Waste Isolation Pilot Plant

Compliance Certification Application

Reference 650

Vaughn, P., Lord, M., and MacKinnon, R. 1995.
DR3: Dynamic Closure of the North End and Hallways." Summary Memorandum of Record to D.R. Anderson, September 28, 1995. SWCF-A:1.1.6.3. Sandia National Laboratories, Albuquerque, NM. WPO 30798.

Submitted in accordance with 40 CFR §194.13, Submission of Reference Materials.

WPO 30794

DR-3: DYNAMIC CLOSURE OF THE NORTH-END AND HALLWAYS
Summary Memo of Record

To: D.R. Anderson
From: P. Vaughn, M. Lord, R. MacKinnon

Subject: FEP Screening Issue DR-3

STATEMENT OF SCREENING DECISION

FEP Screening Issue DR-3 need not be included in future system-level performance assessment calculations.

STATEMENT OF SCREENING ISSUE

This screening effort evaluates the need for including dynamic closure of the north-end and hallways in future system-level performance assessment calculations. In past calculations, the dynamic effect of halite creep and room consolidation on room porosity was modeled only in the waste disposal regions. Other portions of the repository, such as the experimental region in the north end and the hallways, were modeled assuming fixed (invariant with time) properties. In these regions, the permeability was held at a fixed high value representative of nearly unconsolidated material or modestly consolidated. The porosity in these regions was maintained at relatively low values associated with highly consolidated material. It was assumed that this combination of low porosity and high permeability would conservativly overestimate flow through these regions and minimize the capacity of this material to store fluids.

The impact of dynamic closure of the north-end and hallways 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 dynamic closure of the north-end and hallways on these conditions may be important and needs to be evaluated.

APPROACH

Consolidation of the north-end and hallways was implemented in BRAGFLO by relating pressure and time to porosity via the "porosity surface" method. The porosity surface is a look-up table within BRAGFLO that relates cavity closure (void volume) to time and pressure for different gas generation histories. This porosity surface is calculated independently of BRAGFLO by the computer code SANTOS (see Butcher et al. 1991). The porosity surface for the north-end and hallways is different than the one used for consolidation of the disposal room and is based on an empty excavation; it is described in detail in a memo from Stone and Arquello to Butcher entitled 'Porosity Surface Generation for a Disposal Room Without Crushed Salt Backfill' and dated 2/2/95.

A series of BRAGFLO simulations were performed to determine if dynamic consolidation of the north-end and hallways 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 to north-end and hallway consolidation, 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 north-end and hallway consolidation 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 lateral land withdrawal boundary for E1 Up-Dip, E1 Down-Dip, and undisturbed cases are provided in Figure 5 of Appendix 1 in the records package entitled "FEPs Screening Analysis for FEPs DR2, DR3, DR6, DR7, and S6". Each figure compares CCDFs of normalized releases predicted by the baseline model and normalized releases predicted with north-end and hallway consolidation. 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 lateral land withdrawal boundary are presented on the right side of the figure. In the E01-Down and E01-Up cases , the dynamic consolidation curves for releases to the Culebra are very close to the baseline curves for most of their lengths. In the undisturbed case, the dynamic consolidation CCDF is above the baseline curve for only very small releases via the shaft to the Culebra. However, CCDFs for releases to the subsurface boundary of the accessible environment via the marker beds show only minor differences between the dynamic closure and baseline results with the baseline curve consistently above and to the right of the dynamic closure CCDF. These results can be explained in part by the fact that time-varying porosities of the north-end and hallways exceed the conservative cavity porosity (0.075) used in the baseline model for most of the 10000 yrs. This results in greater storage volume capacity and lower repository pressure. Lower pressures result in a lower driving force for release. The time-varying porosities are initially set to 1.0 and during the course of simulation they gradually decrease. For a short duration (500 to 1000 yrs), starting at around 500 yrs, cavity porosities drop slightly below 0.075 and then experience a gradual increase to values well above the value of 0.075.

Performance measures for direct release 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 4 of Appendix 1. Comparison of these table values with the baseline values given in Table 2 indicate that brine pressures tend to be higher in the baseline case. Also, the differences in brine saturations between the baseline and closure model are insignificant, except possibly the maximum medium, and mean brine saturation at 100 years. At these low saturations, however, the brine is relatively immobile and releases to the intruding wellbore will be small, both in the baseline and dynamic closure cases. This condition is further compounded by the fact that, besides pressures being less than the baseline case, the brine pressures are well below hydrostatic pressure in the wellbore (approximately 7.8 MPa). Pressures must exceed hydrostatic pressure before direct releases up the borehole during drilling can occur (based on a hydrostatic column of drilling mud). In summary, dynamic closure of the north-end and hallways has a negligible effect on waste room conditions relevant to releases during a drilling intrusion.

BASIS FOR RECOMMENDED SCREENING DECISION

Based on the CCDFs, the inclusion of consolidation of the north-end and hallways in BRAGFLO results in overall lower computed releases to the accessible environment than the baseline case. In addition, dynamic consolidation has an insignificant effect on waste room conditions relevant to direct releases during a drilling intrusion. As a result, the baseline model is conservative (over predicts potential releases) in its treatment of closure and consolidation of the north-end and can be eliminated from consideration in the baseline PA model.

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Total # of pages in document includes
15 pages of preface material and
~~129~~ 125 pages of text 12/20/95

INFORMATION ONLY

Record of FEP Screening Work

FEP ID # DR-2 Capillary Action (Wicking) Within the Waste
FEP ID # DR-3 Dynamic Consolidation of the North End and Hallways
FEP ID # DR-6 Brine Puddling in the Repository Due to Heterogeneities
FEP ID # DR-7 Permeability Varying with the Consolidation in Closure Regions
FEP ID # S-6 Dynamic Alterations of the Disturbed Rock Zone/Transition Zone

The following package contains:

- Screening Argument for the above FEP (s)
- Technical Review Form (follows this cover page)
- 1 Completed Comment Forms for DR-2 (p. 41)
  (If no comments received fill in N/A)
- 1 Completed Comment Forms for DR-3 (p. 42)
  (If no comments received fill in N/A)
- 1 Completed Comment Forms for DR-6 (p. 43)
  (If no comments received fill in N/A)
- 1 Completed Comment Forms for DR-7 (p. 44)
  (If no comments received fill in N/A)
- 2 Completed Comment Forms for S-6 (p. 45a, 46,47)
  (If no comments received fill in N/A)
- Response to Comments (follows Technical Review Form)

In total 6 pages of response(s) to comments are included in this records package.

This document represents implementation of:

- Technical comments presented during WIPP Project Management Review Sessions held September 8, 28,29 and open managerial review session.

Signed:

D.R. Anderson D. R. Anderson Dated 12/12/95
(6749 Department Management Approval) Signature

Lead Staff [signature] Dated 12/1/95
(6749) Signature
Division Number

SWCF-A: 1.1.6.3:PA:QA:TSK: ~~DR & S~~ DR-2, DR-3, DR-6, DR-7 & S6 JL 12/20/95

FEP Title: CAPILLARY ACTION (WICKING)

FEP ID: DR-2

Reviewer Instructions
Check "Yes" for each item reviewed and found acceptable.
Check "No" for each item reviewed and found not acceptable.

1. Are the calculations applicable, correct, and adequate?

(YES) NO NA (for reasoned argument FEP's)

Comments (attach pages as needed)

2. Are the screening arguments derived from the calculations or arguments applicable, correct, and adequate?

(YES) NO

Comments (attach pages as needed)

3. Is the record package documenting the screening effort, complete? Use Criteria found in Appendix D of the FEP Plan Version 5.1.

(YES) NO

Comments (attach pages as needed)

Does the record packages contain sufficient information for an independent person with equivalent technical background to understand the work, evaluate the technical quality of the work, continue unfinished work, and/or reproduce the work and its primary results.

(YES) NO

Comments (attach pages as needed)

Report your assessment along with deficiencies if any and, if appropriate, make recommendations for addressing the deficiencies (attach pages as needed).

Signature of technical reviewer(s) and lead staff member indicates that the package reviewed was complete, accurate, and acceptable.

Technical Reviewer(s) (attach pages as needed)

Name (Print)	Signature	Date
M. G. MARIETTA	M. G. Marietta	10/15/95
Name (Print)	Signature	Date

Lead Staff

Name (Print)	Signature	Date
P. Vaughn	Palmer Vaughn	10/17/95

Management Concurrence

Name (Print)	Signature	Date
Margaret Chu		10/17/95

QA SL 12/20/95

SCWF-A:1.1.6.3:PA:~~NQ~~:TSK: DR-2 (FEP ID)

FEP Title: DYNAMIC CLOSURE OF THE NORTH END AND HALLWAYS

FEP ID: DR-3

Reviewer Instructions
Check "Yes" for each item reviewed ond found acceptable.
Check "No" for each item reviewed and found not acceptable.

1. Are the calculations applicable, correct, and adequate?

(YES) NO NA (for reasoned argument FEP's)

Comments (attach pages as needed)

2. Are the screening arguments derived from the calculations or arguments applicable, correct, and adequate?

(YES) NO

Comments (attach pages as needed)

3. Is the record package documenting the screening effort, complete? Use Criteria found in Appendix D of the FEP Plan Version 5.1.

(YES) NO

Comments (attach pages as needed)

Does the record packages contain sufficient information for an independent person with equivalent technical background to understand the work, evaluate the technical quality of the work, continue unfinished work, and/or reproduce the work and its primary results.

(YES) NO

Comments (attach pages as needed)

Report your assessment along with deficiencies if any and, if appropriate, make recommendations for addressing the deficiencies (attach pages as needed).

Signature of technical reviewer(s) and lead staff member indicates that the package reviewed was complete, accurate, and acceptable.

Technical Reviewer(s) (attach pages as needed)

Name (Print)	Signature	Date
M.G. MARIETTA	M.G. Marietta	10/15/95
Name (Print)	Signature	Date

Lead Staff

Name (Print)	Signature	Date
P. Vaughn	Palmer Vaughn	10/17/95

Management Concurrence

Name (Print)	Signature	Date
Margaret Chu QA JL 12/20/95		10/17/95

SCWF-A:1.1.6.3:PA~~NQ~~:TSK: DR-3 (FEP ID)

iii

FEP Title: BRINE PUDDLING IN THE REPOSITORY

FEP ID: DR-6

Reviewer Instructions
Check "Yes" for each item reviewed and found acceptable.
Check "No" for each item reviewed and found not acceptable.

1. Are the calculations applicable, correct, and adequate?

(YES) NO NA (for reasoned argument FEP's)

Comments (attach pages as needed)

2. Are the screening arguments derived from the calculations or arguments applicable, correct, and adequate?

(YES) NO

Comments (attach pages as needed)

3. Is the record package documenting the screening effort, complete? Use Criteria found in Appendix D of the FEP Plan Version 5.1.

(YES) NO

Comments (attach pages as needed)

Does the record packages contain sufficient information for an independent person with equivalent technical background to understand the work, evaluate the technical quality of the work, continue unfinished work, and/or reproduce the work and its primary results.

(YES) NO

Comments (attach pages as needed)

Report your assessment along with deficiencies if any and, if appropriate, make recommendations for addressing the deficiencies (attach pages as needed).

Signature of technical reviewer(s) and lead staff member indicates that the package reviewed was complete, accurate, and acceptable.

Technical Reviewer(s) (attach pages as needed)

Name (Print)	Signature	Date
M.G. MARIETTA	M. G. Marietta	10/15/95
Name (Print)	Signature	Date

Lead Staff

Name (Print)	Signature	Date
P. Vaughn	Palmer Vaughn	10/17/95

Management Concurrence

Name (Print)	Signature	Date
Margaret Chu QA SL 12/20/95		10/17/95

SCWF-A:1.1.6.3:PA~~:NC~~:TSK: DR-6 (FEP ID)

CV

FEP Title: PERMEABILITY VARYING WITH POROSITY IN CLOSURE REGIONS

FEP ID: DR-7

Reviewer Instructions
Check "Yes" for each item reviewed and found acceptable.
Check "No" for each item reviewed and found not acceptable.

1. Are the calculations applicable, correct, and adequate?

(YES) NO NA (for reasoned argument FEP's)

Comments (attach pages as needed)

2. Are the screening arguments derived from the calculations or arguments applicable, correct, and adequate?

(YES) NO

Comments (attach pages as needed)

3. Is the record package documenting the screening effort, complete? Use Criteria found in Appendix D of the FEP Plan Version 5.1.

(YES) NO

Comments (attach pages as needed)

Does the record packages contain sufficient information for an independent person with equivalent technical background to understand the work, evaluate the technical quality of the work, continue unfinished work, and/or reproduce the work and its primary results.

(YES) NO

Comments (attach pages as needed)

Report your assessment along with deficiencies if any and, if appropriate, make recommendations for addressing the deficiencies (attach pages as needed).

Signature of technical reviewer(s) and lead staff member indicates that the package reviewed was complete, accurate, and acceptable.

Technical Reviewer(s) (attach pages as needed)

Name (Print)	Signature	Date
M.G. MARIETTA	M. G. Marietta	10/15/95
Name (Print)	Signature	Date

Lead Staff

Name (Print)	Signature	Date
Palmer Vaughn	Palmer Vaughn	10/17/95

Management Concurrence

Name (Print)	Signature	Date
Margaret Chu QA 10/20/95		10/17/95

SCWF-A:1.1.6.3:PA~~NC~~:TSK: DR-7 (FEP ID)

V

FEP Title: DYNAMIC ALTERATION OF THE DRZ/TRANSITION ZONE

FEP ID: S-6

Reviewer Instructions
Check "Yes" for each item reviewed and found acceptable.
Check "No" for each item reviewed and found not acceptable.

1. Are the calculations applicable, correct, and adequate?

(YES) NO NA (for reasoned argument FEP's)

Comments (attach pages as needed)

2. Are the screening arguments derived from the calculations or arguments applicable, correct, and adequate?

(YES) NO

Comments (attach pages as needed)

3. Is the record package documenting the screening effort, complete? Use Criteria found in Appendix D of the FEP Plan Version 5.1.

(YES) NO

Comments (attach pages as needed)

Does the record packages contain sufficient information for an independent person with equivalent technical background to understand the work, evaluate the technical quality of the work, continue unfinished work, and/or reproduce the work and its primary results.

(YES) NO

Comments (attach pages as needed)

Report your assessment along with deficiencies if any and, if appropriate, make recommendations for addressing the deficiencies (attach pages as needed).

Signature of technical reviewer(s) and lead staff member indicates that the package reviewed was complete, accurate, and acceptable.

Technical Reviewer(s) (attach pages as needed)

Name (Print)	Signature	Date
M.G. MARIETTA	M. G. Marietta	10/15/95
Name (Print)	Signature	Date

Lead Staff

Name (Print)	Signature	Date
Michael Lord	Michael Lord	10/17/95
Palmer Vaughn	Palmer Vaughn	10/17/95

Management Concurrence

Name (Print)	Signature	Date
Margaret Chu		10/17/95

QA: N 12/20/95

SCWF-A:1.1.6.3:PA~~NQ~~:TSK: S-6 (FEP ID)

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RESPONSE TO COMMENT(s) FOR FEP DR2

Comment from Stephen Webb
(Commentor's name)

Response to Comment (1)

I disagree with the conjecture in ¶ 1 and 2. As far as the comments in ¶ 3, the commentor is mistaken in that: 1) a horizontal Salado is not modeled (Dip of Salado and Repository is simulated), 2) the so-called brine and gas bucket approach is not used, 3) it is perfectly reasonable to use conditional CCDF of release to Culebra and lateral boundaries as metrics (If Culebra flow and transport had been included, they would have only diluted any sensitivity to DR2 which is not a Culebra issue), and 4) uncertainty is captured by LHS sampling and Monte Carlo using sample size 20 and considering undisturbed as well as two human intrusion scenarios.

Signature Palmer Vaughn

Date 9/29/95

SWCF-A:1.1.6.3:PA:QA:TSK: DR2 (FEP ID#)

VLL

RESPONSE TO COMMENT(s) FOR FEP DR3

Comment from Stephen Webb
(Commentor's name)

Response to Comment (1)

Reviewer has same comment as DR2. I disagree with the conjecture in ¶ 1 and 2. As far as the comments in ¶ 3, the commentor is mistaken in that: 1) a horizontal Salado is not modeled (Dip of Salado and Repository is simulated), 2) the so-called brine and gas bucket approach is not used, 3) it is perfectly reasonable to use conditional CCDF of release to Culebra and lateral boundaries as metrics (If Culebra flow and transport had been included, they would have only diluted any sensitivity to DR2 which is not a Culebra issue), and 4) uncertainty is captured by LHS sampling and Monte Carlo using sample size 20 and considering undisturbed as well as two human intrusion scenarios.

Signature Palmer Vaughn

Date 9/29/95

SWCF-A:1.1.6.3:PA:QA:TSK: DR3 (FEP ID#)

RESPONSE TO COMMENT(s) FOR FEP DR6

Comment from Stephen Webb
(Commentor's name)

Response to Comment (1)

Reviewer has same comment as DR2. I disagree with the conjecture in ¶ 1 and 2. As far as the comments in ¶ 3, the commentor is mistaken in that: 1) a horizontal Salado is not modeled (Dip of Salado and Repository is simulated), 2) the so-called brine and gas bucket approach is not used, 3) it is perfectly reasonable to use conditional CCDF of release to Culebra and lateral boundaries as metrics (If Culebra flow and transport had been included, they would have only diluted any sensitivity to DR2 which is not a Culebra issue), and 4) uncertainty is captured by LHS sampling and Monte Carlo using sample size 20 and considering undisturbed as well as two human intrusion scenarios.

Signature Patrick Vaughn

Date 7/29/95

SWCF-A:1.1.6.3:PA:QA:TSK: DR6 (FEP ID#)

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RESPONSE TO COMMENT(s) FOR FEP DR7

Comment from Stephen Webb
(Commentor's name)

Response to Comment (1)

Reviewer has same comment as DR2. I disagree with the conjecture in ¶ 1 and 2. As far as the comments in ¶ 3, the commentor is mistaken in that: 1) a horizontal Salado is not modeled (Dip of Salado and Repository is simulated), 2) the so-called brine and gas bucket approach is not used, 3) it is perfectly reasonable to use conditional CCDF of release to Culebra and lateral boundaries as metrics (If Culebra flow and transport had been included, they would have only diluted any sensitivity to DR2 which is not a Culebra issue), and 4) uncertainty is captured by LHS sampling and Monte Carlo using sample size 20 and considering undisturbed as well as two human intrusion scenarios.

Signature Palmer Vaught

Date 9/29/95

SWCF-A:1.1.6.3:PA:QA:TSK: DR7 (FEP ID#)

X

RESPONSE TO COMMENT(s) FOR FEP S-6

Comment from Stephen Webb
(Commentor's name)

Response to Comment (1)

Reviewer has same comment as DR2. I disagree with the conjecture in ¶ 1 and 2. As far as the comments in ¶ 3, the commentor is mistaken in that: 1) a horizontal Salado is not modeled (Dip of Salado and Repository is simulated), 2) the so-called brine and gas bucket approach is not used, 3) it is perfectly reasonable to use conditional CCDF of release to Culebra and lateral boundaries as metrics (If Culebra flow and transport had been included, they would have only diluted any sensitivity to DR2 which is not a Culebra issue), and 4) uncertainty is captured by LHS sampling and Monte Carlo using sample size 20 and considering undisturbed as well as two human intrusion scenarios.

Comment from Al Lappin
(Commentor's name)

Response to Comment (2)

The commentor is expanding the scope of S-6 beyond the original scope by including the DRZ surrounding the shaft system. His concerns are best addressed in the shaft seal system design. My understanding is that time-dependent DRZ characteristics are being considered as part of the shaft seal design and will be incorporated in the NWVP and CCA PA calculations.

The commentor's alternative screening decision is included, but I would add "and bounding" to the end of the last bullet.

Signature Palmer Vaughn

Date 9/29/95

SWCF-A:1.1.6.3:PA:QA:TSK: S-6 (FEP ID#)