RAI Volume 4, Chapter 2.4, Second Set, Number 1:

Clarify apparent inconsistencies between the Performance Confirmation Plan and the Safety Analysis Report (SAR) with respect to activities for design testing. Explain which parameters are associated with each activity related to the requirement for design testing. Describe how performance confirmation work for each parameter associated with an activity addresses the requirement for design testing.

Basis: In Table 2-1 of its Performance Confirmation (PC) Plan (SNL, 2008), the applicant identifies six activities as being related to accomplishing the requirement for design testing (10 CFR 63.133). These include:

- Seepage Monitoring
- Thermally Accelerated Drift Near-Field Monitoring
- Thermally Accelerated Drift In-Drift Environment
- Construction Effects Monitoring
- Thermally Accelerated Drift Thermal-Mechanical Monitoring
- Seal [and backfill] Testing

Section 3.3.3 (Design Testing) of the applicant's PC Plan (SNL, 2008) discusses only one of these areas, the seal testing activity. The PC Plan does not discuss which aspects (parameters) of the other five activities relate to design testing.

In Table 4-2 of its SAR, the applicant identifies only five activities as being related to accomplishing the requirement for design testing (10 CFR 63.133). These include:

- Seepage Monitoring
- Thermally Accelerated Drift near-field Monitoring
- Construction Effects Monitoring
- Thermally Accelerated drift Thermal-Mechanical Monitoring
- Seal and backfill testing

SAR Section 4.2.3 (Design Testing Other Than Waste Packages) discusses a set of activities that, except for the seal and backfill testing activity, differs from those identified in SAR Table 4-2. SAR Section 4.2.3 references the drift inspection, thermally accelerated drift near-field monitoring, thermally accelerated in-drift environment monitoring and thermally accelerated thermal-mechanical monitoring activities (SAR Sections 4.2.1.8, 4.2.1.9, 4.2.1.11, and 4.2.2.4 respectively). In addition, SAR 4.2.3 does not elaborate on which aspects (parameters) of these activities relate to design testing.

1. RESPONSE

SAR Section 4.2 describes the activities under the Performance Confirmation Program; some of these activities have aspects that inform design testing requirements. SAR Section 4.2.3, Design Testing Other than Waste Packages, lists Performance Confirmation activities related to design testing that are not described in other sections of the SAR. Seal and Backfill testing is the only activity listed under SAR Section 4.2.3 because it is the only remaining activity that is not discussed in other SAR sections but is included in 10 CFR 63.133. Those Performance Confirmation activities referenced at the end of SAR Section 4.2.3, as noted in the RAI Basis, are intended to assess thermal interaction effects to meet requirements for 10 CFR 63.133(a). Drift Inspection (SAR Section 4.2.1.8), as mentioned in SAR Section 4.2.3, but not listed in SAR Table 4-2 with 10 CFR 63.133(a), indirectly informs design testing requirements by supporting the goals of the thermally accelerated drift activities and confirmation of the general state of the drift. The Performance Confirmation activities shown in SAR Table 4-2 that are aligned with 10 CFR 63.133 (Design Testing) are clarified in this response to include Thermally Accelerated Drift In-Drift Environment Monitoring (SAR Section 4.2.1.11), as shown in Table 2-1 from *Performance Confirmation Plan* (SNL 2008).

As described in SAR Section 4, the scope of the Performance Confirmation Program does not include controls of administrative processes or operational activities associated with fabrication and installation, materials qualification, waste acceptance, or waste package handling. Those activities are discussed in SAR Sections 1.3.4 and 5.6.

While various testing activities are planned as described in the response to RAI 4.2.4-2-002, the design testing under the Performance Confirmation Program is focused on performance assessment. The selection of the types of data or information needed by the Performance Confirmation Program is based upon the risk-informed, performance-based activity assessment as described in SAR Section 4.1.1 and the completeness assessment in Section A.4.1[a] of *Performance Confirmation Plan* (SNL 2008). The type of information important for engineered systems and components for Performance Confirmation includes the environmental conditions that the engineered systems and components will be exposed to in the emplacement drifts. The testing of engineered systems and components related to waste package testing is covered under SAR Section 4.2.4, which also includes testing of drip shield materials because of the similarities in the testing approaches for waste package and drip shield materials (SAR Section 4.2.4).

Consistent with the response to RAI 4.2.4-002, candidate parameters as discussed in SAR Chapter 4 will be finalized in the appropriate Performance Confirmation test plan and will be provided to the NRC at first issuance prior to test implementation.

2. COMMITMENTS TO NRC

None

3. DESCRIPTION OF PROPOSED LA CHANGE

None.

4. REFERENCES

SNL (Sandia National Laboratories) 2008. *Performance Confirmation Plan.* TDR-PCS-SE-000001 REV 05 AD 01. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20080227.0003; DOC.20080324.0002.

RAI Volume 4, Chapter 2.4, Second Set, Number 2:

Provide additional information on the performance confirmation program for design testing of the drip shield system.

Basis: The two engineered components within the emplacement drift that DOE classifies as important to waste isolation are the waste package and drip shield (SAR Section 1.3.4). SAR Section 4.2.1 states that the drip shield protects the waste package from seepage and rockfall, and must maintain integrity under expected post-emplacement conditions in order to function as anticipated. DOE identifies that some performance confirmation activities directly monitor waste package and drip shield condition in a thermally accelerated drift.

SAR Section 4.1 states that the performance confirmation program for testing engineered systems and components used in the design will be developed and initiated as early as practicable during construction, and will continue into the operational period. This program will include evaluation of materials and design for drip shields, as described in SAR Section 1.3.4.7. While Chapter 4 of the SAR provides information about the program for monitoring and testing waste packages, no information is provided in the SAR about design testing of drip shields. For instance, there is no description of the drip shield design testing program such as: its purpose, what aspects of the drip shield design (e.g., structural capacity to withstand peak loads) would be tested, a description of current understanding, and methodologies to be used in testing. Furthermore, no information is provided on testing the effectiveness of drip shield placement procedures. SAR Section 1.3.4 and SAR Chapter 4 provide only two references to performance confirmation testing of the drip shield system or related components. These are:

- Drip shield material specimens will be exposed in emplacement drifts as part of the dust buildup monitoring activity.

- Materials used to fabricate drip shield components will be evaluated in the corrosion testing activity.

While only two grades of titanium are used for the various drip shield components, it is not clear which specific components would be subject to design testing (see SAR Table 1.3.4-4; Standard Nomenclature for Drip Shield Components).

1. RESPONSE

The DOE's demonstration that the drip shield system can be fabricated and installed, and will function as intended by design, consists of two parts: (1) fabrication and installation operations testing, and (2) the Performance Confirmation Program. First, the fabrication and installation operations testing is separate from the Performance Confirmation Program and ensures that the drip shield will conform to the postclosure control parameter specifications, described in SAR Table 1.3.4-5, that specify design, construction, and installation requirements necessary to meet postclosure performance specifications. Second, the Performance Confirmation Program confirms the characteristics of the drip shield materials that are the basis for those postclosure control parameters and drip shield durability. The characteristics of the materials are based upon the risk-informed, performance-based activity assessment and completeness assessment performed for the Performance Confirmation Program (SAR Section 4 and SNL 2008, Section A.4.1[a]). The two-part approach is consistent with Section 1.5 of *Performance Confirmation Plan* (SNL 2008).

Analytical results summarized in SAR Section 2.3.4.5 simulate the structural response of the drip shield under the following conditions:

- Static rock rubble load from fallen host rock from tunnel collapse in drifts located in lithophysal rock units
- Impact from large size and mass rock blocks in drifts located in nonlithophysal rock units, during a seismic event
- Interlocked drip shields subjected to design basis ground motion 2 (DBGM-2) and beyond design basis ground motion (BDBGM).

Reliable and proven analytical tools used to perform these analyses, as described in SAR Section 2.3.4.5, model and simulate the structure and characteristics of the assembly and its response to the applicable loads with a high degree of resolution of the drip shield dimensions, geometric characteristics, and strength parameters. The comprehensiveness and fidelity of these drip shield analyses preclude the need to prescribe full- or small-scale, fully integrated, structural capability testing of the assembly under the various service loading conditions during the prototyping program. The prototyping program will perform testing (including appropriate component and weld strength testing as necessary), define fabrication methods, and perform inspections that are necessary to assure that the performance characteristics of the drip shield at the time of placement satisfy the initial conditions of the drip shield performance analyses.

At the clarification call on January 13, 2010, the NRC requested relative schedules for design testing activities and confirmation that drip shields will be installed in the thermally accelerated drift. As communicated at the clarification call, the schedule for Performance Confirmation test plans has been provided to the NRC in the response to RAI 4.2.4-002. Drip shields are expected to be installed in all, or part, of the thermally accelerated drift shortly before ventilation is terminated (SNL 2008, Section 3.4.5). Planning for Performance Confirmation testing within a thermally accelerated drift will be finalized in the Performance Confirmation test plan consistent

with the schedule provided in the response to RAI 4.2.4-002. Additional information regarding the thermally accelerated drift was provided to the NRC in the response to RAI 4.2.4-003. A relative schedule for fabrication and installation operations testing is provided within this response.

1.1 Fabrication and Installation Operations Testing

The DOE will perform testing of the drip shield system as a part of drip shield development and during the initial start up of the repository systems. Those activities are separate from the Performance Confirmation Program, and occur prior to installation of the drip shields in the subsurface facility. Conformance to the postclosure control parameter specifications (SAR Table 1.3.4-5) will be achieved through fabrication inspections and through implementation of fabrication and installation procedures that meet postclosure performance requirements.

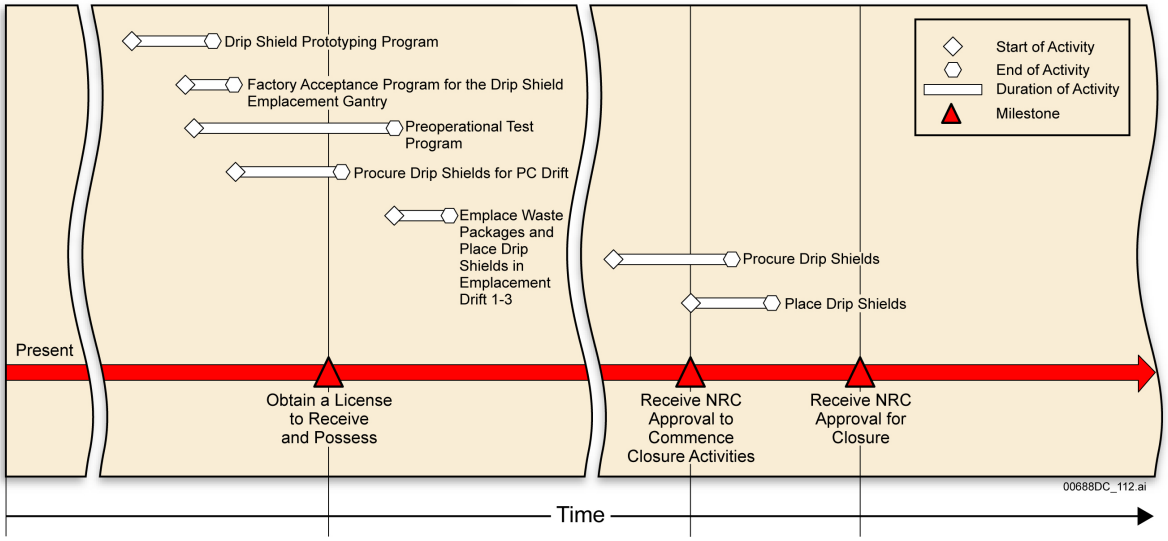
Several programs will be implemented during the preclosure period to control drip shield fabrication and handling operations. These programs will ensure compliance with the postclosure requirements for the drip shield, and include the following:

- **Drip Shield Prototyping Program—**This program, as discussed in SAR Section 1.3.4.7.7 and in the response to RAI 2.2.1.1.2-003, ensures that the design, fabrication, and fabrication inspection parameters are satisfied. The program will inform the final design of the drip shield for deployment in the thermally accelerated drift and for fabrication in advance of large scale production.

- **Factory Acceptance Program for the Drip Shield Emplacement Gantry—**The drip shield emplacement gantry is described in SAR Section 1.3.4.7. The drip shield emplacement gantry is similar in operations to the transport and emplacement vehicle (TEV) and will undergo a similar design development and testing program as the TEV, as described in the response to RAI 2.2.1.1.7-8-004. The factory acceptance program will demonstrate the capabilities of both the drip shield and the handling unit (drip shield emplacement gantry), and the interlocking capability of the drip shield as described and illustrated in SAR Section 1.3.4.

- **Preoperational Test Program—**The preoperational test program, described in SAR Section 5.5, will provide verification of the operations and equipment performance to obtain consistent results during drip shield handling and placement operations, including the accuracy of placement and effectiveness of the monitoring and alarm functions. The development of operating procedures for placement of the drip shields during this same period, described in SAR Section 5.6, will ensure that operations are compliant with the requirements of the handling and placement parameters.

Figure 1 illustrates a possible timeline for implementation of these programs and their interdependencies. The drip shield prototyping program and factory acceptance program for the drip shield emplacement gantry will begin first and proceed approximately in parallel. The drip shield prototyping program will include testing to ensure that the appropriate postclosure control parameters, assumptions, and performance requirements obtained from the postclosure analyses are satisfied during the fabrication process. This includes demonstration of the interlocking features as well as demonstration of the design capability to meet the requirements related to transportation and handling.



NOTE: PC = Performance Confirmation.

Figure 1. Possible Timeline for Implementation of Drip Shield Programs

The emplacement gantry will be engineered and fabricated to meet repository operating requirements, and a factory acceptance program will be used to demonstrate the drip shield emplacement gantry's capability to satisfy those requirements, including lifting, transporting along rails, and placement of drip shields. The factory testing will include placement of drip shields in order to demonstrate proper mating for the interlocking feature of the drip shields and the remote monitoring capability and audible alarms that are required. The procurement of the first drip shields, and finalization of these programs will be completed prior to emplacement of waste packages and drip shields in the third drift of the first panel (Emplacement Drift 1-3). This drift is identified for Performance Confirmation Program testing activities, including emplacement of drip shields (SNL 2008, Section 3.4.5).

The preoperational test program will test the performance of the emplacement gantry components to place drip shields in the repository environment to assure that they can place the drip shields, interlocked properly, without damage to the drip shields. This functional testing begins once a limited number of drip shields are procured and are available on site, and when a drip shield emplacement gantry is also available. Development of operating procedures, conducted in concert with the testing, ensures that the drip shields can be received, stored,

handled, transported, and emplaced in accordance with the requirements, in a manner which can be repeated successfully for each drip shield.

Some drip shields will be placed in the Performance Confirmation Test Drift (Panel 1, Emplacement Drift 3), consistent with the test plans that will be developed to provide an early demonstration of placement of the drip shields in an operational environment similar to that of the closure phase.

Finally, prior to closure, the balance of the drip shields needed for the repository will be procured, fabricated, and inspected to the appropriate acceptance criteria that demonstrate acceptable installation to the drip shield performance analyses initial conditions. The drip shields will be emplaced with equipment already demonstrated to be capable of performing the operations.

1.2 Performance Confirmation Program

As described in SAR Section 4, the scope of the Performance Confirmation Program does not include controls of administrative processes or operational activities associated with fabrication and installation, materials qualification, waste acceptance, or waste package handling. These activities are discussed in SAR Sections 1.3.4 and 5.6, and further discussed in Section 1.1 above.

The selection of data or information needed by the Performance Confirmation Program is based upon the risk-informed, performance-based activity assessment as described in SAR Section 4.1.1 and the completeness assessment in Section A.4.1[a] of *Performance Confirmation Plan* (SNL 2008). The major degradation mode that can affect the performance of engineered systems and components is corrosion (SAR Section 4.2.1.11). The performance confirmation activities for the drip shield system related to design testing focus on corrosion testing of the drip shield materials (SAR Section 4.2.4). Corrosion-related testing for both waste package and drip shield materials is presented in SAR Section 4.2.4 because of the similarities in the testing approach. Corrosion of the drip shield depends, in part, on the emplacement drift environment. Drift Inspection (SAR Section 4.2.1.8) indirectly informs design testing by supporting the goals of the thermally accelerated drift activities and confirmation of the general state of the drift. The environmental conditions monitored by the activities described in SAR Sections 4.2.1.9, 4.2.1.10, and 4.2.1.11 address coupled thermal-hydrologic-chemical processes that affect the amount and chemistry of the water and other environmental variables (SAR Section 4.2.4). The deliquescent properties of the salts decrease the relative humidity at which corrosion reactions occur. Thus, the composition of the dust material that falls and accumulates on the drip shield surfaces is relevant to evaluating engineered barrier component performance (SAR Section 4.2.1.8). Dust buildup monitoring is relevant to confirming the absence of localized corrosion potential on the drip shield surfaces due to dust deliquescence.

In summary, the Performance Confirmation Program activities relevant to drip shield performance are:

- Drift Inspection (SAR Section 4.2.1.8)
- Dust Buildup Monitoring (SAR Section 4.2.1.10)
- Thermally Accelerated Drift In-drift Environment Monitoring (SAR Section 4.2.1.11)
- Corrosion Testing (SAR Section 4.2.4.2)
- Corrosion Testing of Thermally Accelerated Drift Samples (SAR Section 4.2.4.3).

Consistent with the response to RAI 4.2.4-002, candidate parameters as discussed in SAR Section 4 and supported by *Performance Confirmation Plan* (SNL 2008) will be finalized in the appropriate Performance Confirmation test plan and will be provided to the NRC at first issuance prior to test implementation.

2. COMMITMENTS TO NRC

None.

3. DESCRIPTION OF PROPOSED LA CHANGE

None.

4. REFERENCES

SNL (Sandia National Laboratories) 2008. *Performance Confirmation Plan.* TDR-PCS-SE-000001 REV 05 AD 01. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20080227.0003; DOC.20080324.0002.