DOC.20080324.0002

Technical Report Administrative Change Notice

QA: QA
Page 1 of 2

Complete only applicable items.

1. Document No.:	TDR-PCS-SE-000001	2. Revision & Addendum No.:	05 AD01	3. ACN No.:	01
4. Title:	Performance Confirmation Plan				
5. No. of Pages Attached:	21				

6. Approvals:

Originator:	Roger J Henning Print Name and Sign	[signature]	3/21/2008 Date
Lead Checker:	Ernest Hardin Print name and sign	[signature]	3/21/08 Date
Lead QCS/Lead Lab QA Reviewer:	Charles Beach Print name and sign	[signature]	3-21-08 Date
Responsible Manager:	Frank Hansen Print name and sign	[signature]	3-21-08 Date

7. Affected Pages	8. Description of Change:
	Changes are a result of OCRWM LP-7.5Q accepted with conditions, as documented on a Deliverable Review Comment Sheet dated 3/10/2008.
Summary and Organization, page iii[a], bullet item 2	Removed "…and allows for final approval of the test plan by the Office of Civilian Radioactive Waste Management."
3[a], page 1[a]	Added a new Section 3.3.1.1[a] documenting changes to the precipitation activity to the pages as needed to delete the chemistry and reflect that six stations were selected for precipitation monitoring.
3[a], page 1[a]	Added a new Section 3.3.3.1[a] documenting changes needed to the pages in the original PC Plan to cover changes to the Seals Testing activity, consistent with the current design where the design addresses seals as closure of the shafts and ramps that includes backfilling for the entire depth of the opening. Site investigation boreholes within or near the footprint of the repository block will be backfilled and plugged with material compatible with the host rock. These design features are intended to meet the intrusion scenarios, and are not performance related.
3.5.1[a], page 2[a], last paragraph	This paragraph represents a change to the precipitation activity, which is in Section 3.3.1.1 of the PC Plan. This paragraph is now incorporated into addendum Section 3.3.1.1 to capture changes to that activity. Second paragraph, last sentence that reads "The following is an example implementation that is necessary for the PC test plan for precipitation monitoring." This section which previously covered justification for changes to Section 3.3.1.1[a] is now deleted. Section 3.5.1[a] is now replaced by Section 3.3.1.1.
3.5.2[a], page 3[a], 1st paragraph, last sentence before bullets	Removed "as required by regulation".
3.5.2[a], page 3[a], bullets	Added as last bullet: • "Establishes reportable ranges and limits".

1. Document No.:	TDR-PCS-SE-000001	2. Revision & Addendum No.:	05 AD01	3. ACN No.:	01

4. Title: Performance Confirmation Plan

3.5.2[a], page 3[a], Footnote 2	Changed to definition from original PC Plan: "Condition Limits are the discrete value(s) or trend(s) outside (upper or lower) the expected range that results in more detailed evaluation and potentially additional sampling, including adversely developing trends as defined in the PC Test Plans."
3.5.3[a], page 4[a], 1st paragraph	Changed "incorporates" to "incorporate".
3.5.5[a], page 6[a]	Added a new Section 3.3.3.1[a] with the changes needed to the pages in the original PC Plan activity. This section now only covers the justification for the changes to Section 3.3.3.1[a]. Section 3.5.5[a] is now replaced by Section 3.3.3.1[a] with changes incorporated.
3.5.5.[a], page 6[a], 2nd paragraph, 3rd sentence	Added "as required by regulation".
3.5.5[a], page 6[a], last paragraph, last sentence	Removed "and determined".
7.1[a], page 7[a]	Added DIRS 170246, 165991, 169734, and 176722.
7.1[a], page 8[a]	Added DIRS 183206 and 144992.
7.1[a], page 9[a]	Added DIRS 176828.
7.3[a], page 10[a]	Added section heading "7.3[a] DATA TRACKING NUMBERS" and DIRS 182694
A.4.1[a], page A-5[a], 2nd paragraph	Paragraph starting with "High", changed first sentence to read: A rating of high is allocated to an uncertain parameter if a change in that parameter from the mean to the 95th percentile results in change of dose by a factor of 5 or more. Adding "or more." to the end of the sentence.
A.4.1[a], page A-5[a], 3rd paragraph	Paragraph starting with "Medium", changed the first sentence to read: A rating of medium is assigned to an uncertain parameter when a change from a mean value to the 95th percentile results in change of dose by a factor of 2 to 5. Adding "to 5." to the end of the sentence.
Table A-1[a], page A-13[a]	Added a footnote d: "[d] For definitions of input parameters refer to "Input Parameters Important to Uncertainty" on pages A-15[a] through A-17[a]." Footnote [d] is added to table caption after "Summary of Input Parameter…".
A.4.2[a], page A-16[a], Paragraph starting MICC14 Paragraph starting MICNP237 Paragraph starting MICTC99	In each place at the end of the descriptions of MICC14, MICNP237, MICTC99, replaced "…, so a performance confirmation activity is not planned." with "… . Whereas the performance confirmation program is designed to provide data that address the operation of designated barriers after permanent closure (consistent with 10 CFR 63.131(a)(2) [DIRS 180319]), the biosphere is not identified as such a barrier for the postclosure performance assessment (SNL 2008 [DIRS 177464]). This is appropriate because many aspects of the biosphere model and its risk sensitivity are controlled by factors not subject to confirmation, including regulatory input and international protocols."
Table A-2[a], page A-51[a] Second Row	Added "Seismicity monitoring" to the PC activity column.

SUMMARY AND ORGANIZATION

This addendum to Revision 05 of *Performance Confirmation Plan* (PC Plan) (BSC 2004 [DIRS 172452]) is created for four primary purposes:

1. To emphasize that individual performance confirmation (PC) test plans contain detailed implementation information. The purpose of the PC Plan is to provide a higher-level planning document that identifies activities, intended scope, and candidate parameters.

2. To illustrate the process for developing the PC test plans. The process requires cross-disciplinary review as the test plan is being developed.

3. To describe the methodology for selecting parameters and quantifying condition limits. Final selection of parameters and condition limits is documented in the individual PC test plans.

4. To document a completeness review of existing performance confirmation activities as detailed in Appendix A[a].

The PC Plan is expected to be updated periodically. These revisions or addenda are intended to ensure consistency between the plans for confirmation and the information used in the Safety Analysis Report (SAR). Technical documents such as the postclosure nuclear safety design basis (PoNSDB) and the total system performance assessment (TSPA) documents were used for this addendum to assess performance confirmation activities for relevance.

The organization of this addendum corresponds to the major outline of the parent report and includes all sections mandated by the governing procedure (LS-PRO-001), regardless of whether or not a mandated section is being modified. Mandated sections, in other words, are reproduced in this addendum for procedural compliance and convenience of cross-referencing, but may not contain actual modifications to the parent report. In such cases, the addendum section contains a bracketed statement of "No modification" under the section heading.

Conversely, sections not mandated by procedure (i.e., most subsections) are reproduced in this addendum only if they contain a modification to the corresponding section of the parent report, which is also true of any other addendum elements (i.e., figures, tables, equations, or appendices). Unless added as new elements not present in the parent report, the numbering of addendum elements such as figures, tables, equations, and appendices corresponds to the numbering in the parent report. Bracketed designators (e.g., "[a]") are added to all numbered elements in this addendum to distinguish them from corresponding elements in the parent report.

In every case, the modifications presented in this addendum are preceded by bracketed, italicized text explaining why the modification was made and how it relates to the corresponding element in the parent report. When appropriate, this explanatory text may cite page and paragraph numbers from the parent report for cross-referencing purposes.

1[a]. INTRODUCTION

[No modification to parent report.]

2[a]. REQUIREMENTS AND GUIDANCE

[No modification to parent report.]

3[a]. DESCRIPTION OF PERFORMANCE CONFIRMATION ACTIVITIES

[Sections 3.1, 3.2, 3.3, and 3.3.1 in the parent document are unchanged.]

3.3.1.1[a] Precipitation Monitoring

Activity Description–This activity includes precipitation monitoring. Precipitation represents the maximum input of water to the Upper Natural Barrier. Candidate parameters that may be measured include: precipitation rate and quantity. This is a long-term field collection activity providing a direct measurement of the parameters. Precipitation monitoring began during site characterization and will continue until closure. Meteorological monitoring, in conjunction with this performance confirmation activity, is also expected to support the environmental safety and health compliance program.

Purpose–The purpose of this activity is to evaluate the precipitation input parameter that relates to seepage modeling. This activity includes testing and monitoring to evaluate the results and assumptions of conceptual and numerical models used to describe the hydrologic conditions at Yucca Mountain. Precipitation quantity, distribution (i.e., spatial and temporal), will be monitored to assess and extend the precipitation record at the site. It will also provide for a comparison with seepage data. The Upper Natural Barrier contributes to waste isolation by limiting the amount of water available to contact the Engineered Barrier System and by establishing the physical and chemical environment that contributes to the long life of the Engineered Barrier System. As shown in Figure 1-1, infiltration into the Upper Natural Barrier is limited through a combination of low precipitation, evapotranspiration, and runoff. This activity directly addresses the performance of the Upper Natural Barrier because precipitation serves as the maximum input of water to the repository system from the environment.

Selection Justification–This activity was selected because it directly addresses one of the bases for evaluating the performance of the Upper Natural Barrier and the requirements of the regulations. Precipitation serves as the maximum input of water to the repository system from the environment. As such, this activity is important to understanding seepage monitoring activities, and understanding input and output values of the process that carries water from the surface, through the unsaturated zone, and potentially down into the emplacement drifts. Information obtained from precipitation monitoring will be used as input to the unsaturated zone flow model for the evaluation of other quantities potentially important to repository performance (e.g., seepage time histories).

If the trends measured in the related seepage monitoring activities exceed the predicted ranges, the precipitation data will be used in the evaluation of those seepage measurements. Precipitation is the most significant environmental factor controlling net infiltration at Yucca

Mountain (BSC 2003, [DIRS 165991] Table 6-8). The results from the risk-informed, performance-based activity selection approach described in Section 1.4.1 indicate high confidence that the measurements represent the temporal and spatial scale over the area of the repository during the preclosure measurement period. There is confidence that the modeled range of this parameter will not be exceeded during the measurement period. This activity is a relatively straightforward continuation of an existing activity to confirm the precipitation input parameter for the seepage model, placing seepage measurements in context.

For the reasons presented above, this activity addresses the requirements of 10 CFR 63.131(a)(2). Specifically, that the performance confirmation program must provide data that indicate, where practicable, whether natural systems and components required for repository operation, and that are designed or assumed to operate as barriers after permanent closure, are functioning as intended and anticipated.

Current Understanding–Precipitation monitoring was conducted at 29 operating precipitation-monitoring stations in the field for evaluating the record at Yucca Mountain. Stations recorded precipitation and other meteorologic data as they occurred. Measurement recording is equipment specific, but usually recording is done every number of minutes (for electronically measured parameters such as temperature) or recording of a certain volume over time in the case of tipping buckets (during an event). Storage gauges total the precipitation received since the last time they were serviced. Office activities include obtaining meteorologic and climatic data collected by others from surrounding areas for comparison with the local Yucca Mountain record. This includes evaluating the statistical basis for the evaluation of fluctuations and extreme events that might affect infiltration, percolation, seepage, and transport. After site curtailment, six stations (1, 2, 3, 6, 8, and 9) continued operation as part of the precipitation monitoring performance confirmation activity.

Data collected will be used to evaluate precipitation inputs in support of the process model abstraction. The current performance assessment model simulates climatic change by using three separate distributions at different times in the compliance period. Table 3-3 compares estimates of annual precipitation for the present-day record to the expected average annual precipitation used in the Infiltration Model (SNL 2008 [DIRS 182145]).

Table 3-3[a]. Actual and Expected Average Precipitation for the Performance Confirmation Precipitation Stations at and near Yucca Mountain

Station	Elevation (m)	Actual Average Annual Precipitation (mm)	Expected Average Annual Precipitation (mm)
Reference[a]	1,524.0	—	213
Site 1	1,143.0	200.9	156
Site 2	1,478.0	198.5	176
Site 3	1,279.0	223.8	195
Site 6	1,315.0	225.3	196
Site 8[b]	1,123.0	198.1	150
Site 9	838.0	116.0	99

Source: BSC 2007 [DIRS 182591] (actual average precipitation data for Sites 1, 2, 3, 6, 8, and 9, 1994-2006); SNL 2008 [DIRS 182145], Table F-3[a] (expected average annual precipitation for Sites 1, 2, 3, 6, and 9); DTN: SN0701T0502206.040 [DIRS 182694] (1,000-year records of daily data).

[a] Reference is related to an assumption in the model that precipitation is assumed to occur at the same time in all parts of the domain. The frequency of precipitation is calculated for a reference elevation of 1,524 m and is applied to all cells of the domain. This assumption was necessary because there are insufficient data to predict the spatial distribution of precipitation for each event. In the model each precipitation value is related to elevation of the cell and the reference value. Expected values at each site are tied in the same manner to the reference, based on the elevation of the station, not the historical record at the site.

[b] Expected average annual precipitation for Site 8 is calculated using the same method based on reference value and elevation.

It is not expected that the precipitation monitoring during the construction or operations period will deviate significantly from the present-day (modern) climate ranges. Table 3-3[a] will serve as the initial basis for comparison with performance confirmation data (Section 4.1). Trends will be treated as described in (Sections 4 and 4.2).

Anticipated Methodology–This activity includes long-term monitoring. Precipitation monitoring at Yucca Mountain presently uses two types of precipitation gauges. The first type is a tipping bucket gauge that defines the temporal nature of the events. The tipping bucket gauge, funnel, and rocker mechanism records the precipitation event as a cumulative number of 0.01-inch events and records the time they occurred. The second type of precipitation gauge is a storage gauge that consists of a large can, a funnel, and a measuring tube. Although this second type provides only a composite (total) precipitation amount it provides a confidence check for the tipping bucket gauge.

The precipitation-monitoring stations at Yucca Mountain are described in the *Yucca Mountain Site Description* (BSC 2004, [DIRS 169734] Section 6). Some are tipping bucket gauge and a storage gauge (BSC 2006 [DIRS 176722]). Others are equipped with tipping bucket gauges but no storage gauges.

Because the precipitation monitoring activities will be conducted for an extended period, updates to the equipment, sampling program, and methodologies are expected (Brandt 2004 [DIRS 170246]).

The testing data are typically evaluated as an annual or seasonal range of precipitation and moisture conditions. A limit on the amount of precipitation would be established based on historical data, future climate assumptions, and the sensitivity of performance assessment models. If the precipitation exceeded a predetermined limit, or was increasing at a rate that may cause it to exceed expected ranges during the postclosure period, an evaluation of the potential impact on the understanding of system performance would be conducted and reported as described in Section 4.

This activity will not adversely affect the ability of the repository to meet performance objectives because the monitoring is noninvasive and occurs at the surface. Additionally, precipitation-monitoring activities do not result in the introduction of materials with chemical compositions that could transport through the natural system and affect the performance of the repository. Further evaluations on waste isolation and test-to-test interference will be conducted during the detailed test planning.

[Sections 3.3.1.2 through 3.3.1.11, 3.3.2 (entire), and 3.3.3 in the parent document are unchanged.]

3.3.3.1[a] Seal Testing

Activity Description–This activity includes laboratory testing of borehole backfill and plugging effectiveness and field testing of backfill placement and compaction procedure effectiveness. Candidate parameters that may be measured include borehole backfill and plugging; and shaft / ramp backfill materials, configuration, and performance. Laboratory analysis and field-testing activities can provide direct measurements and indirect observations. This activity is principally related to regulatory requirements. This is a new activity to the Project. Laboratory testing will be initiated during early stages of development of the repository. Testing backfill procedures will be conducted during repository operations. As such, for the field-testing, the locations, durations, and design of the testing are very preliminary at this time.

Purpose–The purpose of this activity is to evaluate design assumptions for implementation of backfilling and plugging measures to effect permanent repository closure. The design addresses seals by specifying that closure of the shafts and ramps shall include backfilling for the entire depth of the opening. Site investigation boreholes within or near the footprint of the repository block will be backfilled and plugged.

Seal effectiveness criteria that will be evaluated include that seal and closure systems must be mechanically, chemically, geologically, and thermally compatible with the subsurface environment. Backfill placement and compaction procedures will be evaluated against design requirements.

Selection Justification–Seal testing is an important activity because of regulatory requirements that seals and backfill function effectively as components installed for repository closure which contribute to precluding human and animal intrusion.

This activity was not included in the risk-informed, performance-based activity selection approach described in Section 1.4.1. However, this activity is designed to meet the requirements 10 CFR 63.133(a), (c), and (d), but also help support the objectives of 10 CFR 63.131(a)(2). Specifically, this activity addresses the requirements that during the early or developmental stages of construction, a program for testing of engineered systems and components used in the design, such as borehole and shaft seals, must be conducted. Tests must be conducted to evaluate the effectiveness of borehole, shaft, and ramp seals before full scale operation proceeds to seal boreholes, shafts, and ramps. Also, testing to evaluate effectiveness of backfill placement and compaction procedures must be conducted before beginning permanent backfill placement. In addition, it must be evaluated whether natural and engineered systems and components required for repository operation, and that are designed or assumed to operate as barriers after permanent closure, are functioning as intended and anticipated.

Current Understanding–Closure of shafts, ramps, and boreholes by these measures has been determined not to be important to barrier capability and is therefore not included among the features evaluated in the completeness analysis of Appendix A[a] to this addendum. Notwithstanding these changes, the associated confirmatory testing activity remains relevant to performance confirmation because of regulatory requirements and will be conducted before full scale operation proceeds to backfilling of shafts and ramps, or backfilling and plugging of boreholes. Testing to evaluate the effectiveness of backfill placement and compaction procedures will be conducted before beginning permanent backfill placement, using methods that will be demonstrated to be commensurate with the importance of backfilling shafts and ramps, and backfilling and plugging of boreholes, to postclosure waste isolation performance. Performance-based analysis, and the experience base available for backfill preparation and placement, will be used as applicable to confirm that the testing approach is justified. Use of laboratory and in situ testing methodologies will be evaluated and determined in the development of the test plan for the confirmation activity.

The performance confirmation program for testing engineered systems and components used in the design will be developed as early as practicable during construction. It will include evaluation of materials and designs for borehole, shaft, and ramp closure. Laboratory testing and testing to evaluate placement of granular materials are common engineering activities for subsurface openings and waste disposal sites so numerous standards and methodologies exist. These existing standards and methodologies will be evaluated before testing begins for applicability to the needs of Yucca Mountain. Planning for this activity is preliminary in nature; other methods and approaches may be employed and will be described in updates to this plan.

Shaft and ramp closure testing will be more complex. An established baseline specific to Yucca Mountain is not available at this time. But as noted above, analogue information for the performance, testing and analysis of seals is widely available in the engineering literature. In any event, onsite (in situ), large-scale shaft and ramp testing will provide relevant data for performance evaluations. Again, testing can be conducted under a wide range of conditions and there will be ample time to compare results with performance expectations; make appropriate adjustments to designs or performance models, or both.

Design specifications and candidate configurations are presented in: *Closure Seal Locations and Geologic Environment Study* (CRWMS M&O 2000 [DIRS 144992]); and *Closure and Sealing Design Calculation* (BSC 2007 [DIRS 183206]).

Backfilling of shafts and ramps, and backfilling and plugging of boreholes will be conducted as part of closure of the repository. Closure of the repository also includes removal of materials designated as non-committed. Emplacement drifts are not planned to be backfilled with the present design. Field-testing to evaluate effectiveness of backfill placement and compaction procedures will be conducted prior to placement of backfill. Planning for these components of the activity is not developed; methods and approaches that may be employed, will be described in the PC Test Plan.

The ramps and shafts closure design may change as more detailed information becomes available from detailed geologic mapping during construction. During construction mapping, locations for testing may be determined.

Anticipated Methodology–Use of laboratory and in situ testing methodologies will be evaluated and determined in the development of the test plan for the confirmation activity. Field-testing of shaft and ramp closure may be conducted in large diameter openings that originate from alcoves or the observation drift, in full-scale drifts, or in comparable rock formations outside the repository footprint. Tests designed to evaluate the effectiveness of borehole, shaft, and ramp closure will be conducted as part of repository operations. Field tests will be used to evaluate the effectiveness of backfill placement and compaction procedures, against design requirements. These results are compared to design specifications on performance. If the results from testing and monitoring exceeded a predetermined limit that would cause the closure system to be ineffective, an evaluation of the potential impact would be conducted and reported as described in Section 4. It is likely that the closure systems would be redesigned and retested to meet design criteria.

The laboratory portion of this activity cannot adversely affect the ability of the repository to meet performance objectives, because it would be conducted offsite. The field-testing portion of this activity is not expected to adversely affect the ability of the repository to meet performance objectives because the testing will be conducted in a very small portion of the underground openings and is expected to occur outside of the repository footprint where waste is to be emplaced. Further evaluations on waste isolation and test-to-test interference will be conducted during the detailed test planning. Integration with Design and Engineering to define the underground layout will be conducted during the detailed test planning.

[Section 3.3.4 (entire) in the parent document is unchanged.]

[The following sections are added after Section 3.4 of the parent report. This additional information evaluates aspects of the performance confirmation planned program against new results from TSPA and new analysis of barrier capability. In addition, the plan is modified to address new design information on sealing of shafts, ramps, and boreholes.]

3.5[a]. ADDITIONAL ANALYSIS OF PERFORMANCE CONFIRMATION ACTIVITIES

3.5.1[a]. Content of Performance Confirmation Test Plans

The decision analysis process resulting in the PC activities is based on the most current technical information available. Results of the decision analysis are assessed periodically to ensure that the activities intended for performance confirmation continue to be relevant.

Parameters and methods considered in the PC Plan (BSC 2004 [DIRS 172452]) are sometimes conceptual in nature, as is common when considering future work. As the PC test plans are developed, the rigor necessary for planning the details of the activity and developing the expected limits and condition limits may result in the need to make some changes to the activity as described in the PC Plan. Thus, anticipated methodology may deviate from the exact wording in the PC Plan. Development of the PC test plans results in a more mature and realistic description of the PC activity, which is appropriate and expected during the detailed planning stage of the PC activity. Justifications for deviations from the PC Plan (BSC 2004 [DIRS 172452]) are documented in the PC test plans, when appropriate. This distinction between the PC Plan and the PC test plans is necessary to ensure flexibility when testing and monitoring details are finalized in the PC test plans.

The PC Plan (BSC 2004 [DIRS 172452]) includes twenty activities selected from a performance-based risk-informed process. Each of the twenty activities includes multiple parameters and monitoring options. The performance confirmation program periodically updates the PC Plan to ensure that the information therein is consistent with the license baseline information and reflects the most current understanding of the postclosure safety analysis. Confirmation activities may be reevaluated during the licensing phase, specifically as requested during review by the U.S. Nuclear Regulatory Commission (NRC). Proposed PC scope changes are carefully examined using the requirements in 10 CFR 63.44 [DIRS 180319]. Also, it is verified that the reporting processes developed for performance confirmation are consistent with reporting conditions of construction permits in 10 CFR 50.55 [DIRS 181964].

The performance confirmation program is conducted to evaluate the adequacy of assumptions, data, and analyses that led to the findings that permitted construction of the repository and subsequent emplacement of the wastes. Revisions and updates to the PC Plan (BSC 2004 [DIRS 172452]) are expected and necessary. The reasons for changing the PC Plan may include a better understanding of the performance assessment models with respect to barrier performance, improved understanding of details of features and processes with respect to barrier capability, and possible design changes or programmatic decisions. Its implementation supports the technical building blocks of the performance assessment. Testing and monitoring details for performance confirmation are delineated in individual PC test plans, in which parameters, ranges, and condition limits are quantified. The activities described in the existing PC Plan, which represents the performance confirmation baseline for the license application, are comprehensive in scope but not yet all defined in detail. Specific PC activities will be further defined as additional PC test plans are developed after license application submittal.

Many of the twenty activities included in the PC Plan (BSC 2004 [DIRS 172452]) represent generalized processes and methodologies, and all of the activities can be implemented in a number of ways. Some PC activities are described in detail in the PC Plan, while others are conceptual and require additional consideration as the PC test plans are developed. The descriptions of the activities in the PC Plan provide the expected starting point and anticipated methodologies. There is no intended requirement regarding performance confirmation methodologies set by the language in the PC Plan. The candidate parameters, test concepts, and implementation technologies developed for the PC Plan remain preliminary until they are formalized in the more-detailed PC test plans. For example, other technologies may be located that could allow for direct measurement of a parameter that previously had been derived from surrogates or other parameters. This addendum ensures flexibility for implementation of requisite details in the individual PC test plans.

3.5.2[a]. Process for Development of the PC Test Plans

Development of PC test plans follows quality assurance procedure SCI-PRO-002, *Planning for Science Activities*. Testing and monitoring activities that are identified and undertaken for the purpose of performance confirmation include the information required by SCI-PRO-002, as well as the following information:

- The planning documents for performance confirmation include "Performance Confirmation Test Plan" in their title.[1]
- Each PC test plan describes the relevance of the activity to performance assessment, if appropriate.
- The PC test plan describes the regulatory requirement, if appropriate.
- The PC test plan describes observations, measurements, and expected data quality objectives.
- The PC test plan describes the process for reporting unexpected results or conditions.
- Establishes reportable ranges and limits.

Further details on the contents of the PC test plans are provided in Section 5 of the parent report.

Two key aspects of a successful PC program are: (1) the selection of the parameters to be measured or monitored, and (2) the determination of the conditions for which the NRC will be notified regarding measured and monitored information that differs from the technical baseline. Condition limits[2] are set for confirmation parameters being monitored. When these condition limits are exceeded, the PC program is obligated to report to the U.S. Department of Energy (DOE), which will notify the NRC, as discussed in the main text of the PC Plan and recapitulated in the PC test plans. There may be parameters that do not have the condition limits because the performance assessment is structured to cover a very broad range of values. In these cases, the parameters are collected to evaluate trends or to support other PC activities.

The PC Plan (BSC 2004 [DIRS 172452]) documents the overall strategy for implementing the performance confirmation program. It identifies and describes the development of a list of performance confirmation activities as well as candidate parameters for each activity. Specific information regarding a particular performance confirmation activity—the actual selection of parameters based on the candidates identified in the PC Plan (BSC 2004 [DIRS 172452]), the setting of condition limits, and details of the testing and data acquisition methods—are documented in PC test plans.

[1] The exception to this is the construction effects monitoring test plan (BSC 2006 [DIRS 177845]), which was the first PC test plan to be developed and which was completed before the SCI-PRO-002 requirements went into effect.

[2] Condition Limits are the discrete value(s) or trend(s) outside (upper or lower) the expected range that results in more detailed evaluation and potentially additional sampling, including adversely developing trends as defined in the PC Test Plans.

Justification is provided when a PC test plan deviates from the descriptions in the PC Plan (BSC 2004 [DIRS 172452]). Confirmation activities may change during the licensing process, perhaps in response to feedback from the NRC during the licensing review. Proposed PC scope changes are carefully examined and vetted against the requirements in 10 CFR 63.44 [DIRS 180319]. The reporting processes developed for performance confirmation are consistent with reporting conditions of construction permits in 10 CFR 50.55 [DIRS 181964] and 10 CFR 21 [DIRS 176626].

3.5.3[a]. Selection of Parameters and Condition Limits

It is anticipated that the list of performance confirmation activities and associated candidate parameters is reviewed and updated as necessary. New information includes results of sensitivity studies. For example, in each of the three specific PC test plans that have already been prepared based on the information contained in the PC Plan, parameters are selected and quantified in terms of expected ranges and condition limits. The circumstances of each testing and monitoring activity dictate unique treatment of the parameter ranges and limits.[3] The PC test plans identify one or more parameters to be monitored for a particular activity as well as the associated monitoring, testing, and data collection, including the methods for analyzing and evaluating this information (the process described in the PC Plan (BSC 2004 [DIRS 172452], Figure 4-1) will be followed). They also establish bounds for parameters, condition limits, the basis for the limits, and required actions if these limits are exceeded. The condition limits are set below the point at which the models predict reduction in barrier or total system capability. The parameter-selection efforts incorporate, as applicable, results from a risk-informed knowledge base that includes the analysis/model reports, the technical data input packages, the TSPA compliance model, and ongoing sensitivity and uncertainty analyses. The parameter-selection process utilizes the experience and insights possessed by subject matter experts (SMEs), from both the process modeling and TSPA. Activities and parameters associated with the waste retrievability requirement from Section 1.4.3 of the PC Plan (BSC 2004 [DIRS 172452]) are evaluated for their importance to meeting that requirement, in conjunction with the appropriate design and engineering teams.

The TSPA simulations provide the basis for the compliance analysis presented in the license application. Other specially designed impact and sensitivity analyses augment the risk-informed knowledge base detailed in the PC Plan (BSC 2004 [DIRS 172452]) for evaluating performance confirmation parameters. In addition, targeted impact analyses (i.e., analyses that change a selected aspect of repository performance to quantify the impact that aspect has on total system performance) are also conducted to determine objectively which activities and parameters are most important to each barrier's performance as well as to total system performance.

Once parameters are selected, expected ranges, condition limits, and other related information are developed using the risk-informed knowledge base, and documented in the PC test plans. The SMEs develops expected ranges to capture the input set provided to the TSPA, as documented in analysis/model reports and technical data input packages. The expected ranges are developed considering: (1) allowance for natural or measurement-related variability,

[3] Some of the PC Plan activities are regulatory requirements and are not derived from the TSPA, such as specific requirements for retrievability, mapping, and seal-testing.

barrier capabilities, whereas TSPA identifies which of these capabilities are represented in risk and performance determinations.

Technical reviews and discussions involved representatives from Lead Lab's Performance Assessment System Integration and Performance Confirmation staff, as well as DOE's Office of the Chief Scientist (OCS). Subject matter experts assessed the relationships between the current version of the TSPA (i.e., the basis of the safety case of the license application), the performance assessment models supporting the TSPA, and the 20 activities identified in the PC Plan. In addition, this group included authors of the PoNSDB to ensure consistency between features that were designated as important to barrier capability and testing and monitoring activities within the PC Plan.

3.5.4.[a] Completeness Review Analysis Results

[No modification to parent report.]

3.5.5.[a] Modification of the Plan for Testing and Backfill and Plugs Used for Sealing

[Paragraph deleted.]

3.5.6[a] Conclusions

This exercise demonstrates that the performance confirmation plan remains relevant to the license application bases, including the TSPA (risk significance) and PoNSDB (barrier capability). The evaluation affirms that the PC Plan activities support the technical basis for postclosure performance assessment of the natural and engineered barriers. No new performance confirmation activities have been identified based on this analysis. Comparison to the TSPA sensitivity information provided in Appendix A[a] shows that the most risk-significant TSPA parameters are informed by performance confirmation activities. From the completeness review documented in Appendix A[a], it is concluded that the planned performance confirmation activities, as defined in the parent report, are sufficient to address the features and characteristics that describe barrier capability. The PC Plan is expected to be revised again in the future to reflect developments in support for the safety case. The PC test plans contain the detailed identification and evaluation of parameters, bounds, and condition ranges, as demonstrated by the completed and available examples of those plans.

4[a]. DATA MANAGEMENT, ANALYSIS, AND REPORTING

[No modification to parent report.]

5[a]. TEST PLANNING AND IMPLEMENTATION

[No modification to parent report.]

6[a]. SCHEDULE

[No modification to parent report.]

7[a]. REFERENCES

7.1[a]. DOCUMENTS CITED

[The following reference listings pertain only to their use in this addendum.]

170246 Brandt, A. 2004. *Precipitation Monitoring at Yucca Mountain.* Document Number: SIP-UNLV-030, Rev. 0. Las Vegas, Nevada: University and Community College System of Nevada. ACC: MOL.20040629.0238.

165991 BSC (Bechtel SAIC Company) 2003. *Analysis of Infiltration Uncertainty.* ANL-NBS-HS-000027 REV 01. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20031030.0003.

170035 BSC 2004. *Conceptual Model and Numerical Approaches for Unsaturated Zone Flow and Transport.* MDL-NBS-HS-000005 REV 01. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20040922.0006; DOC.20050307.0009.

169987 BSC 2004. *CSNF Waste Form Degradation: Summary Abstraction.* ANL-EBS-MD-000015 REV 02. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20040908.0001; DOC.20050620.0004.

166107 BSC 2004. *Drift Degradation Analysis.* ANL-EBS-MD-000027 REV 03. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20040915.0010; DOC.20050419.0001; DOC.20051130.0002; DOC.20060731.0005.

172452 BSC 2004. *Performance Confirmation Plan.* TDR-PCS-SE-000001 REV 05. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20041122.0002.

171764 BSC 2004. *Seepage Calibration Model and Seepage Testing Data.* MDL-NBS-HS-000004 REV 03. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20040922.0003; DOC.20051121.0012.

169734 BSC 2004. *Yucca Mountain Site Description.* TDR-CRW-GS-000001 REV 02 ICN 01. Two volumes. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20040504.0008.

177845 BSC 2006. *Technical Work Plan for: Construction Effects Monitoring.* TWP-MGR-GE-000006 REV 01. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20060915.0004.

176722 BSC 2006. *Technical Work Plan for: Meteorological Monitoring and Data Analysis.* TWP-MGR-MM-000001 REV 03. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20060206.0003.

183206 BSC 2007. *Closure and Sealing Design Calculation.* 800-KMC-MGR0-00200-000-00D. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20070925.0083; ENG.20080129.0001.

182591 BSC 2007. *Local Meteorology of Yucca Mountain, Nevada, 1994-2006.* TDR-MGR-MM-000002 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20070905.0008.

183627 BSC 2008. *Postclosure Modeling and Analyses Design Parameters.* TDR-MGR-MD-000037 REV 02. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080108.0002.

144992 CRWMS M&O 2000. *Closure Seal Locations and Geologic Environment Study.* TDR-SCS-MG-000002 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000122.0037.

101836 ICRP (International Commission on Radiological Protection) 1991. "1990 Recommendations of the International Commission on Radiological Protection." Volume 21, No. 1-3 of *Annals of the ICRP.* ICRP Publication 60. New York, New York: Pergamon Press. TIC: 235864.

181244 SNL (Sandia National Laboratories) 2007. *Abstraction of Drift Seepage.* MDL-NBS-HS-000019 REV 01 ADD 01. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20070807.0001.

177399 SNL 2007. *Biosphere Model Report.* MDL-MGR-MD-000001 REV 02. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20070830.0007.

177418 SNL 2007. *Dissolved Concentration Limits of Elements with Radioactive Isotopes.* ANL-WIS-MD-000010 REV 06. Las Vegas, Nevada: Sandia National Laboratory. ACC: DOC.20070918.0010.

177407 SNL 2007. *EBS Radionuclide Transport Abstraction.* ANL-WIS-PA-000001 REV 03. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20071004.0001.

177412 SNL 2007. *Engineered Barrier System: Physical and Chemical Environment.* ANL-EBS-MD-000033 REV 06. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20070907.0003.

180778 SNL 2007. *General Corrosion and Localized Corrosion of the Drip Shield.* ANL-EBS-MD-000004 REV 02 ADD 01. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20060427.0002; DOC.20070807.0004; DOC.20071003.0019.

178519 SNL 2007. *General Corrosion and Localized Corrosion of Waste Package Outer Barrier.* ANL-EBS-MD-000003 REV 03. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20070730.0003; DOC.20070807.0007.

181648 SNL 2007. *In-Drift Natural Convection and Condensation.* MDL-EBS-MD-000001 REV 00 AD 01. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20050330.0001; DOC.20051122.0005; DOC.20070907.0004.

180506 SNL 2007. *In-Package Chemistry Abstraction.* ANL-EBS-MD-000037 REV 04 ADD 01. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20070816.0004.

183950 SNL 2007. *Performance Confirmation Test Plan for Precipitation Monitoring.* TWP-MGR-MM-000002 REV 01. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20071114.0008.

177396 SNL 2007. *Radionuclide Transport Models Under Ambient Conditions.* MDL-NBS-HS-000008 REV 02 ADD 01. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20050823.0003; DOC.20070718.0003.

177391 SNL 2007. *Saturated Zone Site-Scale Flow Model.* MDL-NBS-HS-000011 REV 03. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20070626.0004; DOC.20071001.0013.

176828 SNL 2007. *Seismic Consequence Abstraction.* MDL-WIS-PA-000003 REV 03. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20070928.0011.

181953 SNL 2007. *Stress Corrosion Cracking of Waste Package Outer Barrier and Drip Shield Materials.* ANL-EBS-MD-000005 REV 04. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20070913.0001.

184614 SNL 2007. *UZ Flow Models and Submodels.* MDL-NBS-HS-000006 REV 03 AD 01. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20080108.0003; DOC.20080114.0001.

183041 SNL 2008. *Features, Events, and Processes for the Total System Performance Assessment: Analyses.* ANL-WIS-MD-000027 REV 00. Las Vegas, Nevada: Sandia National Laboratories.

184433 SNL 2008. *Multiscale Thermohydrologic Model.* ANL-EBS-MD-000049 REV 03 AD 02. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20080201.0003.

177464 SNL 2008. *Postclosure Nuclear Safety Design Bases.* ANL-WIS-MD-000024 REV 01. Las Vegas, Nevada: Sandia National Laboratories.

182145 SNL 2008. *Simulation of Net Infiltration for Present-Day and Potential Future Climates.* MDL-NBS-HS-000023 REV 01 AD 01. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20080201.0002.

183478 SNL 2008. *Total System Performance Assessment Model /Analysis for the License Application.* MDL-WIS-PA-000005 REV 00 AD 01. Las Vegas, Nevada: Sandia National Laboratories.

[The following reference listings pertain only to their use in this addendum.]

7.2[a]. CODES, STANDARDS, REGULATIONS, AND PROCEDURES

176626 10 CFR 21. 2006. Energy: Reporting of Defects and Noncompliance. Internet Accessible.

181964 10 CFR 50. 2007. Energy: Domestic Licensing of Production and Utilization Facilities. Internet Accessible.

180319 10 CFR 63. 2007. Energy: Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada. Internet Accessible.

184076 40 CFR 197. 2006. Protection of Environment: Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada. Internet Accessible.

178394 70 FR 53313. Implementation of a Dose Standard After 10,000 Years. Internet Accessible.

SCI-PRO-002, *Planning for Science Activities.*

7.3[a]. DATA TRACKING NUMBERS

182694 SN0701T0502206.040. Calculated Weather Summary for the Present-Day Climate, Rev 1. Submittal date: 01/10/2007.

A.4[a] DISCUSSION

The performance confirmation activities as documented in the PC Plan were developed using risk insights to focus attention on issues important to public health and safety. The approach was based on three criteria applied to a set of parameters identified by the subject matter experts: (1) how sensitive is barrier capability and system performance to the parameter, (2) what is the level of confidence in the current knowledge about the parameter, and (3) how accurately can information be obtained by a particular test activity. This process facilitated selection of activities that were designated risk-informed and performance-based. This selection process included knowledge of the TSPA used for site recommendation as well as the technical basis of ongoing science. The models used to develop the compliance analysis have been updated over the few years since the multi-attribute utility analysis was used to identify the performance confirmation activities. Hence, the primary purpose of this review is to ensure that the license application includes an appropriate performance-based, risk-informed confirmation program.

A.4.1[a] TSPA Models/Parameters Importance to Dose

The evaluation team applied their judgment to the entire list of models and parameters that support the postclosure technical baseline. For evaluation purposes, the team assigned ranking of High, Medium, or Low to each model and parameter. Although this part of the evaluation is subjective, the panel used the following guidelines to help assign rankings.

High. A rating of high is allocated to an uncertain parameter if a change in that parameter from the mean to the 95th percentile results in change of dose by a factor of 5 or more. Similarly, the absence of a model process or feature, or absence of a parameter (e.g., by removing the model or assigning a null value to the controlling parameter in a TSPA sensitivity analysis), would generate a high rating if it changed the results by an equivalent amount.

Medium. A rating of medium is assigned to an uncertain parameter when a change from a mean value to the 95th percentile results in change of dose by a factor of 2 to 5. Similarly, the absence of a model process or feature, or absence of a parameter (e.g., by removing the model or assigning a null value to the controlling parameter in a TSPA sensitivity analysis), would generate a medium rating if it changed the results by an equivalent amount.

Low. A designation of low is given to any model or parameter that is deemed below medium.

It should be noted that values for standard rank regression coefficient (SRRC) were also used to guide the panel's qualitative evaluations. The SRRC values were available from Appendix K of the TSPA analysis model report (SNL 2008 [DIRS 183478]) and are described in Section A.4.2[a]. The evaluation and ranking of each TSPA model is summarized by model below.

<u>Models and Evaluation</u>

<u>Infiltration</u>. The importance of surface infiltration to total expected dose to the RMEI is evaluated as low for the first 10,000 years. No evaluation was performed for the post-10,000-year analyses, as percolation is prescribed by the proposed NRC rule at 10 CFR 63.342(c)(2) (70 FR 53313 [DIRS 178394]). The effect of infiltration is quantified in

In the context of stepwise regression analysis, variable importance is indicated by the sign and size of the standardized rank regression coefficients (SRRCs). SRRCs provide an estimate of the monotonic relationship between input variables and the output variable under consideration. Further, a positive SRRC indicates that the independent variable and dependent variable (in this case, total expected dose to the RMEI (*EXPDOSE*)) tend to increase and decrease together, whereas a negative SRRC indicates that the independent and dependent variable tend to move in opposite directions. Low, medium, and high rankings are based on the following values of SRRCs:

High: SRRC > |0.3|
Medium: |0.1| < SRRC ≤ |0.3|
Low: SRRC ≤ |0.1|

Values of SRRC as bracketed above were compared to the sensitivity analysis results in Figures K.8.1-2 and K.8.2-2 of the TSPA analysis/model report (SNL 2008 [DIRS 183478], Appendix K). Those parameters meeting the medium and high thresholds are summarized in Table A-1[a].

Table A-1[a]. Summary of Input Parameters[d] Important to Uncertainty for the 10,000-Year and Post-10,000-Year Periods

10,000-Year Period [a]		Post-10,000-Year Period [b]	
Medium Importance	**High Importance**	**Medium Importance**	**High Importance**
IGRATE	SCCTHRP	EP1LOWPU	IGRATE
SZGWSPDM		EP1LOWNU	WDGCA22
MICTC99		SCCTHRP [c]	SZGWSPDM
INFIL		INFIL	SCCTHRP [c]
SZFISPVO		SZFISPVO	
MICC14		EP1NPO2	
DSNFMASS		MICNP237	
		SZCONCOL	
		MICTC99	
		GOESITED	
		PHCSS	

[a] Determined from the Boolean union of data from SNL 2008 [DIRS 183478], Figure K.8.1-2(a)[a], using classification rules from text.

[b] Determined from the Boolean union of data from SNL 2008 [DIRS 183478], Figure K.8.2-2(a)[a], using classification rules from text.

[c] Included in both Medium and High categories to show that the importance of stress corrosion cracking (SCC) decreases in the assessments at approximately 200,000 years and beyond, when general corrosion gradually dominates the modes of waste package damage.

[d] For definitions of input parameters refer to "Input Parameters Important to Uncertainty" on pages A-15[a] through A-17[a].

The significance to uncertainty of models is based on the uncertainty of parameters used in those models, as described in this section. Further, additional insights for parameters of importance can be developed based on identifying those radionuclides that are key contributors to expected dose. For the first 10,000-year period, the primary contributors to dose are ^{99}Tc and ^{239}Pu. For the post-10,000-year period, the primary contributors are ^{129}I, ^{242}Pu, ^{239}Pu, ^{226}Ra, and ^{237}Np (SNL 2008 [DIRS 183478]). Parameters that control transport of these radionuclides to the

INFIL – Pointer variable for determining infiltration conditions: nominal 10th, 30th, 50th, or 90th percentile infiltration cases (dimensionless). This parameter provides the weighting factors for these four cases, for the three climates used in TSPA for the first 10,000 years. The parameters contained within the TSPA parameter INFIL correspond to infiltration uncertainty cases 1 through 4, proceeding from the lowest nominal percentile to the highest. The use of all these percentiles is intended to cover the uncertainties associated with the infiltration for each climate. The two future climates—the monsoon and glacial-transition—account for possible climate-induced changes in precipitation and net infiltration. Activities to evaluate this parameter include precipitation monitoring, subsurface mapping, UZ testing, seepage monitoring, and subsurface water and rock testing.

MICC14 – Groundwater BDCF for ^{14}C in modern interglacial climate ((Sv/yr)/(Bq/m^3)). The groundwater BDCFs predict, in a stochastic manner to allow for parametric uncertainty, the annual dose (Sv/yr) to the RMEI for a unit activity concentration (1 Bq/m^3) in the groundwater for each radionuclide considered by TSPA. This factor is developed from an extensive number of input parameters from multiple external sources detailed in the biosphere model. Whereas the performance confirmation program is designed to provide data that address the operation of designated barriers after permanent closure (consistent with 10 CFR 63.131(a)(2) [DIRS 180319]), the biosphere is not identified as such a barrier for the postclosure performance assessment (SNL 2008 [DIRS 177464]). This is appropriate because many aspects of the biosphere model and its risk sensitivity are controlled by factors not subject to confirmation, including regulatory input and international protocols.

MICNP237 – Groundwater BDCF for ^{237}Np in modern interglacial climate ((Sv/yr)/(Bq/m^3)). This factor is developed from an extensive number of input parameters from multiple external sources detailed in the biosphere model. Whereas the performance confirmation program is designed to provide data that address the operation of designated barriers after permanent closure (consistent with 10 CFR 63.131(a)(2) [DIRS 180319]), the biosphere is not identified as such a barrier for the postclosure performance assessment (SNL 2008 [DIRS 177464]). This is appropriate because many aspects of the biosphere model and its risk sensitivity are controlled by factors not subject to confirmation, including regulatory input and international protocols.

MICTC99 – Groundwater BDCF for ^{99}Tc in modern interglacial climate ((Sv/yr)/(Bq/m^3)). This factor is developed from an extensive number of input parameters from multiple external sources detailed in the biosphere model. Whereas the performance confirmation program is designed to provide data that address the operation of designated barriers after permanent closure (consistent with 10 CFR 63.131(a)(2) [DIRS 180319]), the biosphere is not identified as such a barrier for the postclosure performance assessment (SNL 2008 [DIRS 177464]). This is appropriate because many aspects of the biosphere model and its risk sensitivity are controlled by factors not subject to confirmation, including regulatory input and international protocols.

PHCSS – Pointer variable used to determine pH in CSNF Cell #1 (waste form domain) under liquid influx conditions (dimensionless). Controls solubilities for certain radionuclides, particularly actinides, which may be solubilized by high or low pH conditions.

SCCTHRP – Residual stress threshold for SCC nucleation of Alloy 22 (as a fraction of yield strength in MPa). The threshold stress is taken to be 90% to 105% of the input value for yield strength. The abstraction in the TSPA of SCC initiation and growth, due to both incipient cracks and weld flaws, uses the slip dissolution-film rupture mechanism. Inputs to this slip dissolution mechanism include the residual stress threshold along with input data for the threshold stress intensity factor, an incipient crack size, and crack growth-rate parameters. The uncertainty in residual stress threshold is based in part on stress distributions obtained in finite element modeling of waste package lid welds. The time required for cracks to penetrate the waste package wall and thereby allow releases to occur depends partly on the general corrosion rate of Alloy 22 and the thickness of the outer corrosion barrier (OCB). Activities to evaluate this parameter are included in performance confirmation corrosion testing.

SZCONCOL – Ambient concentration of colloids in groundwater (g/mL). This parameter is used to calculate the retardation of radionuclides in colloidal transport. This parameter depends on the groundwater chemistry, specifically, the ionic strength and pH, which determines whether colloids are stable under ambient conditions. These measurements are included in SZ hydrology testing and monitoring performance confirmation activities.

Table A-2[a]. FEPs, Barrier Capability, and PC Activity (Continued)

Barrier	Feature	FEP Number/Name/Status	Effect on Barrier Capability	Core Parameter Characteristic	PC Activity
LNB	Saturated Zone	1.2.02.01.0A Fractures **Included**	Fracture characteristics are important to the barrier capability for the saturated zone, because groundwater flow occurs primarily within the fracture network in the volcanic tuff units. The fracture networks in the saturated zone at Yucca Mountain appear to be well-connected over large distances at the scales of interest (hundreds of meters to kilometers). These fracture networks, in turn, control the movement of the dissolved and colloidal radionuclides below the water table. Fracture characteristics (e.g., fracture porosity, flowing interval porosity, and flowing interval spacing) are included in the SZ flow and transport abstraction model using a dual porosity effective continuum approach. Their associated uncertainties are represented through the parameter distributions, which were sampled when generating the breakthrough curves for the TSPA.	**ITBC:** Saturated Zone Properties Saturated Zone Flow Saturated Zone Transport	Saturated zone fault zone hydrology testing Saturated zone monitoring
LNB	Saturated Zone	1.2.02.02.0A Faults **Included**	Faults affect the groundwater flow paths, influence the horizontal anisotropy in permeability, and can enhance dispersion by increasing permeability heterogeneities along the saturated zone flow paths. Therefore, faults are incorporated into the SZ flow and transport abstraction model through the use of rock properties, and uncertainties in fault-related parameters such as horizontal anisotropy are also probabilistically included in the model. Faults are considered ITBC for the saturated zone because they may act as preferred conduits or barriers to flow.	**ITBC:** Saturated Zone Properties Saturated Zone Flow Saturated Zone Transport	Saturated zone fault zone hydrology testing Saturated zone monitoring Seismicity monitoring