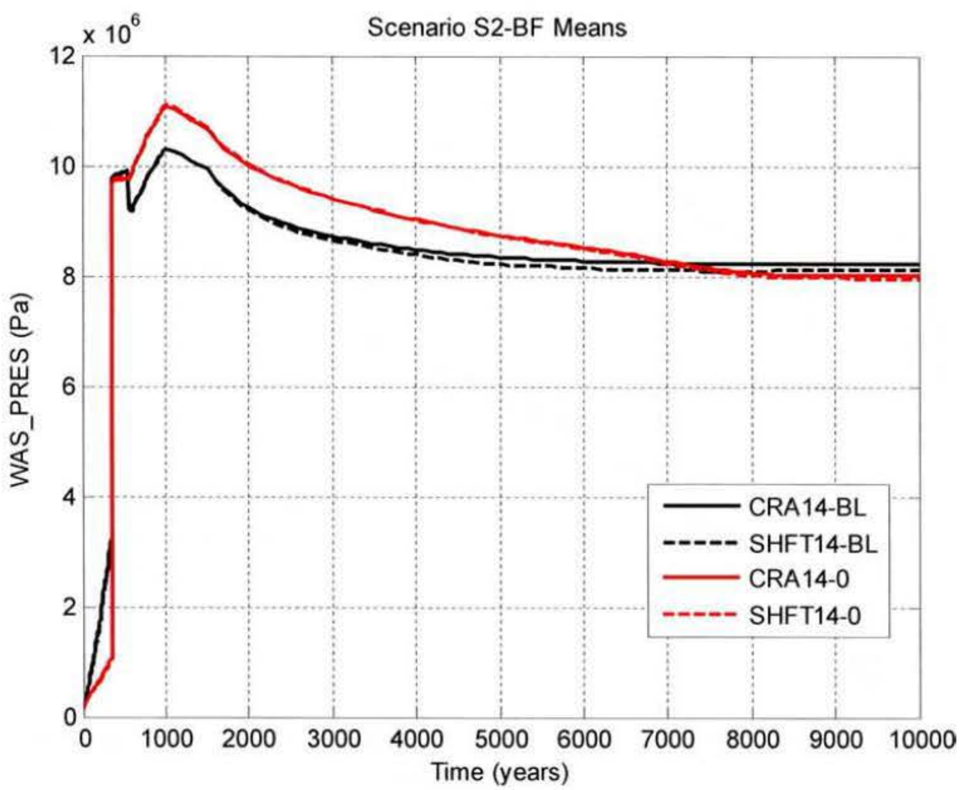

Figure 5-18: Pressure Means for the Waste Panel, Scenario S2-BF

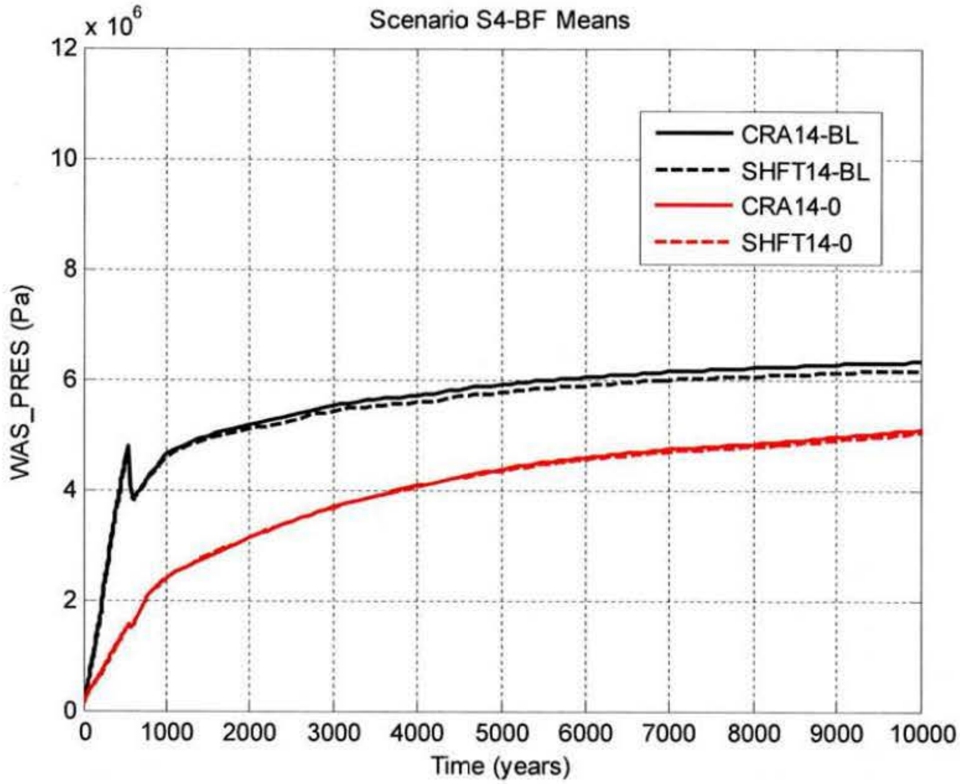

Figure 5-19: Pressure Means for the Waste Panel, Scenario S4-BF

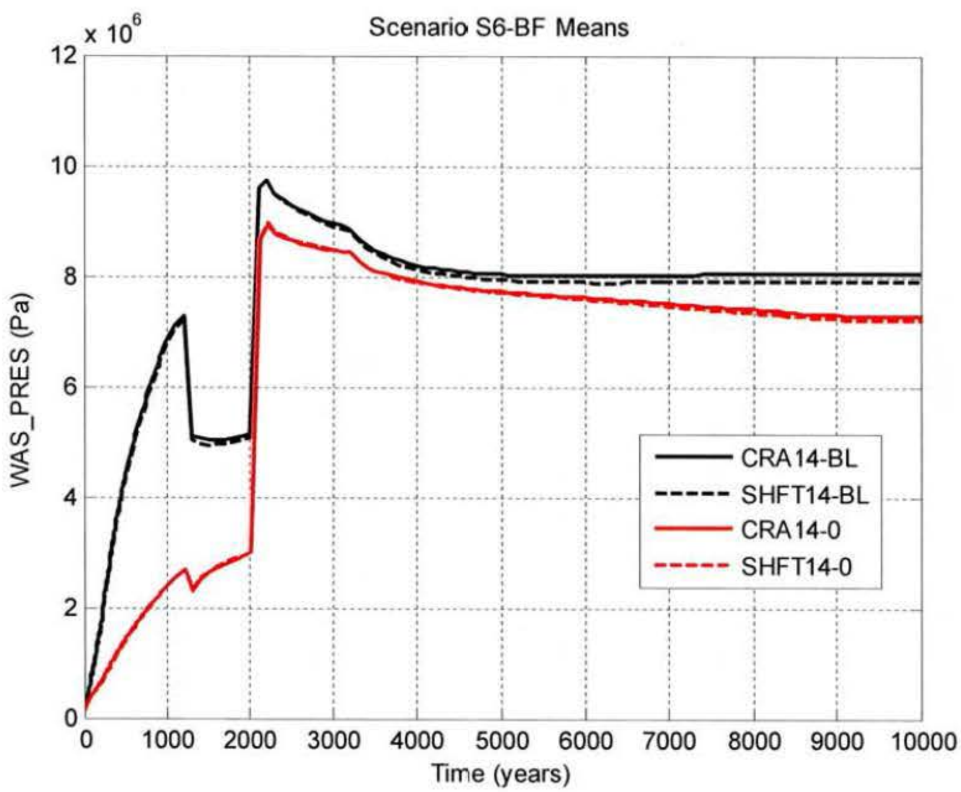

Figure 5-20: Pressure Means for the Waste Panel, Scenario S6-BF

Table 5-1: Pressure Statistics for Cases CRA14-BL and SHFT14-BL

Quantity (units)	Description	Scenario	Mean Value (at 10,000 years)		Maximum Value	
			CRA14-BL	SHFT14-BL	CRA14-BL	SHFT14-BL
EXP_PRES (MPa)	Pressure in the Experimental Region	S1-BF	8.02	7.40	14.35	13.62
		S2-BF	7.72	7.16	13.23	12.86
		S4-BF	6.91	6.36	13.23	12.85
		S6-BF	7.54	7.00	13.20	12.84
OPS_PRES (MPa)	Pressure in the Operations Region	S1-BF	8.05	7.41	14.41	13.67
		S2-BF	7.75	7.17	13.32	12.92
		S4-BF	6.94	6.37	13.32	12.92
		S6-BF	7.57	7.01	13.30	12.91
NRR_PRES (MPa)	Pressure in the North Rest-of-Repository	S1-BF	8.88	8.37	15.92	15.88
		S2-BF	8.49	8.07	15.94	15.86
		S4-BF	7.59	7.21	15.92	15.84
		S6-BF	8.31	7.90	15.91	15.85
SRR_PRES (MPa)	Pressure in the South Rest-of-Repository	S1-BF	9.18	8.76	15.97	15.94
		S2-BF	8.64	8.33	15.99	15.94
		S4-BF	7.53	7.26	15.97	15.91
		S6-BF	8.44	8.14	15.97	15.92
WAS_PRES (MPa)	Pressure in the Southernmost Waste Panel	S1-BF	9.46	9.10	15.90	15.85
		S2-BF	8.24	8.11	16.31	16.32
		S4-BF	6.32	6.17	14.10	14.23
		S6-BF	8.06	7.92	14.48	14.43

Table 5-2: Pressure Statistics for Cases CRA14-0 and SHFT14-0

Quantity (units)	Description	Scenario	Mean Value (at 10,000 years)		Maximum Value	
			CRA14-0	SHFT14-0	CRA14-0	SHFT14-0
EXP_PRES (MPa)	Pressure in the Experimental Region	S1-BF	4.69	4.23	14.27	13.77
		S2-BF	5.23	4.74	14.20	13.81
		S4-BF	4.16	3.75	13.84	13.29
		S6-BF	4.99	4.51	13.88	13.34
OPS_PRES (MPa)	Pressure in the Operations Region	S1-BF	4.73	4.25	14.34	13.83
		S2-BF	5.27	4.76	14.28	13.86
		S4-BF	4.20	3.77	13.92	13.35
		S6-BF	5.03	4.53	13.96	13.40
NRR_PRES (MPa)	Pressure in the North Rest-of-Repository	S1-BF	5.49	5.17	15.71	15.66
		S2-BF	6.03	5.69	15.66	15.59
		S4-BF	4.85	4.61	15.62	15.57
		S6-BF	5.78	5.46	15.63	15.59
SRR_PRES (MPa)	Pressure in the South Rest-of-Repository	S1-BF	5.91	5.68	15.85	15.83
		S2-BF	6.39	6.14	15.80	15.80
		S4-BF	5.06	4.91	15.79	15.79
		S6-BF	6.15	5.92	15.81	15.79
WAS_PRES (MPa)	Pressure in the Southernmost Waste Panel	S1-BF	6.63	6.44	15.73	15.72
		S2-BF	8.02	7.96	16.15	16.15
		S4-BF	5.10	5.03	14.85	14.89
		S6-BF	7.29	7.21	14.96	15.02

5.2 Brine Flow

Pressure reductions in repository waste regions typically result in increased brine inflow to those areas. As seen in the pressure results already discussed, the addition of the two access drifts for the proposed exhaust shaft lowers the mean pressure in repository waste regions. The impact of this pressure reduction on cumulative brine inflow to the north rest-of-repository waste area can be seen in Figure 5-21 to Figure 5-24. As seen in those figures, mean brine inflows to the northernmost repository waste region are slightly elevated in all scenarios when the new shaft and its drifts are included in the BRAGFLO grid. Moreover, brine inflow results for this region are nearly identical over all scenarios considered in BRAGFLO.

Brine inflow results for the south rest-of-repository waste region are shown in Figure 5-25 to Figure 5-28. The pressure reduction in this region leads to slightly elevated brine inflows as compared to the CRA-2014 PA results.

Mean brine inflows to the southernmost waste panel modeled in BRAGFLO are very slightly increased when the additional shaft and access drifts are included in the repository representation. From the results already discussed, mean pressures in the southernmost waste panel are nearly identical to, but slightly lower than, those seen in the CRA-2014 PA when the proposed shaft and its access drifts are added. The distance of the southernmost waste panel from the repository north end (as well as intermittent panel closures) essentially insulates it from impacts associated with the proposed shaft and its access drifts. As seen in Figure 5-29 to Figure 5-32, the mean brine inflow to the waste panel obtained for case SHFT14-BL is nearly identical to that found for case CRA14-BL, over all BRAGFLO scenarios. The same behavior is also true for cases SHFT14-0 and CRA14-0.

The addition of the proposed exhaust shaft and its access drifts yields lower mean pressures in the operations and experimental regions. The composite shaft is located between these regions in the BRAGFLO repository representation (see Figure 2-2). Pressure reductions in the operations and experimental regions lead to a reduction in pressure around the shaft base. Consequently, the cumulative volume of brine ejected up the shaft is reduced when the additional exhaust shaft and its drifts are added to the BRAGFLO grid. Mean brine flows up the repository shafts are very small in the CRA-2014 PA results, less than 6 m^3 over 10,000 years in all scenarios, and are even smaller when the additional shaft and access drifts are included in the repository representation (see Figure 5-33 to Figure 5-36).

Mean brine flows up the intrusion borehole are only slightly impacted by the additional shaft and its access drifts. As already discussed, pressures in, and brine inflows to, the southernmost waste panel are barely affected by the addition of the proposed exhaust shaft and its access drifts. Consequently, as seen in Figure 5-37 to Figure 5-39, mean brine flows up the intrusion borehole are nearly identical to results found in the CRA-2014 PA.

Brine flow summary statistics are given in Table 5-3 and Table 5-4. In those tables, means are calculated at 10,000 years over all vectors obtained in each particular case. As discussed, the trend is for slightly increased brine inflow to the repository waste regions when the proposed shaft and its drifts are represented. Brine flows up the intrusion borehole are negligibly impacted while flows up the composite shaft are reduced (on average).

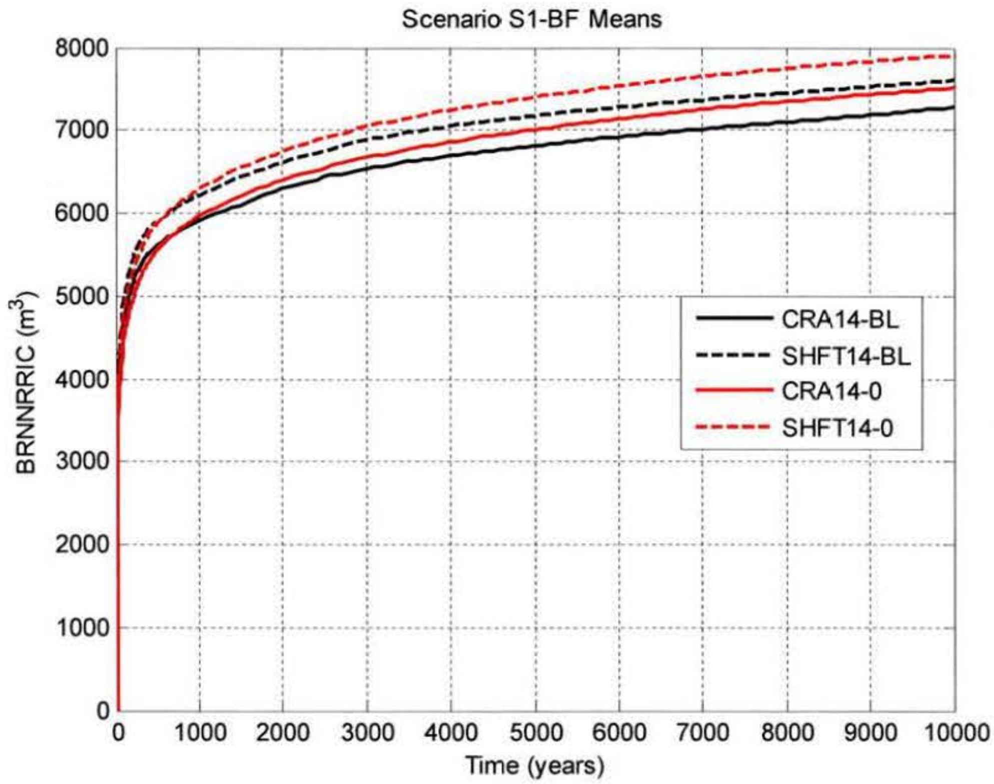

Figure 5-21: Cumulative Brine Inflow to the North Rest-of-Repository, Scenario S1-BF

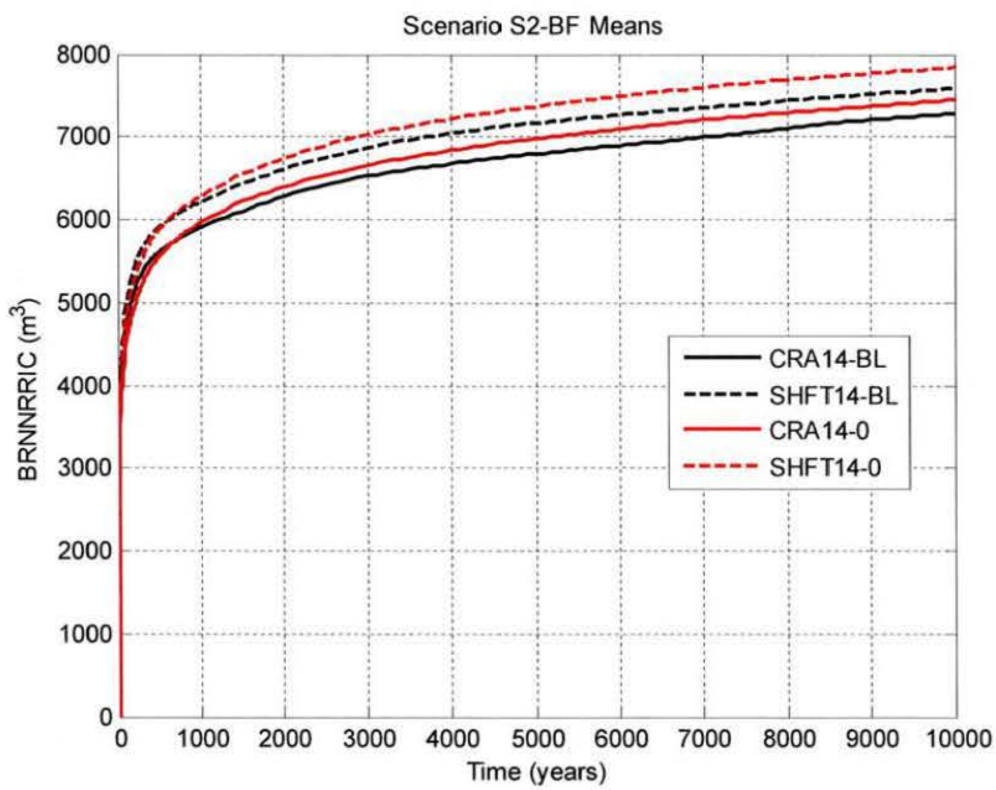

Figure 5-22: Cumulative Brine Inflow to the North Rest-of-Repository, Scenario S2-BF

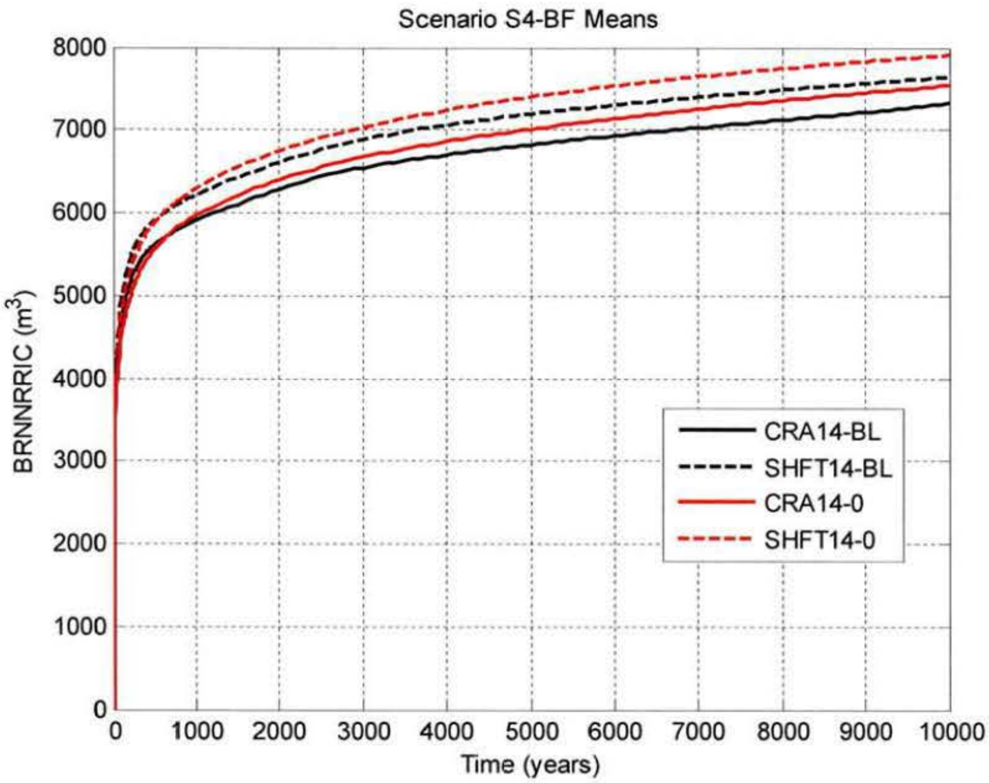

Figure 5-23: Cumulative Brine Inflow to the North Rest-of-Repository, Scenario S4-BF

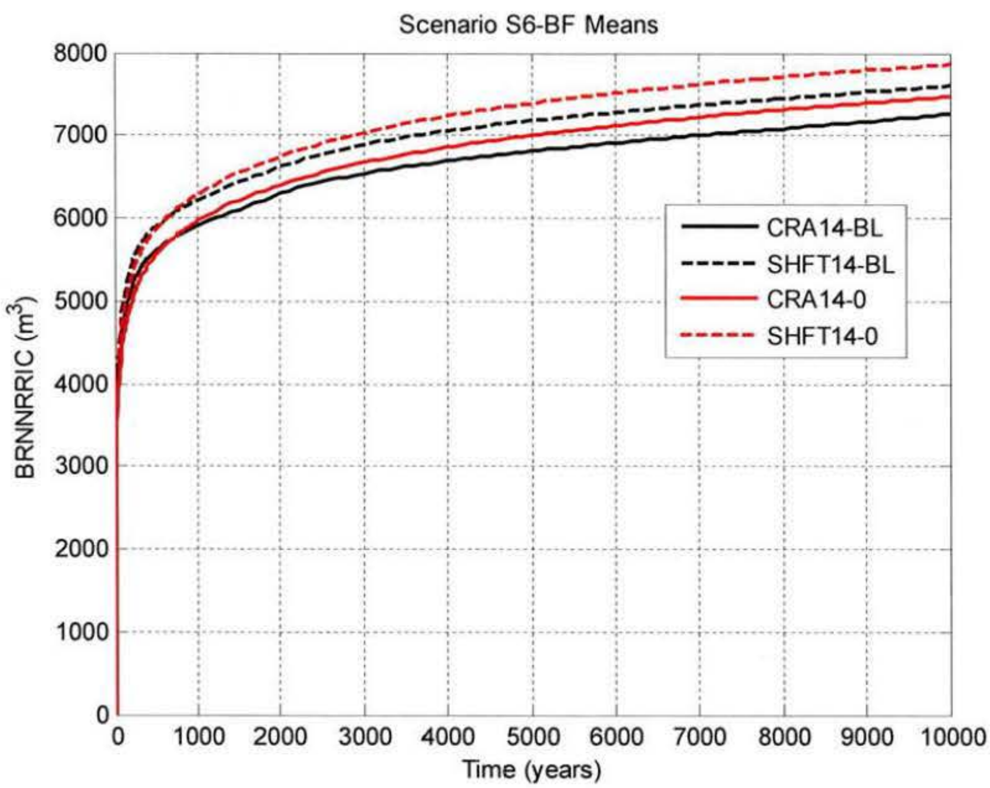

Figure 5-24: Cumulative Brine Inflow to the North Rest-of-Repository, Scenario S6-BF

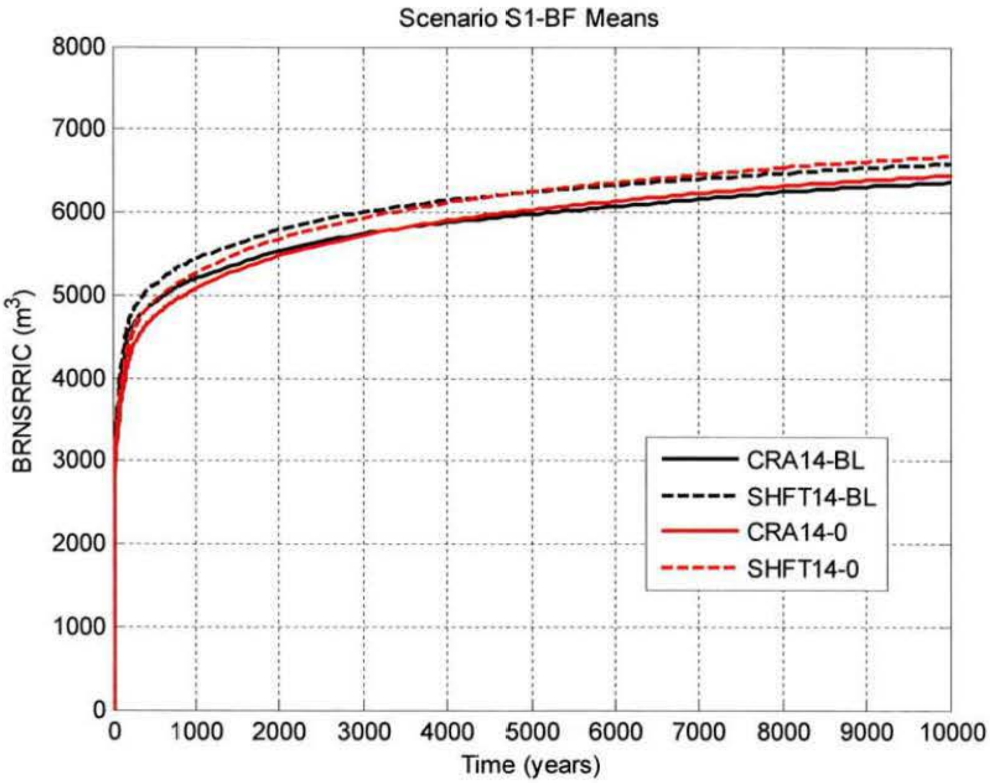

Figure 5-25: Cumulative Brine Inflow to the South Rest-of-Repository, Scenario S1-BF

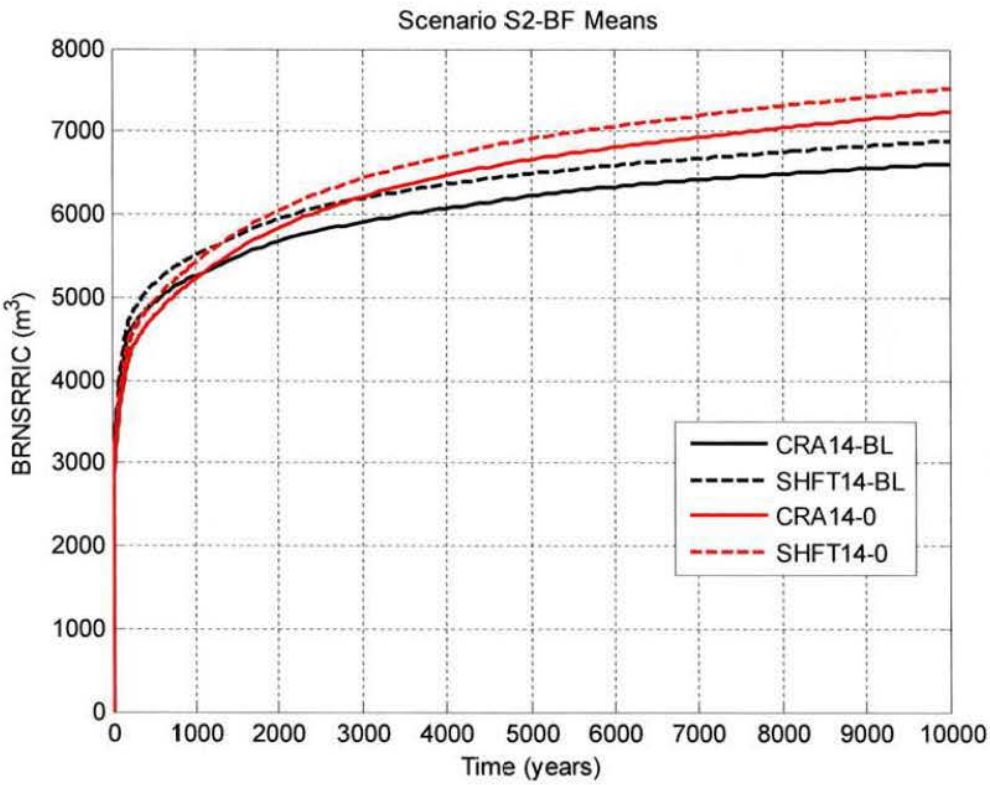

Figure 5-26: Cumulative Brine Inflow to the South Rest-of-Repository, Scenario S2-BF

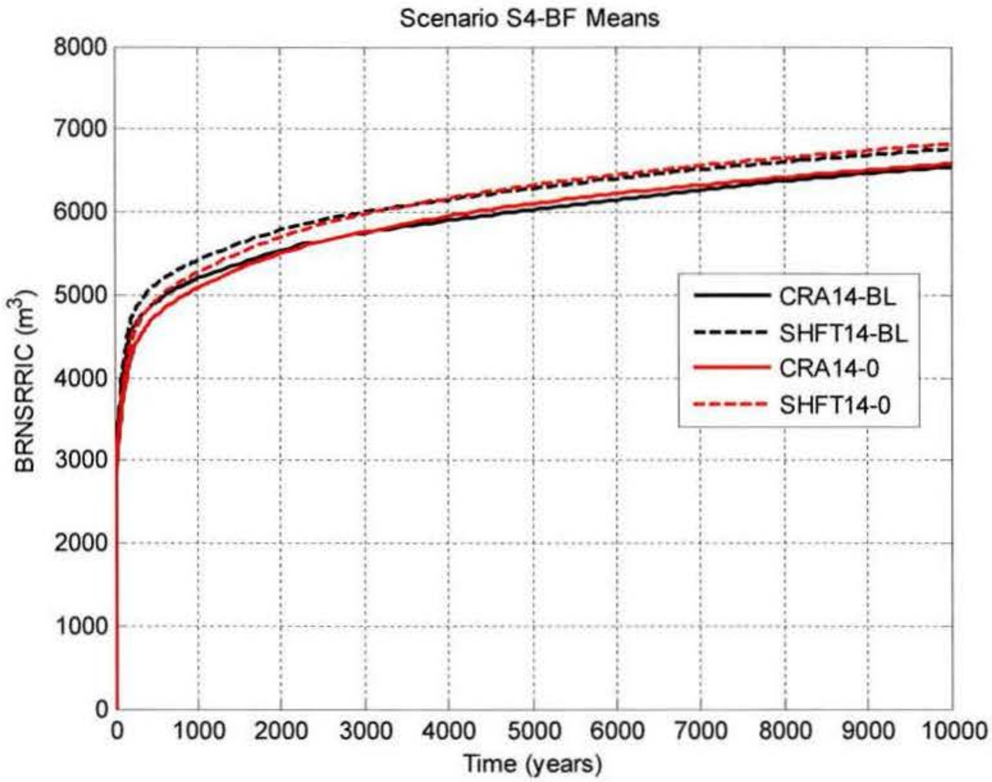

Figure 5-27: Cumulative Brine Inflow to the South Rest-of-Repository, Scenario S4-BF

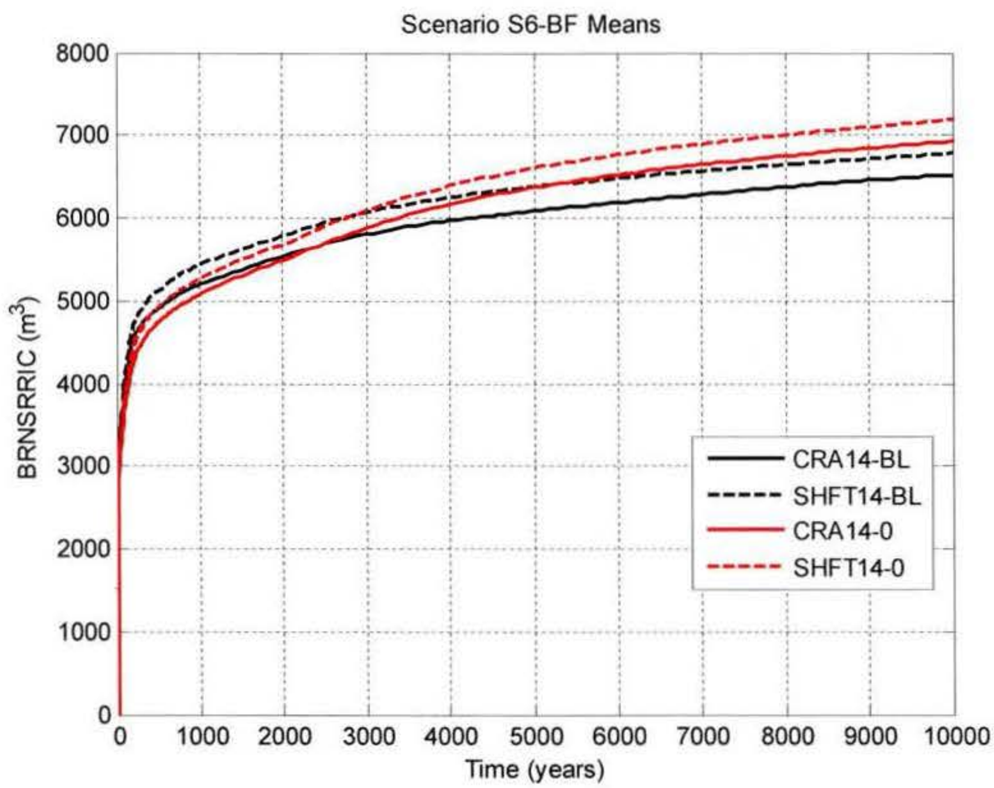

Figure 5-28: Cumulative Brine Inflow to the South Rest-of-Repository, Scenario S6-BF

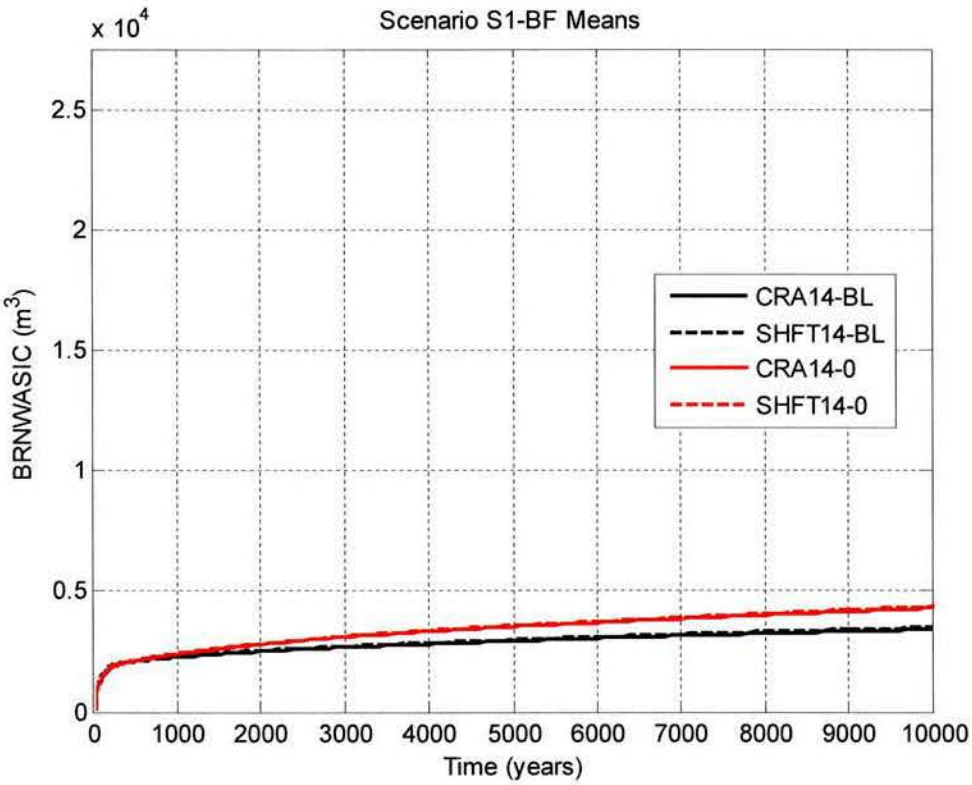

Figure 5-29: Cumulative Brine Inflow to the Waste Panel, Scenario S1-BF

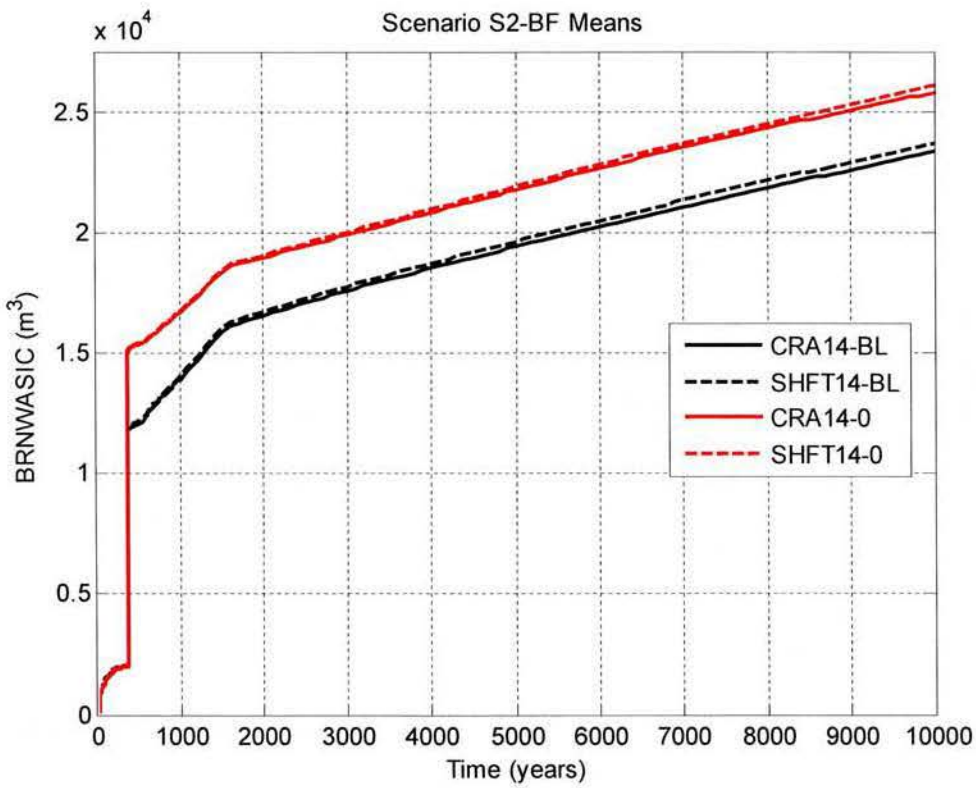

Figure 5-30: Cumulative Brine Inflow to the Waste Panel, Scenario S2-BF

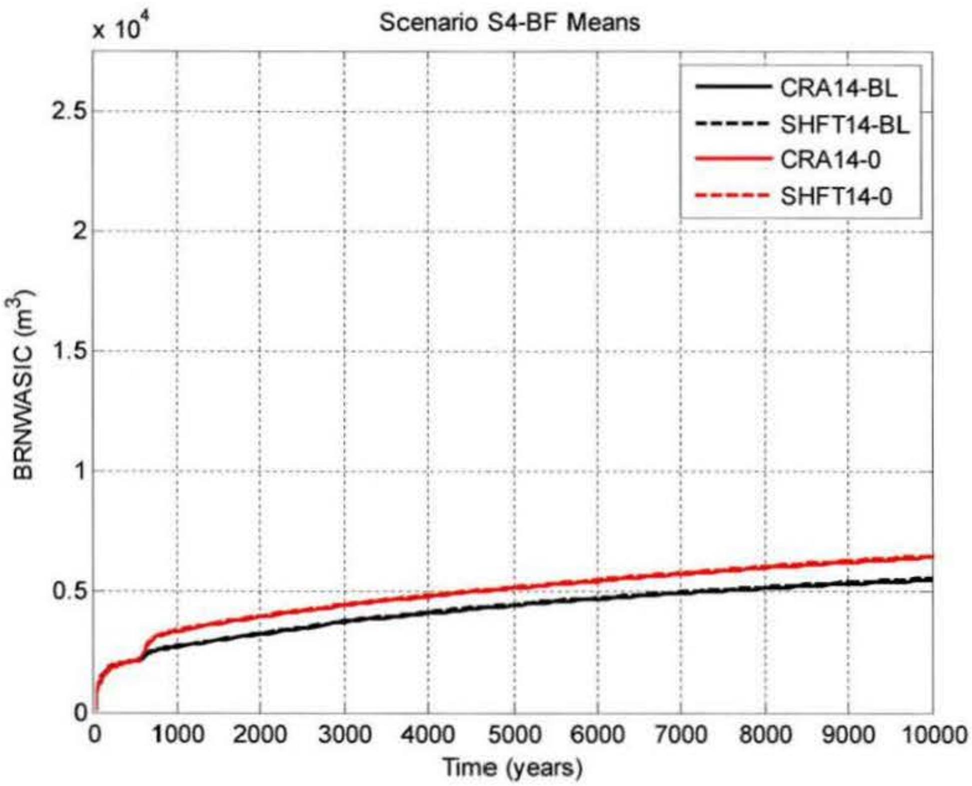

Figure 5-31: Cumulative Brine Inflow to the Waste Panel, Scenario S4-BF

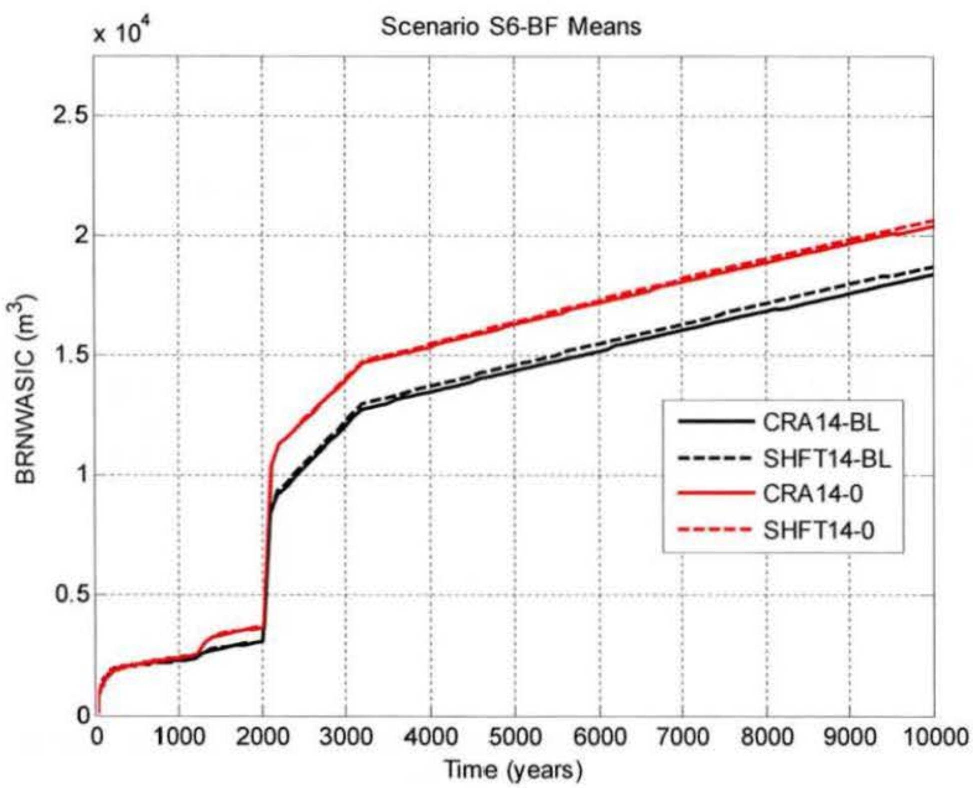

Figure 5-32: Cumulative Brine Inflow to the Waste Panel, Scenario S6-BF

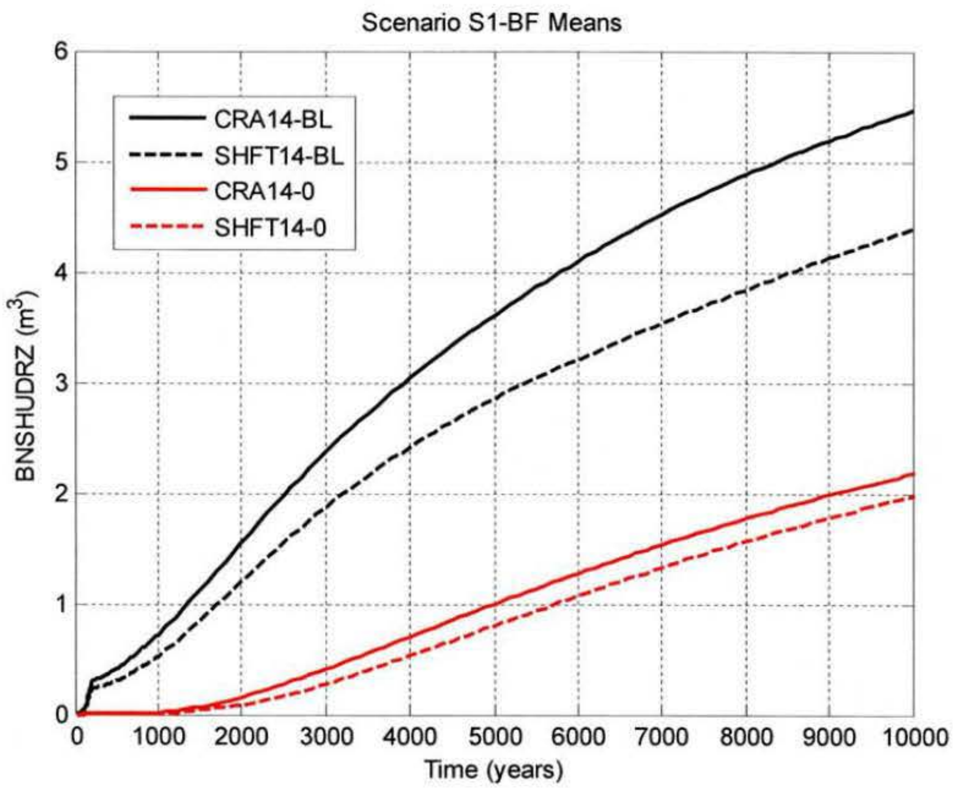

Figure 5-33: Cumulative Brine Flow up the Shaft, Scenario S1-BF

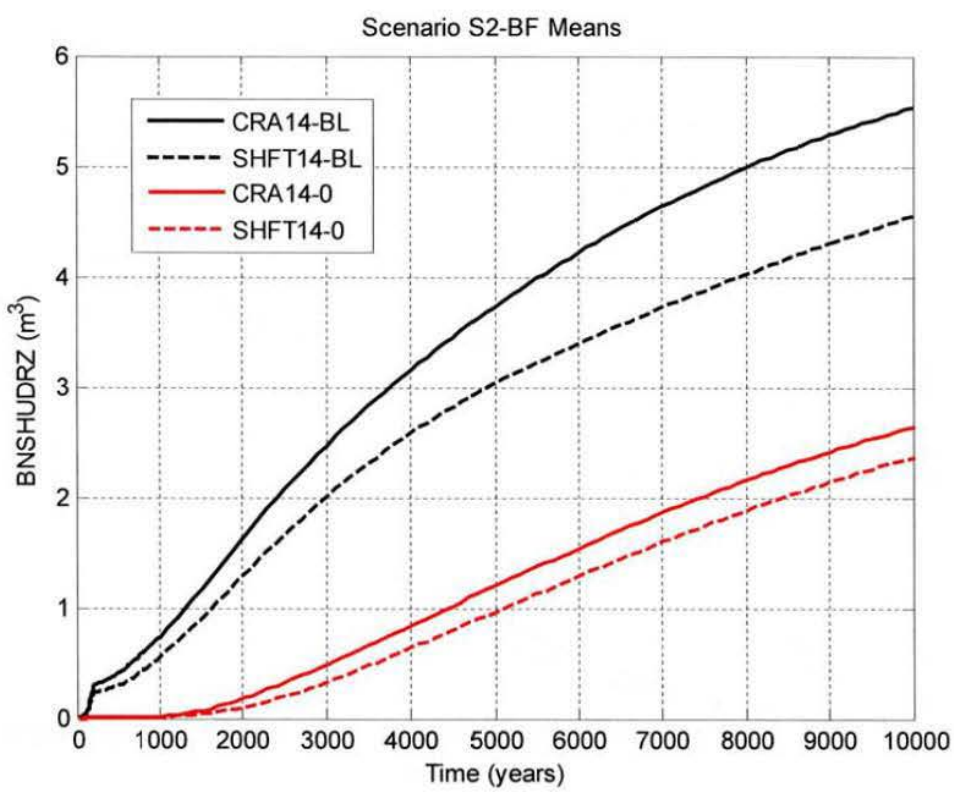

Figure 5-34: Cumulative Brine Flow up the Shaft, Scenario S2-BF

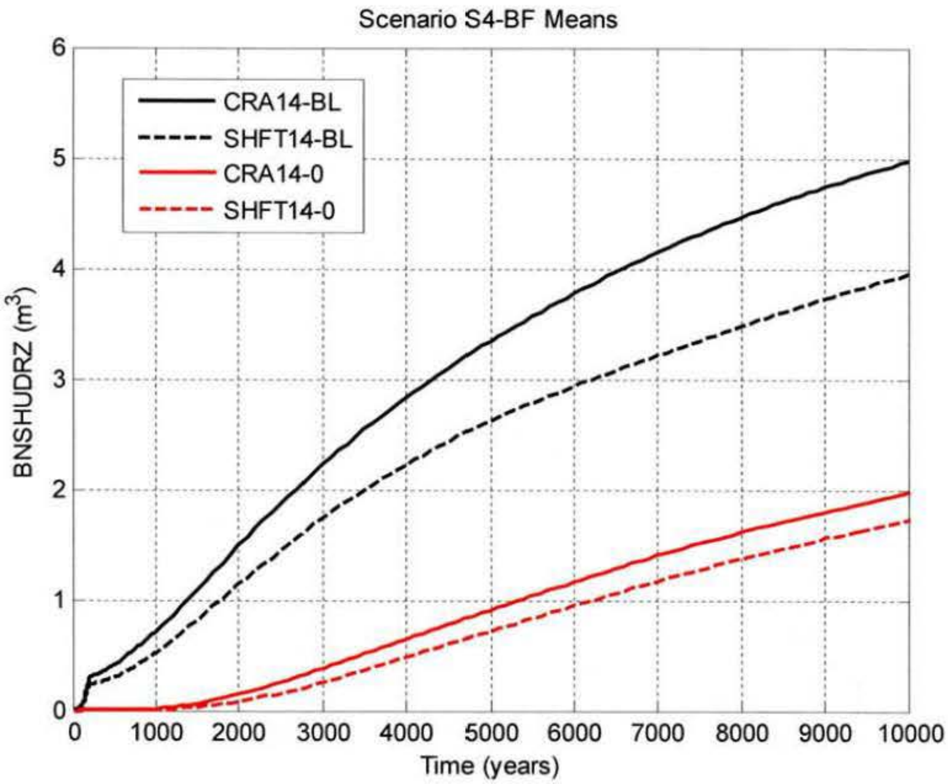

Figure 5-35: Cumulative Brine Flow up the Shaft, Scenario S4-BF

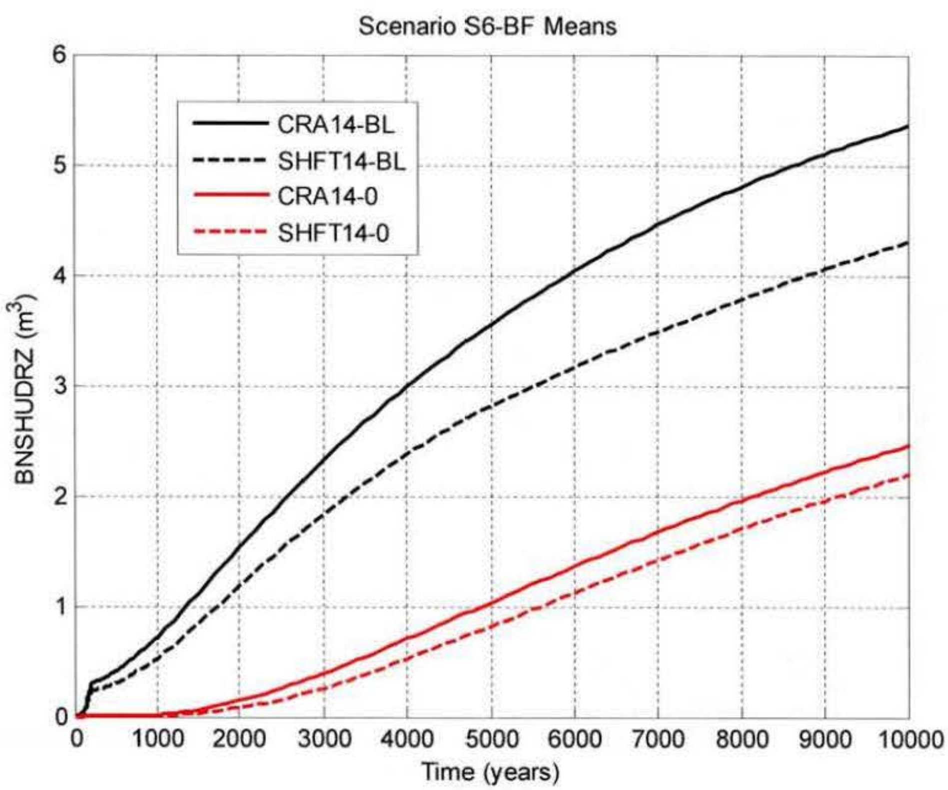

Figure 5-36: Cumulative Brine Flow up the Shaft, Scenario S6-BF

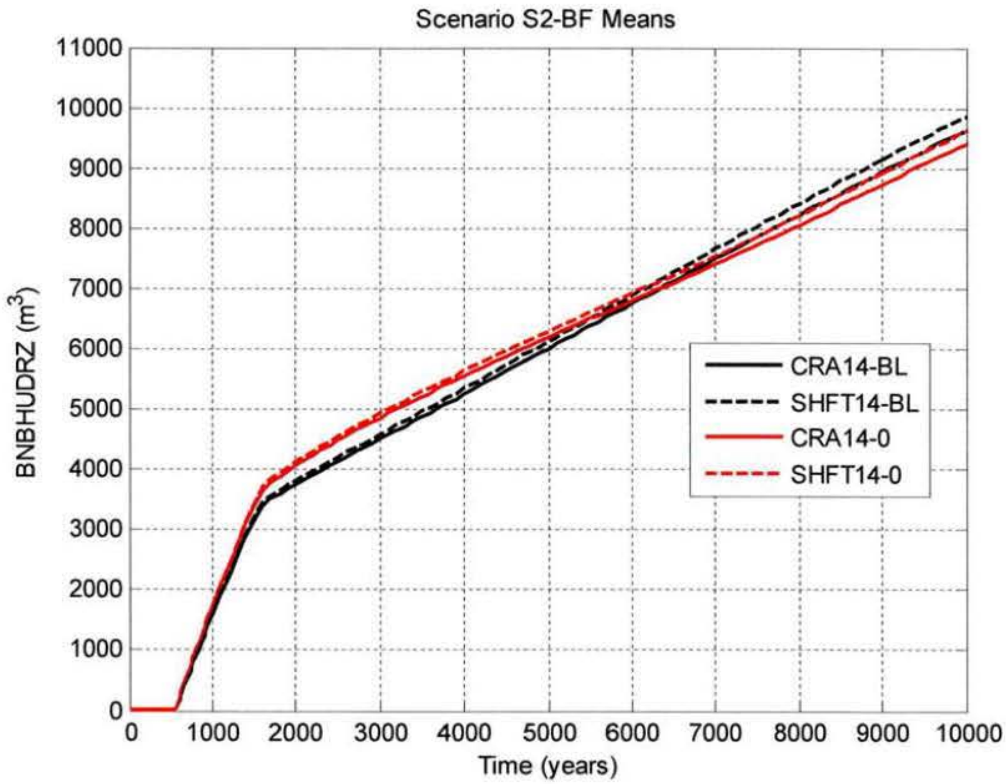

Figure 5-37: Cumulative Brine Flow up the Borehole, Scenario S2-BF

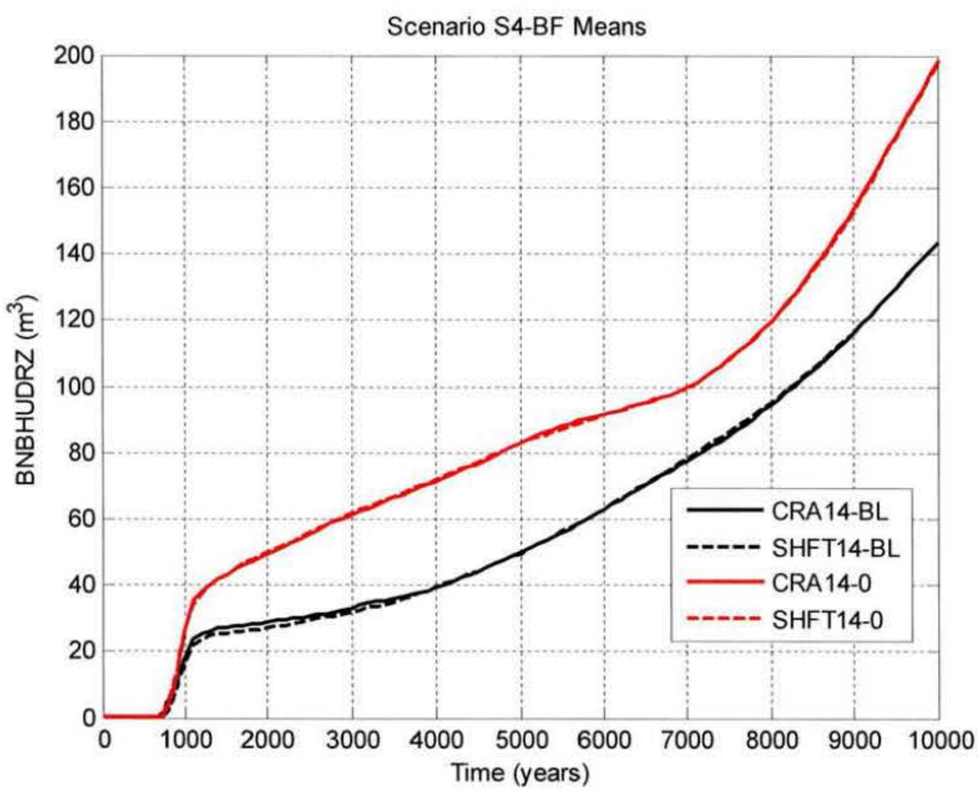

Figure 5-38: Cumulative Brine Flow up the Borehole, Scenario S4-BF

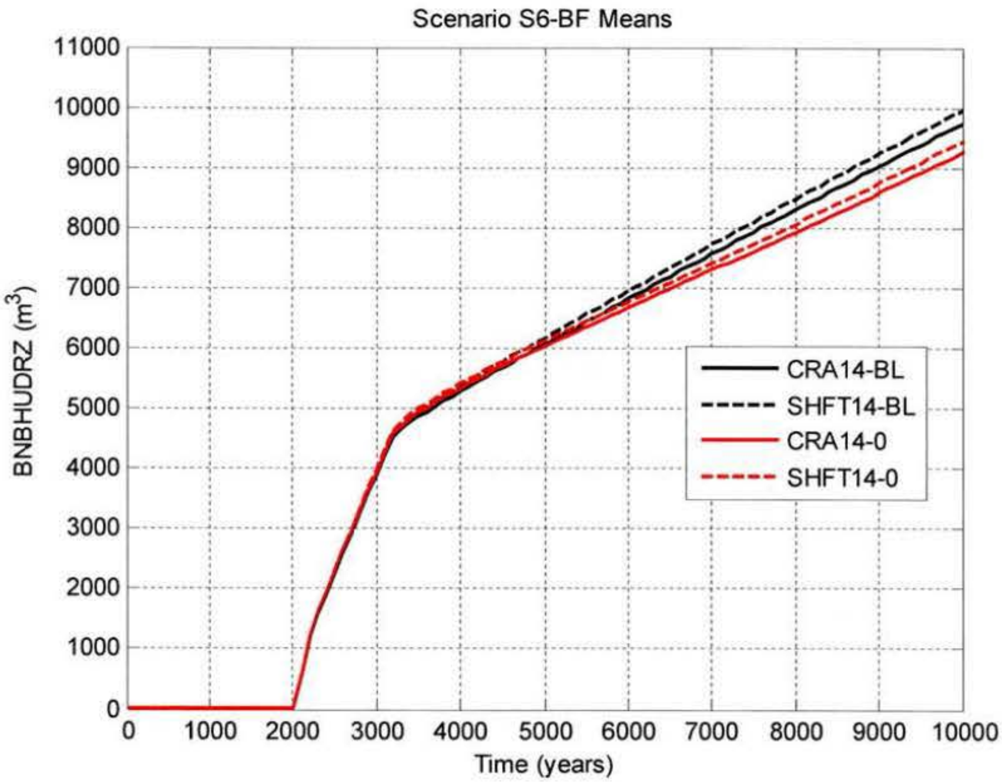

Figure 5-39: Cumulative Brine Flow up the Borehole, Scenario S6-BF

Table 5-3: Cumulative Brine Flow Statistics for Cases CRA14-BL and SHFT14-BL

Quantity (units)	Description	Scenario	Mean Value (at 10,000 years)		Maximum Value	
			CRA14-BL	SHFT14-BL	CRA14-BL	SHFT14-BL
BRNWASIC ($\times 10^3$ m^3)	Cumulative brine flow into the southernmost waste panel	S1-BF	3.40	3.49	16.59	17.06
		S2-BF	23.32	23.68	186.77	192.83
		S4-BF	5.52	5.59	17.90	18.57
		S6-BF	18.34	18.72	182.70	188.57
BRNSRRIC ($\times 10^3$ m^3)	Cumulative brine flow into the south rest-of-repository	S1-BF	6.36	6.59	41.94	47.98
		S2-BF	6.62	6.89	42.11	48.43
		S4-BF	6.54	6.77	43.00	48.50
		S6-BF	6.52	6.79	42.70	48.62
BRNNRRIC ($\times 10^3$ m^3)	Cumulative brine flow into the north rest-of-repository	S1-BF	7.28	7.60	31.28	40.05
		S2-BF	7.29	7.59	31.32	39.81
		S4-BF	7.32	7.65	31.45	40.77
		S6-BF	7.27	7.61	31.46	40.12
BNBHUDRZ ($\times 10^3$ m^3)	Cumulative brine flow up the intrusion borehole	S1-BF	-	-	-	-
		S2-BF	9.64	9.87	174.16	180.18
		S4-BF	0.144	0.144	1.78	1.80
		S6-BF	9.73	9.96	173.83	179.64
BNSHUDRZ (m^3)	Cumulative brine flow up the composite shaft	S1-BF	5.46	4.39	22.55	23.07
		S2-BF	5.54	4.55	23.17	22.22
		S4-BF	4.98	3.95	22.44	21.81
		S6-BF	5.35	4.30	22.78	22.46

Table 5-4: Cumulative Brine Flow Statistics for Cases CRA14-0 and SHFT14-0

Quantity (units)	Description	Scenario	Mean Value (at 10,000 years)		Maximum Value	
			CRA14-0	SHFT14-0	CRA14-0	SHFT14-0
BRNWASIC ($\times 10^3$ m^3)	Cumulative brine flow into the southernmost waste panel	S1-BF	4.28	4.35	16.40	18.05
		S2-BF	25.79	26.06	187.90	194.21
		S4-BF	6.46	6.53	21.04	21.50
		S6-BF	20.41	20.62	184.74	190.54
BRNSRRIC ($\times 10^3$ m^3)	Cumulative brine flow into the south rest-of-repository	S1-BF	6.45	6.68	49.73	51.44
		S2-BF	7.25	7.53	49.63	51.36
		S4-BF	6.58	6.82	49.55	51.74
		S6-BF	6.93	7.19	49.72	52.60
BRNNRRIC ($\times 10^3$ m^3)	Cumulative brine flow into the north rest-of-repository	S1-BF	7.52	7.91	39.27	46.20
		S2-BF	7.45	7.84	39.37	45.57
		S4-BF	7.54	7.91	39.39	45.45
		S6-BF	7.48	7.86	39.22	46.02
BNBHUDRZ ($\times 10^3$ m^3)	Cumulative brine flow up the intrusion borehole	S1-BF	-	-	-	-
		S2-BF	9.41	9.63	173.21	179.26
		S4-BF	0.198	0.198	5.39	5.41
		S6-BF	9.26	9.45	173.36	179.11
BNSHUDRZ (m^3)	Cumulative brine flow up the composite shaft	S1-BF	2.18	1.98	24.66	27.48
		S2-BF	2.65	2.37	23.35	25.71
		S4-BF	1.97	1.73	22.08	21.10
		S6-BF	2.46	2.19	22.81	25.25

5.3 Brine Saturation

Changes to brine inflow in repository waste areas can impact the brine saturation of the waste. As seen in the results already discussed, mean brine inflows to the north rest-of-repository waste region are slightly increased by the addition of the proposed shaft and its access drifts. Brine inflows to this region are practically identical for all BRAGFLO scenarios. Mean brine saturations in the north rest-of-repository are slightly increased, but nearly identical to those found in the CRA-2014 PA. As seen in Figure 5-40 to Figure 5-43, there is very little difference evident in the mean brine saturation curves calculated in this analysis and those from the CRA-2014 PA. Brine saturation results for the north rest-of-repository are practically identical over all BRAGFLO scenarios. The same is also true for brine saturations found for the south rest-of-repository waste region (see Figure 5-44 to Figure 5-47).

Mean brine saturations in the southernmost waste panel are very slightly increased when the proposed shaft and its access drifts are added to the BRAGFLO grid. As seen in Figure 5-48 to Figure 5-51, brine saturations for the intruded panel are nearly identical in this analysis and the CRA-2014 PA. The additional shaft and its access drifts have a negligible impact on the mean brine saturations seen in the southernmost waste panel.

Brine saturation summary statistics are given in Table 5-5 and Table 5-6. In those tables, means are calculated at 10,000 years over all vectors obtained in each particular case. The general trend is that brine saturations increase very slightly in repository waste regions when the proposed new shaft and its access drifts are included in the repository representation.

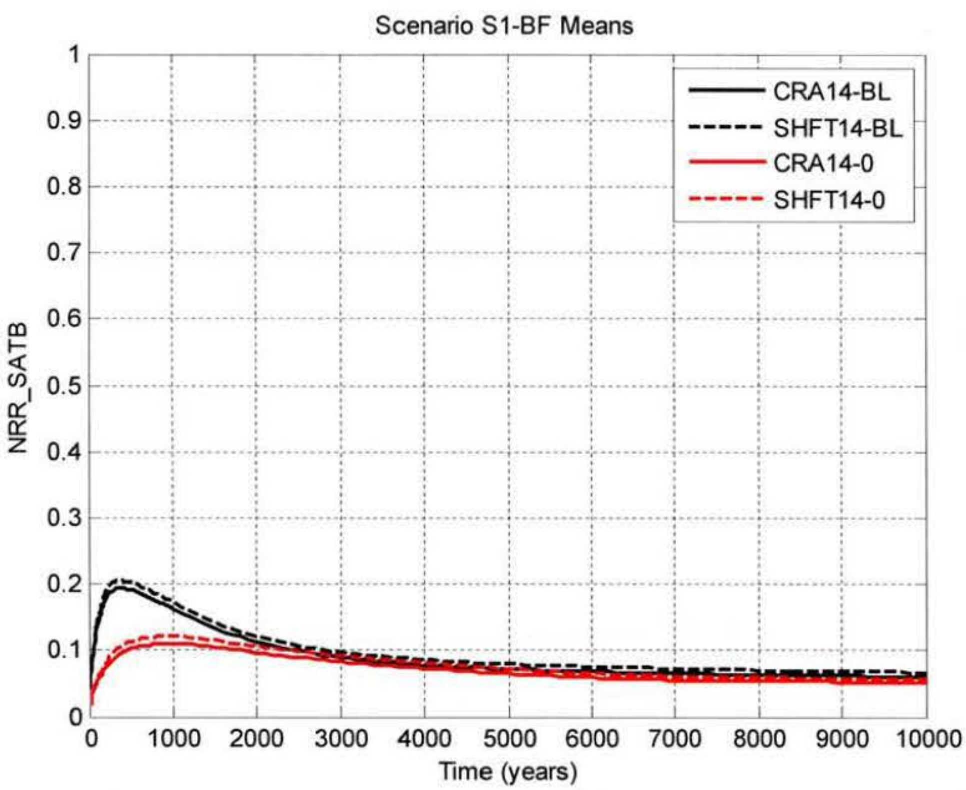

Figure 5-40: Mean Brine Saturations for the North Rest-of-Repository, Scenario S1-BF

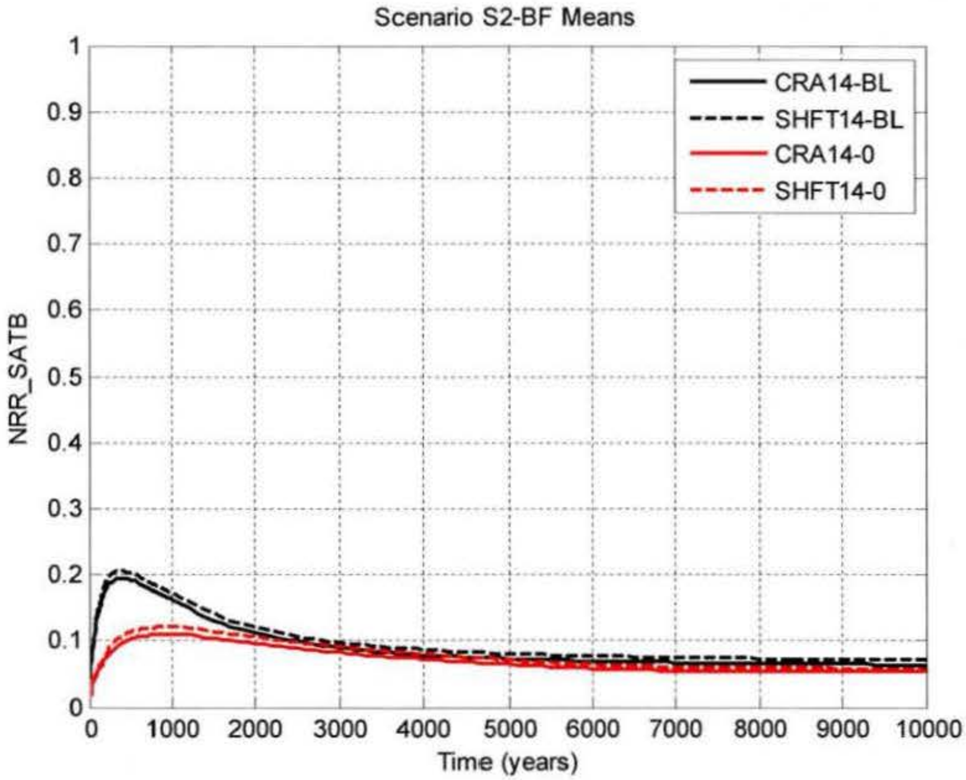

Figure 5-41: Mean Brine Saturations for the North Rest-of-Repository, Scenario S2-BF

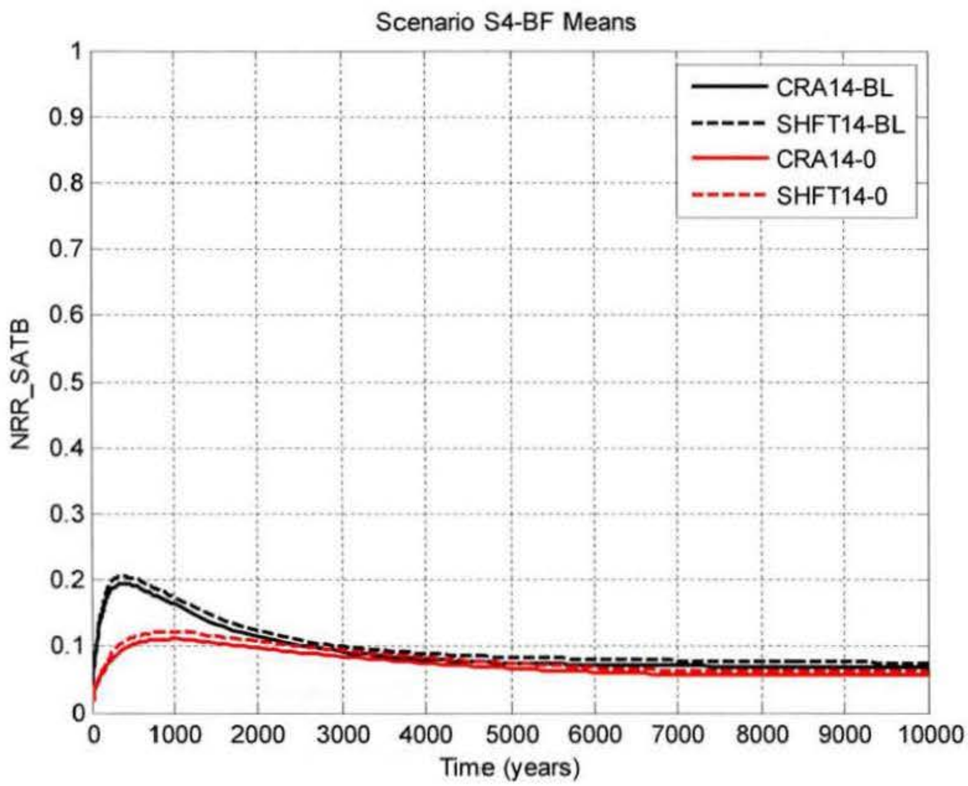

Figure 5-42: Mean Brine Saturations for the North Rest-of-Repository, Scenario S4-BF

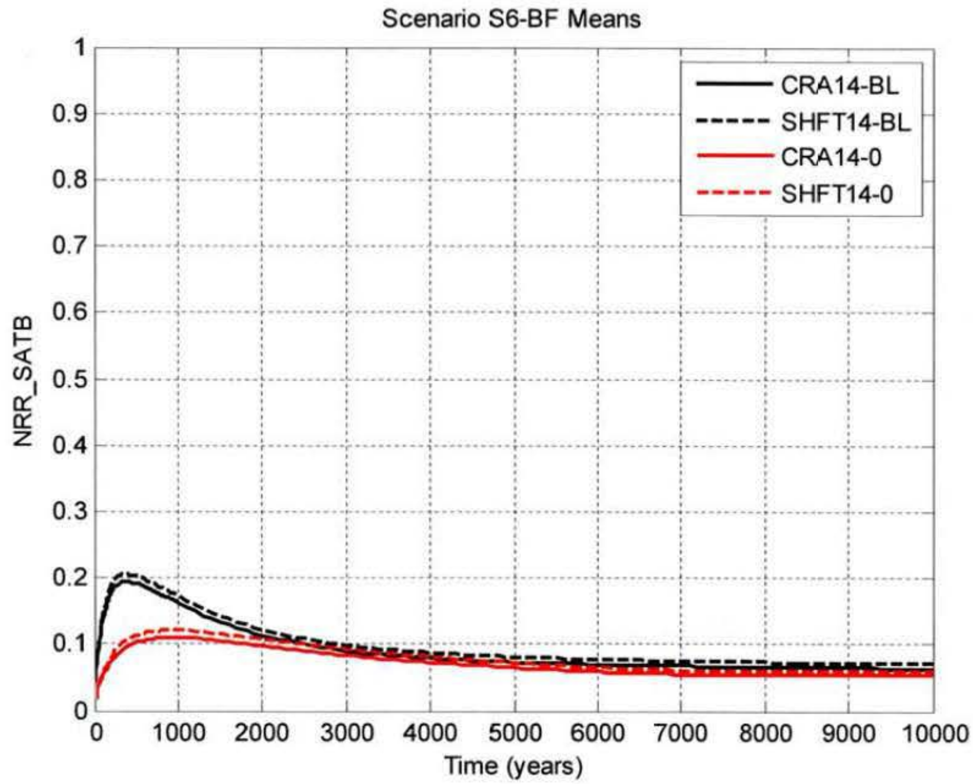

Figure 5-43: Mean Brine Saturations for the North Rest-of-Repository, Scenario S6-BF

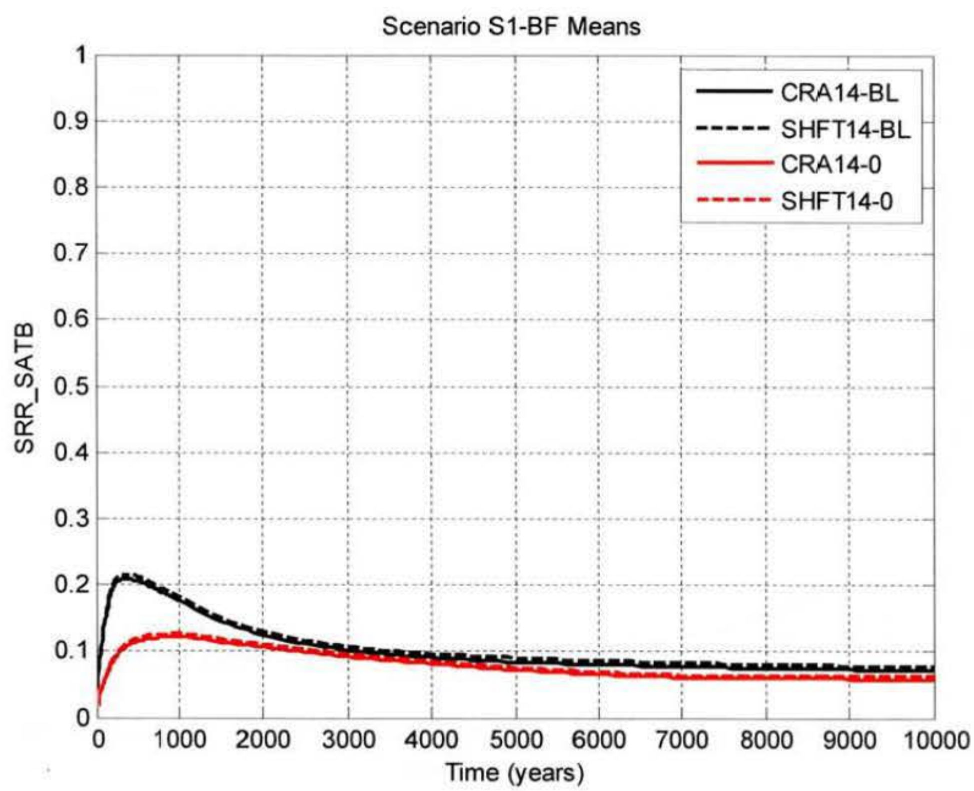

Figure 5-44: Mean Brine Saturations for the South Rest-of-Repository, Scenario S1-BF

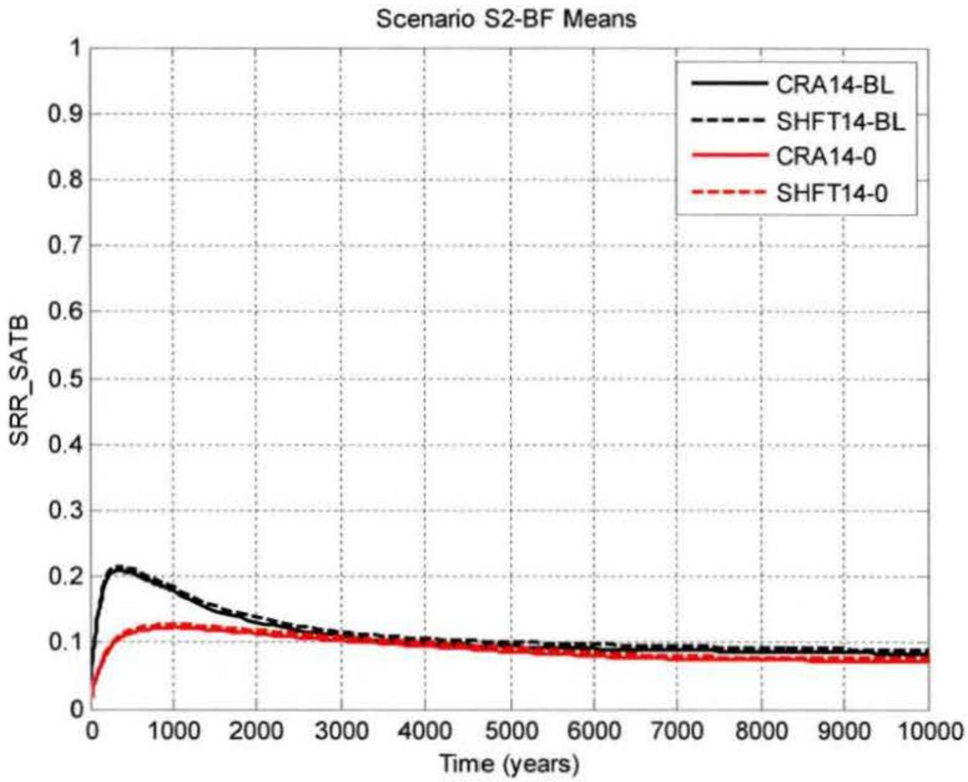

Figure 5-45: Mean Brine Saturations for the South Rest-of-Repository, Scenario S2-BF

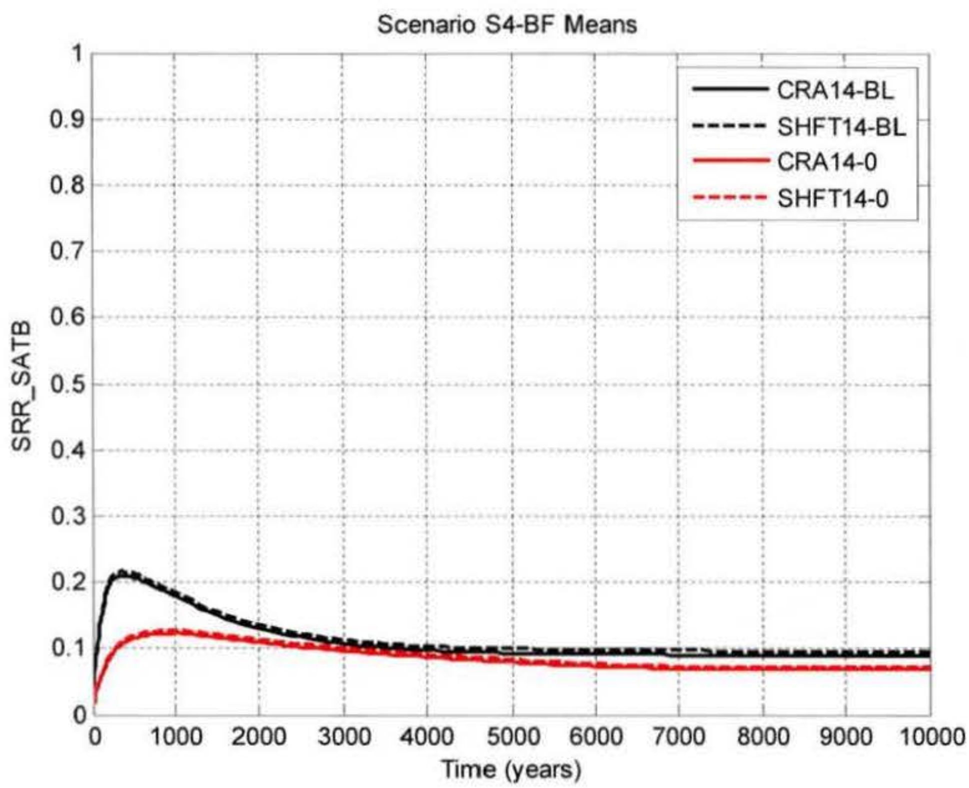

Figure 5-46: Mean Brine Saturations for the South Rest-of-Repository, Scenario S4-BF

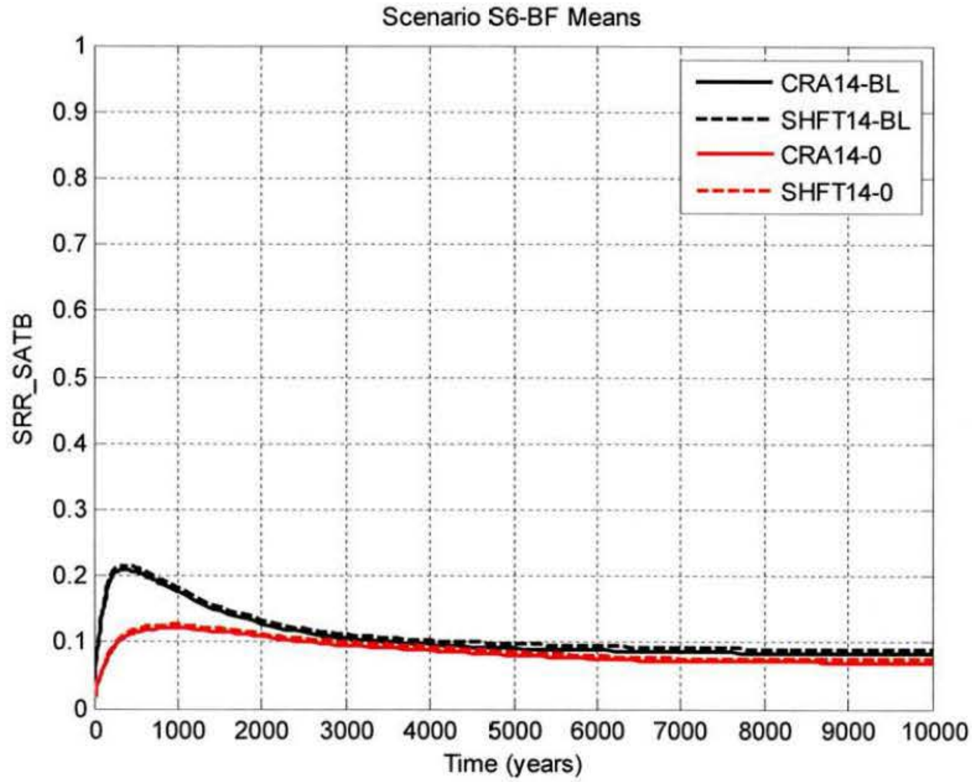

Figure 5-47: Mean Brine Saturations for the South Rest-of-Repository, Scenario S6-BF

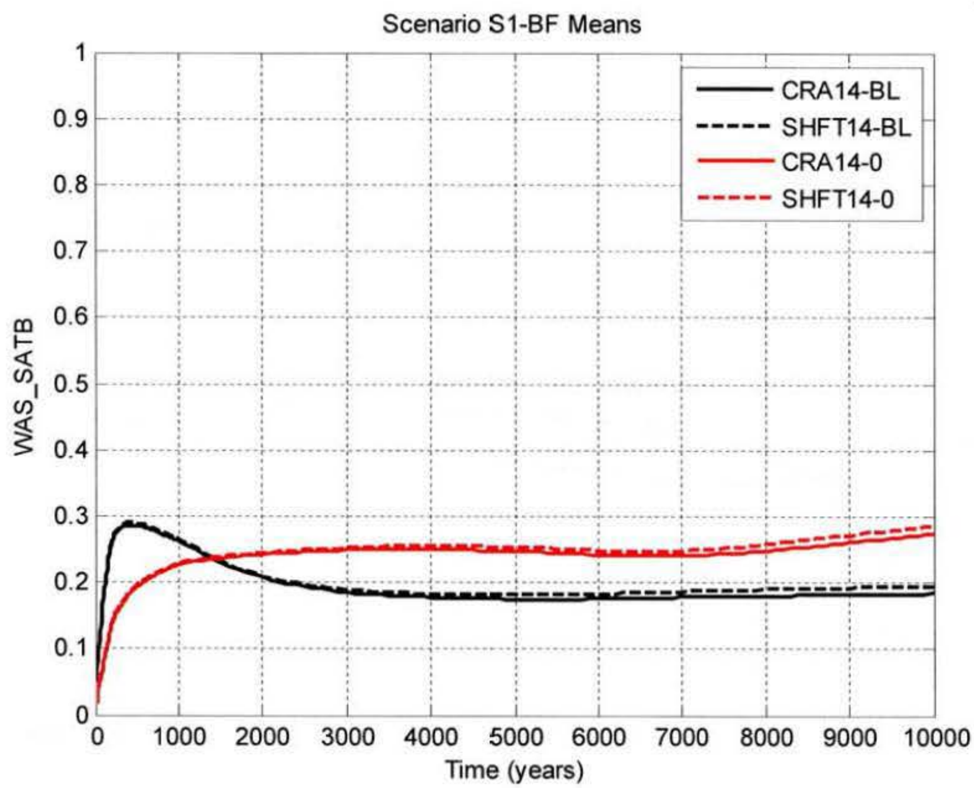

Figure 5-48: Mean Brine Saturations for the Waste Panel, Scenario S1-BF

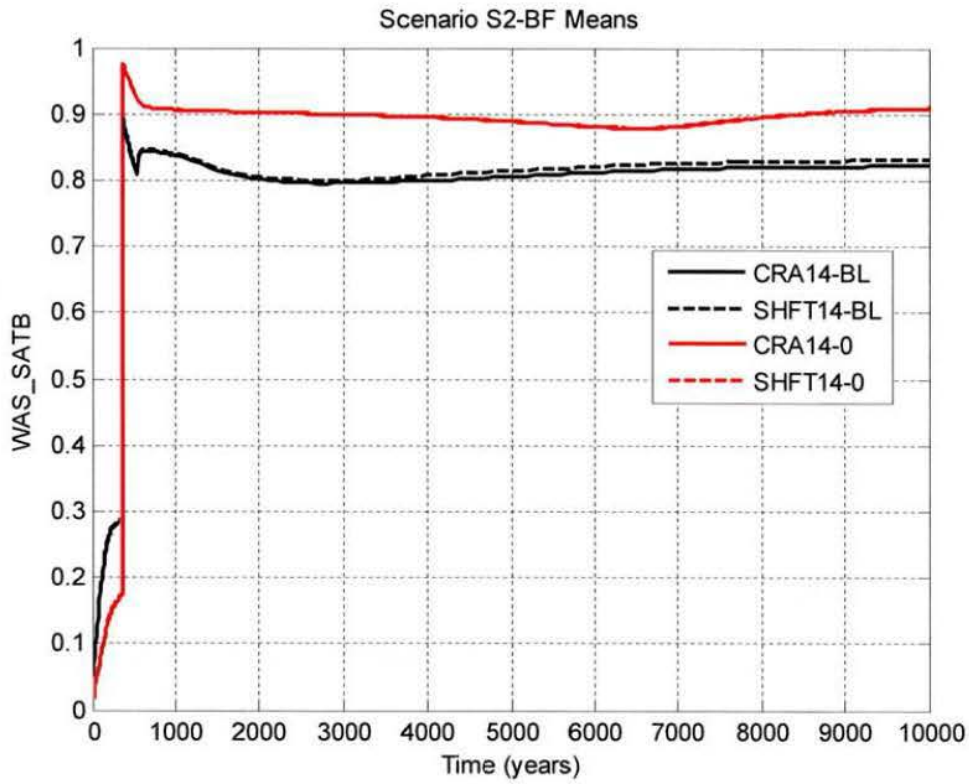

Figure 5-49: Mean Brine Saturations for the Waste Panel, Scenario S2-BF

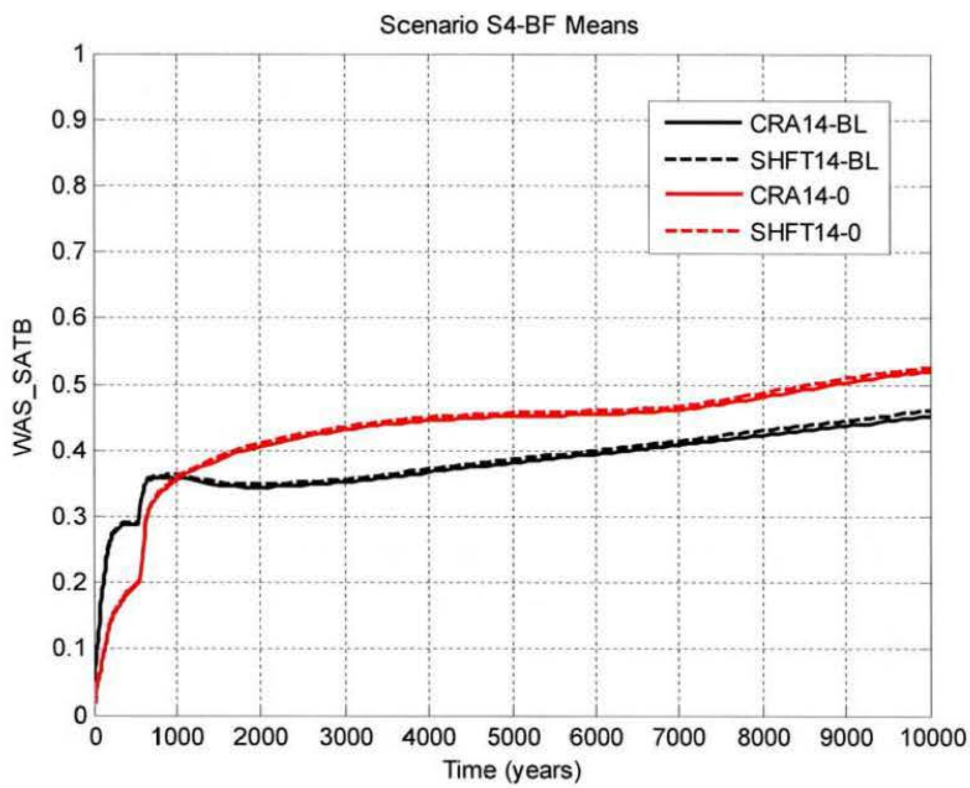

Figure 5-50: Mean Brine Saturations for the Waste Panel, Scenario S4-BF

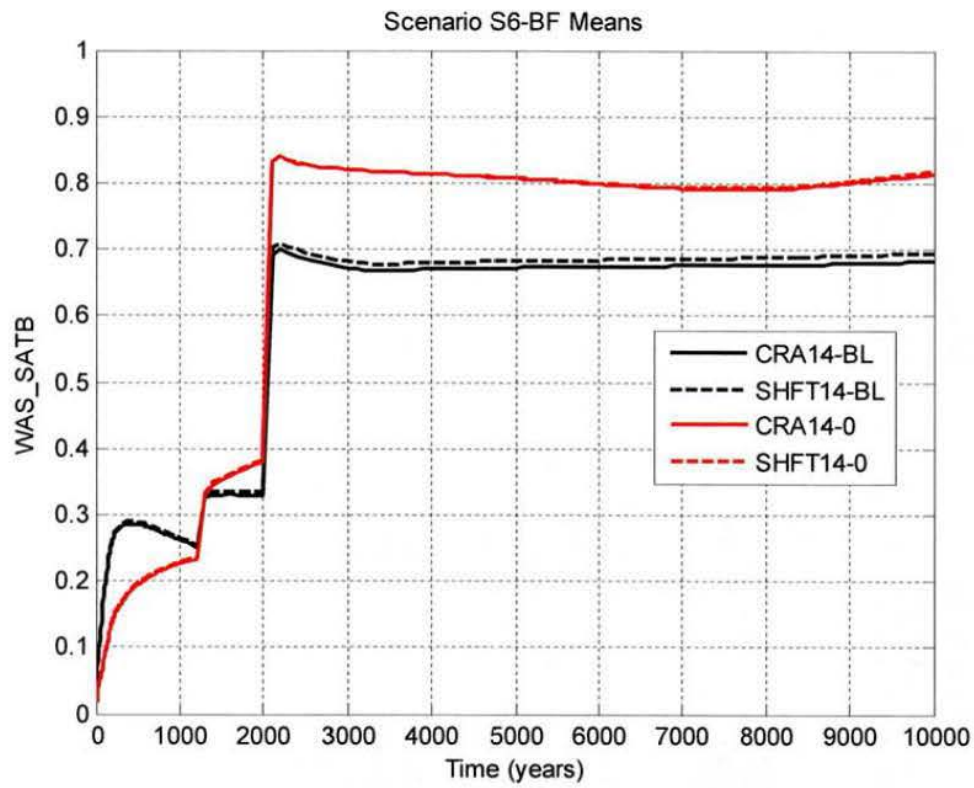

Figure 5-51: Mean Brine Saturations for the Waste Panel, Scenario S6-BF

Table 5-5: Brine Saturation Statistics for Cases CRA14-BL and SHFT14-BL

Quantity (units)	Description	Scenario	Mean Value (at 10,000 years)		Maximum Value	
			CRA14-BL	SHFT14-BL	CRA14-BL	SHFT14-BL
WAS_SATB (none)	Brine Saturation in the Southernmost Waste Panel	S1-BF	0.184	0.196	0.986	0.986
		S2-BF	0.823	0.833	0.997	0.997
		S4-BF	0.453	0.461	0.995	0.995
		S6-BF	0.682	0.695	0.996	0.996
SRR_SATB (none)	Brine Saturation in the South Rest-of-Repository	S1-BF	0.072	0.077	0.952	0.955
		S2-BF	0.084	0.089	0.952	0.952
		S4-BF	0.090	0.096	0.952	0.955
		S6-BF	0.082	0.088	0.952	0.955
NRR_SATB (none)	Brine Saturation in the North Rest-of-Repository	S1-BF	0.060	0.067	0.985	0.980
		S2-BF	0.064	0.071	0.985	0.979
		S4-BF	0.068	0.076	0.985	0.979
		S6-BF	0.064	0.071	0.985	0.980

Table 5-6: Brine Saturation Statistics for Cases CRA14-0 and SHFT14-0

Quantity (units)	Description	Scenario	Mean Value (at 10,000 years)		Maximum Value	
			CRA14-0	SHFT14-0	CRA14-0	SHFT14-0
WAS_SATB (none)	Brine Saturation in the Southernmost Waste Panel	S1-BF	0.273	0.286	0.991	0.991
		S2-BF	0.909	0.910	0.999	0.999
		S4-BF	0.520	0.526	0.996	0.996
		S6-BF	0.814	0.817	0.999	0.999
SRR_SATB (none)	Brine Saturation in the South Rest-of-Repository	S1-BF	0.058	0.062	0.936	0.936
		S2-BF	0.073	0.077	0.936	0.936
		S4-BF	0.069	0.073	0.936	0.936
		S6-BF	0.070	0.074	0.936	0.936
NRR_SATB (none)	Brine Saturation in the North Rest-of-Repository	S1-BF	0.052	0.057	0.720	0.880
		S2-BF	0.053	0.058	0.721	0.879
		S4-BF	0.057	0.063	0.722	0.880
		S6-BF	0.053	0.059	0.721	0.880

5.4 Impacts to Regulatory Compliance

From the results previously discussed, the impacts of the additional shaft and its access drifts are a slight pressure reduction in repository waste regions accompanied by very slight increases to brine saturation (on average). Cumulative brine flows up the composite repository shaft decrease (on average) while flows up the intrusion borehole are primarily unaffected. For the release mechanisms considered in WIPP PA, cuttings and cavings are not dependent on repository pressures or brine saturations, and so are not impacted at all by the additional shaft and drifts. Spallings releases are a function of repository pressure and the waste inventory. Reductions in pressure necessarily translate to reduced spallings release volumes. As a result, spallings releases will be reduced with the addition of the additional shaft and its access drifts, as compared to CRA-2014 PA results.

Brine flows up the intrusion borehole obtained in this analysis and the CRA-2014 PA are nearly identical. Consequently, volumes of brine flowing up the borehole to the Culebra are primarily unaffected by the proposed shaft and drifts. Thus, transport releases through the Culebra and across the land withdrawal boundary will be negligibly different from results calculated in the CRA-2014 PA.

Direct brine releases (DBRs) require sufficient waste panel pressure and brine saturation in order to occur. The repository pressure near the drilling location must exceed the hydrostatic pressure of the drilling fluid, which is specified to be 8 MPa in WIPP PA. The brine saturation in the intruded panel must exceed the residual brine saturation of the waste, a sampled parameter in WIPP PA. As seen, the proposed shaft and its drifts tend to slightly decrease waste region pressure while very slightly increasing waste region brine saturation as compared to the CRA-2014 PA. The combination of slight pressure decrease and very slight brine saturation increase in repository waste regions was also seen in the salt disposal investigation (SDI) impact assessment (Camphouse et al 2011). Indeed, the pressure and brine saturation changes seen in this study are very similar to those seen in the SDI analysis. In the SDI analysis, a focused PA was undertaken to determine the compliance impact resulting from additional excavated volume in the repository north end. It was seen that additional excavated volume in the north end yields slight pressure reductions in repository waste regions accompanied by very slight increases to waste region brine saturation (on average). These changes had a negligible impact on DBRs, and essentially no impact to regulatory compliance. From this, we conclude that the proposed exhaust shaft and its access drifts have a negligible impact on DBRs, and compliance results found in the CRA-2014 PA are primarily unaffected by the addition of another shaft and its access drifts. For reference, the compliance curves obtained for case CRA14-0 (the full compliance calculation of the CRA-2014 PA) are shown in Figure 5-52. The WIPP will continue to meet regulatory compliance with the proposed additional exhaust shaft and access drifts.

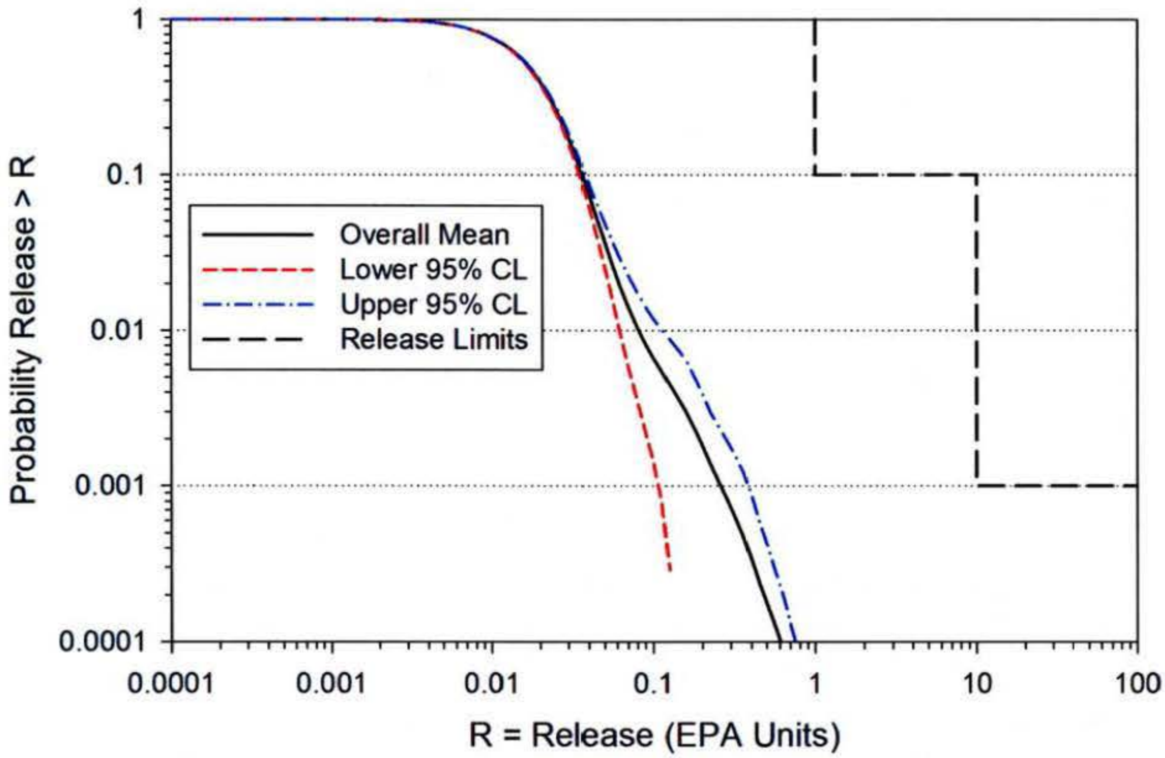

Figure 5-52: CRA-2014 PA Confidence Limits on Overall Mean for Total Normalized Releases

6 Summary

The recent radiological release event at the WIPP site has temporarily halted waste emplacement activities at the facility. A modified ventilation system is envisioned that will provide sufficient airflow necessary for the resumption of full-rate disposal operations in the future. A primary component of the modified ventilation system is an additional exhaust shaft and two access drifts in the north end of the repository. The repository representation used in WIPP PA was modified to include the additional shaft and its drifts. The increased volume in the WIPP north end translated to a reduction in pressure (on average) in that region. Slight pressure reductions were also seen in repository waste regions, with reductions being less pronounced with increased distance from the north end. The slight pressure reductions in repository waste regions yielded very slightly increased brine saturations (on average) in those areas. Brine flows up the borehole during a hypothetical drilling intrusion were nearly identical to those found in the CRA-2014 PA. Brine flows up the composite repository shaft were decreased as compared to the CRA-2014 PA due to the pressure reduction in the north end of the repository. The combination of slightly reduced waste region pressure (on average) and very slightly increased brine saturation was also seen in the SDI impact assessment, where it was found that these slight changes have no noticeable impact on regulatory compliance. It is concluded that WIPP continues to satisfy regulatory compliance limits with the addition of an exhaust shaft and its access drifts, with compliance curves like those found in the CRA-2014 PA for total normalized releases.

7 References

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Long, J. 2013. Execution of Performance Assessment Codes for the CRA-2014 Performance Assessment. Sandia National Laboratories, Carlsbad, NM. ERMS 560016.

8 Run Control

Case SHFT14-BL

Below are the run control tables for case SHFT14-BL.

Table 8-1: Run Script Files for case SHFT14-BL

File	Repository	Comment
RunControl/BRAGFLO.py	$REP/SHFT14BL/BRAGFLO	Python run control script
RunControl//home/run_mast/GD/Run.py	$REP/SHFT14BL/BRAGFLO	Main control script

Where:
$REP = /nfs/data/CVSLIB/WIPP_ANALYSES

Table 8-2: Input Files for case SHFT14-BL

File	Repository	Comment
Input/alg1_bf_CRA14BL.inp	$REP/CRA14BL/ALGEBRACDB	Input file
Input/alg2_bf_CRA14BL.inp	$REP/CRA14BL/ALGEBRACDB	Input file
Input/bf1_CRA14BL_*sn*.inp	$REP/CRA14BL/PREBRAG	Input file
Input/bf1_CRA14BL_*sn*_mod1.inp	$REP/CRA14BL/PREBRAG	Input file
Input/bf1_CRA14BL_*sn*_mod2.inp	$REP/CRA14BL/PREBRAG	Input file
Input/bf2_SHFT14BL_closure.dat	$REP/SHFT14BL/BRAGFLO	Input file
Input/gm_bf_SHFT14BL.inp	$REP/SHFT14BL/GENMESH	Input file
Input/ic_bf_CRA14BL.inp	$REP/CRA14BL/ICSET	Input file
Input/ms_bf_CRA14BL.inp	$REP/CRA14BL/MATSET	Input file

Where:
n is 1-6
$REP = /nfs/data/CVSLIB/WIPP_ANALYSES

Table 8-3: CVS Repositories for case SHFT14-BL

CVS Repositories
ALGEBRACDB
BRAGFLO
GENMESH
ICSET
MATSET
POSTBRAG
POSTLHS
PREBRAG

Table 8-4: Log Files for case SHFT14-BL

File	Repository	Comment
RunControl/BRAGFLO.log	$REP/SHFT14BL/BRAGFLO	log file
RunControl/BRAGFLO.rtf	$REP/SHFT14BL/BRAGFLO	Formatted log file (Word file)

Where:
$REP = /nfs/data/CVSLIB/WIPP_ANALYSES

Table 8-5: Output Files for case SHFT14-BL

File	Repository	Comment
Output/alg1_bf_SHFT14BL_r*i*_*vvvv*.cdb		NOT SAVED:CDB transfer file
Output/alg2_bf_SHFT14BL_r*i*_*sn*_*vvvv*.cdb		NOT SAVED:CDB transfer file
Output/bf2_SHFT14BL_r*i*_*sn*_*vvvv*.inp	$REP/CRA14BL/PREBRAG	BRAGFLO input file
Output/bf2_SHFT14BL_r*i*_*sn*_*vvvv*.log	$REP/SHFT14BL/BRAGFLO	Logfile
Output/bf2_SHFT14BL_r*i*_*sn*_*vvvv*.sum	$REP/SHFT14BL/BRAGFLO	Summary file
Output/bf3_SHFT14BL_r*i*_*sn*_*vvvv*.cdb		NOT SAVED:CDB transfer file
Output/gm_bf_SHFT14BL.cdb		NOT SAVED:CDB transfer file
Output/ic_bf_SHFT14BL_r*i*_*vvvv*.cdb		NOT SAVED:CDB transfer file
Output/lhs3_bf_SHFT14BL_r*i*_*vvvv*.cdb		NOT SAVED:CDB transfer file
Output/ms_bf_SHFT14BL.cdb		NOT SAVED:CDB transfer file

Where:

i is 1
n is 1-6
vvv is 001-100
$REP = /nfs/data/CVSLIB/WIPP_ANALYSES

Table 8-6: Executable Files for case SHFT14-BL

File	Repository	Comment
Build/Solaris/algebracdb (Ver:2.36)	$CODE/ALGEBRACDB	Manipulates CAMDAT data by evaluating algebraic expressions
Build/Solaris/bragflo (Ver:6.03)	$CODE/BRAGFLO	Computes brine and gas flow in the repository
Build/Solaris/genmesh (Ver:6.09)	$CODE/GENMESH	Generates the CAMDAT computational grid
Build/Solaris/icset (Ver:2.23)	$CODE/ICSET	Assigns initial conditions to the CAMDAT grid elements
Build/Solaris/matset (Ver:9.21)	$CODE/MATSET	Assigns material properties to CAMDAT grid blocks
Build/Solaris/postbrag (Ver:4.02)	$CODE/POSTBRAG	Post-processes data for bragflo
Build/Solaris/postlhs (Ver:4.08)	$CODE/POSTLHS	Assigns sampled parameters to the grid blocks and elements
Build/Solaris/prebrag (Ver:8.03)	$CODE/PREBRAG	Pre-processes data for bragflo

Where:

$CODE = /nfs/data/CVSLIB/WIPP_CODES/PA_CODES

Case SHFT14-0

Below are the run control tables for case SHFT14-0.

Table 8-7: Run Script Files for case SHFT14-0

File	Repository	Comment
RunControl/BRAGFLO.py	$REP/SHFT14/BRAGFLO	Python run control script
RunControl//home/run_mast/GD/Run.py	$REP/SHFT14/BRAGFLO	Main control script

Where:

$REP = /nfs/data/CVSLIB/WIPP_ANALYSES

Table 8-8: Input Files for case SHFT14-0

File	Repository	Comment
Input/alg1_bf_CRA14.inp	$REP/CRA14/ALGEBRACDB	Input file
Input/alg2_bf_CRA14.inp	$REP/CRA14/ALGEBRACDB	Input file
Input/bf1_CRA14_*sn*.inp	$REP/CRA14/PREBRAG	Input file
Input/bf1_CRA14_*sn*_mod1.inp	$REP/CRA14/PREBRAG	Input file
Input/bf1_CRA14_*sn*_mod2.inp	$REP/CRA14/PREBRAG	Input file
Input/bf2_SHFT14_closure.dat	$REP/SHFT14/BRAGFLO	Input file
Input/gm_bf_SHFT14.inp	$REP/SHFT14/GENMESH	Input file
Input/ic_bf_CRA14.inp	$REP/CRA14/ICSET	Input file
Input/ms_bf_CRA14.inp	$REP/CRA14/MATSET	Input file

Where:

n is 1-6
$REP = /nfs/data/CVSLIB/WIPP_ANALYSES

Table 8-9: CVS Repositories for case SHFT14-0

CVS Repositories
ALGEBRACDB
BRAGFLO
GENMESH
ICSET
MATSET
POSTBRAG
POSTLHS
PREBRAG

Table 8-10: Log Files for case SHFT14-0

File	Repository	Comment
RunControl/BRAGFLO.log	$REP/SHFT14/BRAGFLO	log file
RunControl/BRAGFLO.rtf	$REP/SHFT14/BRAGFLO	Formatted log file (Word file)

Where:

$REP = /nfs/data/CVSLIB/WIPP_ANALYSES

Table 8-11: Output Files for case SHFT14-0

File	Repository	Comment
Output/alg1_bf_SHFT14_r*i*_*vvvv*.cdb		NOT SAVED:CDB transfer file
Output/alg2_bf_SHFT14_r*i*_*sn*_*vvvv*.cdb		NOT SAVED:CDB transfer file
Output/bf2_SHFT14_r*i*_*sn*_*vvvv*.inp	$REP/CRA14/PREBRAG	BRAGFLO input file
Output/bf2_SHFT14_r*i*_*sn*_*vvvv*.log	$REP/SHFT14/BRAGFLO	Logfile
Output/bf2_SHFT14_r*i*_*sn*_*vvvv*.sum	$REP/SHFT14/BRAGFLO	Summary file
Output/bf3_SHFT14_r*i*_*sn*_*vvvv*.cdb		NOT SAVED:CDB transfer file
Output/gm_bf_SHFT14.cdb		NOT SAVED:CDB transfer file
Output/ic_bf_SHFT14_r*i*_*vvvv*.cdb		NOT SAVED:CDB transfer file
Output/lhs3_bf_SHFT14_r*i*_*vvvv*.cdb		NOT SAVED:CDB transfer file
Output/ms_bf_SHFT14.cdb		NOT SAVED:CDB transfer file

Where:

i is 1-3
n is 1-6
vvv is 001-100
$REP = /nfs/data/CVSLIB/WIPP_ANALYSES

Table 8-12: Executable Files for case SHFT14-0

File	Repository	Comment
Build/Solaris/algebracdb (Ver:2.36)	$CODE/ALGEBRACDB	Manipulates CAMDAT data by evaluating algebraic expressions
Build/Solaris/bragflo (Ver:6.03)	$CODE/BRAGFLO	Computes brine and gas flow in the repository
Build/Solaris/genmesh (Ver:6.09)	$CODE/GENMESH	Generates the CAMDAT computational grid
Build/Solaris/icset (Ver:2.23)	$CODE/ICSET	Assigns initial conditions to the CAMDAT grid elements
Build/Solaris/matset (Ver:9.21)	$CODE/MATSET	Assigns material properties to CAMDAT grid blocks
Build/Solaris/postbrag (Ver:4.02)	$CODE/POSTBRAG	Post-processes data for bragflo
Build/Solaris/postlhs (Ver:4.08)	$CODE/POSTLHS	Assigns sampled parameters to the grid blocks and elements
Build/Solaris/prebrag (Ver:8.03)	$CODE/PREBRAG	Pre-processes data for bragflo

Where:

$CODE = /nfs/data/CVSLIB/WIPP_CODES/PA_CODES