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U.S. Nuclear Regulatory Commission  
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Subject: Transmittal of "Performance Confirmation Action Plan" (IM20.01402.971.220).

Dear Mr. Pohle:

This letter transmits Intermediate Milestone 20.01402.971.220 "Performance Confirmation Action Plan." This work was undertaken as an activity under the Performance Confirmation Key Technical Issue.

As you know, this plan is designed to establish a framework for U.S. Nuclear Regulatory Commission (NRC) performance confirmation activities and thereby facilitate fulfillment of NRC responsibilities related to performance confirmation. NRC responsibilities related to performance confirmation are varied. Broadly, NRC has a responsibility to develop the capability to review, inspect, and evaluate the DOE performance confirmation program both in the near-term and over the life of the program to assure safety and long-term performance as required by 10 CFR Part 63. NRC needs to maintain an independent knowledge base over the necessary range of technical areas and improve existing understanding of the natural and engineered systems. These independent investigations are to be of both confirmatory and exploratory natures.

At this time, U.S. Department of Energy (DOE) has not yet formalized their performance confirmation activities. The draft DOE performance confirmation plan that was published in May 2000 is expected to be revised. That revision is expected to take account of the substantial reorganization and reprioritization ongoing within the DOE high-level waste program. The NRC performance confirmation plan transmitted by this letter establishes the breadth of the anticipated NRC program. The depth of the various parts of the NRC performance confirmation program will be determined in the future as the DOE program becomes more defined. This stepwise approach to NRC performance confirmation program design will enable our priorities to be consistent with changes in the DOE program and to the safety case that DOE plans to put forward in their anticipated License Application Safety Strategy.



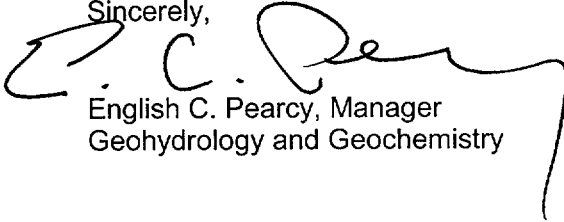
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Mrs. Barbara Meehan  
February 19, 2002  
Page 2

I appreciate your help in preparing this document. Your familiarity with Part 63 and your regulatory perspective have been instrumental in aligning this plan closely with NRC goals and requirements.

If you have any questions or comments about this deliverable, please contact me 210.522.5540.

Sincerely,



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# PERFORMANCE CONFIRMATION ACTION PLAN

*Prepared for*

**U.S. Nuclear Regulatory Commission  
Contract No. NRC-02-97-009**

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**CONTENTS**

<b>Section</b>		<b>Page</b>
1	INTRODUCTION .....	1
2	REGULATORY BASIS .....	2
3	STATUS OF PERFORMANCE CONFIRMATION ACTIVITIES .....	6
4	ACTION PLAN OBJECTIVE .....	6
5	PLANNING ASSUMPTIONS .....	8
6	ACTIVITIES DURING EACH STAGE OF THE REGULATORY PROCESS .....	9
6.1	Site Characterization Stage (Prelicensing) .....	9
6.2	Construction Stage .....	10
6.3	Period Between Construction and License to Receive and Possess Nuclear Materials .....	10
6.4	Operations Stage .....	11
6.5	License Amendment for Permanent Closure .....	11
7	REFERENCES .....	11

## **PREDECISIONAL**

### **1 INTRODUCTION**

Performance confirmation is an integral component in the U.S. Nuclear Regulatory Commission (NRC) stepwise licensing process being implemented for the proposed repository under the Nuclear Waste Policy Act. As each step in the process occurs, the NRC evaluates the U.S. Department of Energy (DOE) assessments and, if reasonably assured the applicable regulations are met, grants approval to proceed. Through a broad program of performance confirmation activities, the NRC will continue to probe and question the DOE assessments to ensure the confidence held by the NRC at the time licensing decisions were made is sustained in light of new information and new understandings resulting from performance confirmation activities. The NRC does not take for granted that initial satisfactory findings would necessarily be confirmed. An objective of performance confirmation is to analyze phenomena and conditions that could require remedial measures or warrant retrieval. Also, new scientific and engineering information or understandings acquired or attained in the future may require changes to repository operations or design to assure safety.

Performance confirmation encompasses a continuous, broad-based, technical program of tests, experiments, and analyses conducted to provide the information needed to confirm the design and performance of the repository system from site characterization through permanent closure, as specified in Subpart F of 10 CFR 63.131(b). Included under performance confirmation are continuing evaluations to confirm the understanding of natural events and processes, geologic and hydrologic responses to excavation and waste emplacement, waste package performance, and repository system operation. NRC staff need to continually evaluate these tests, experiments, and analyses so operational safety and long-term performance of the repository are assured. To fulfill this responsibility, NRC performance confirmation activities will encompass reviews and evaluations, inspections, and independent investigations of both confirmatory and exploratory natures.

The DOE is expected to submit a comprehensive performance confirmation plan with the license application for construction authorization. A draft of this plan was transmitted to the NRC in May 2000 and is currently being revised by the DOE. New and continuing tests and experiments will be identified in the plan. The NRC needs to ensure (i) the performance confirmation program tests the key assumptions of the DOE performance assessment program and (ii) the methods proposed by the DOE in its performance confirmation program are adequate. Criteria in any Yucca Mountain review plan will reflect the risk-informed view that the performance confirmation program should be focused on those conditions and phenomena (e.g., specific geotechnical and design parameters) most important to performance. It is essential for the regulatory program to maintain a breadth of activities to probe the DOE plans, assumptions, and conclusions to allow reasonable and timely response when new information important to repository performance becomes available.

The performance confirmation process ensures continuity and consistency in regulatory oversight and builds public confidence. Effective implementation of the process requires

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## PREDECISIONAL

sufficient resources to provide the breadth of relevant technical expertise, to maintain an independent knowledge base over the range of technical topics, and to allow continuing interactions with the DOE (e.g., audits, inspections, technical exchanges or other forms of interactions).

This action plan will aid in maintaining continuity of the repository program by establishing a path forward for the NRC performance confirmation activities.

## 2 REGULATORY BASIS

The final NRC regulation for Yucca Mountain 10 CFR Part 63 was promulgated on November 2, 2001. The regulation provides the specific requirements for performance confirmation and related considerations. The regulation establishes a stepwise approach for licensing of disposal of high-level waste that is the basis for the performance confirmation requirements. In Section III, Public Comments and Responses, the Commission notes that 10 CFR Part 63 "provides for a multistaged licensing process that affords the Commission the flexibility to make decisions in a logical time sequence that accounts for DOE collecting and analyzing additional information over the construction and operational phases of the repository. Clearly, the knowledge available at the time of construction authorization will be less than at the subsequent stages. However, at each stage, DOE must provide sufficient information to support that stage." (Section III, Public Comments and Responses, p. 55,739)

10 CFR 63.102(c) establishes stages for the repository process:

1. **Site Characterization Stage**—This is the period when the program of exploration and research, both in the laboratory and in the field, is undertaken to establish the geologic conditions and parameter ranges for the Yucca Mountain site, and the surrounding region, that are necessary to assess compliance with the requirements of 10 CFR Part 63. Site characterization includes borings, surface excavations, excavation of exploratory shafts and/or ramps, limited subsurface lateral excavations and borings, and *in-situ* testing at depth needed to determine the suitability of the site. The performance confirmation program is started during this stage.
2. **Construction Stage**—This stage would follow after the issuance of a construction authorization. The NRC would review a license application, including the safety analysis report, prior to construction. The safety analysis report would contain a design and analysis of the performance of the repository based on the site specific information obtained during site characterization. The NRC would prepare a safety evaluation report to document staff findings and document any license conditions.
3. **Operations Stage**—This interval would follow Commission issuance of a license to receive and possess waste. The repository design and performance assessment in the safety analysis report would be updated considering new information obtained during construction of the repository. The period of operations includes the time during which

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## PREDECISIONAL

emplacement of wastes occurs and any subsequent period before permanent closure during which the emplaced wastes are retrievable.

4. **Permanent Closure**—This period would follow Commission issuance of a license amendment for permanent closure. The application to terminate operations and permanently close the repository would again contain an updated safety analysis report with analyses of the performance of the repository considering (i) information obtained about the site during the operation of the repository; and (ii) data collected about the performance of the engineered barriers that indicate, where practicable, whether conditions are within assumed limits and systems are functioning as intended. Permanent closure represents the end of the performance confirmation program; final backfilling of the underground facility, if appropriate; and the sealing of shafts, ramps, and boreholes.

This stepwise approach is consistent with an early recommendation by the National Academy of Science (1979). The National Academy of Science (1979) recommended that repository development "... be a continuing process that includes evaluations of site suitability and satisfactory repository performance before construction, reevaluations during construction and prior to emplacement of wastes, and a final assessment before emplaced wastes are committed to disposal. Corrective actions, including removal of emplaced wastes and site abandonment, should be available options until final qualification and closure of the repository."

This recognition of the need for improved information to support licensing decisions as the stepwise process is implemented is linked to the overall performance objectives for the repository in the definition of performance confirmation in 10 CFR Part 63:

- 10 CFR 63.2, Definitions—Performance confirmation means the program of tests, experiments, and analyses that is conducted to evaluate the adequacy of the information used to demonstrate compliance with the performance objectives in Subpart E of this part.

Within Subpart E, the concept of performance confirmation is functionally related to risk-informed activities:

- 10 CFR 63.102(m), Performance Confirmation—A performance confirmation program will be 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. Key geotechnical and design parameters, including any interactions between natural and engineered systems and components, will be monitored throughout site characterization, construction, emplacement, and operation to identify any significant changes in the conditions assumed in the license application that may affect compliance with the performance objectives specified at Sec. 63.113(b) and (c).

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The burden of defining the key parameters and interactions between natural and engineered systems and components, as well as the level of detail needed, is clearly assigned in 10 CFR Part 63 to the DOE: “[I]t is important to note that it is DOE responsibility to develop the details of a performance confirmation plan that focuses on those natural and engineered systems and components important to repository performance and operation. The requirements allow DOE the flexibility to develop a focused and effective performance confirmation program.” (Section III, Public Comments and Responses, p. 55,745)

Subpart F of 10 CFR Part 63 contains explicit requirements for the performance confirmation program:

### 10 CFR 63.131, General Requirements

- (a) The performance confirmation program must provide data that indicate, where practicable, whether:
  - (1) Actual subsurface conditions encountered and changes in those conditions during construction and waste emplacement operations are within the limits assumed in the licensing review; and
  - (2) 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.
- (b) The program must have been started during site characterization, and it will continue until permanent closure.
- (c) The program must include *in situ* monitoring, laboratory and field testing, and *in situ* experiments, as may be appropriate to provide the data required by paragraph (a) of this section.
- (d) The program must be implemented so that:
  - (1) It does not adversely affect the ability of the geologic and engineered elements of the geologic repository to meet the performance objectives.
  - (2) It provides baseline information and analysis of that information on those parameters and natural processes pertaining to the geologic setting that may be changed by site characterization, construction, and operational activities.
  - (3) It monitors and analyzes changes from the baseline condition of parameters that could affect the performance of a geologic repository.

### 10 CFR 63.132, Confirmation of Geotechnical and Design Parameters

- (a) During repository construction and operation, a continuing program of surveillance, measurement, testing, and geologic mapping must be conducted to ensure that geotechnical and design parameters are confirmed and to ensure that appropriate action is taken to inform the Commission of design changes needed to accommodate actual field conditions encountered.
- (b) Subsurface conditions must be monitored and evaluated against design assumptions.

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- (c) Specific geotechnical and design parameters to be measured or observed, including any interactions between natural and engineered systems and components, must be identified in the performance confirmation plan.
- (d) These measurements and observations must be compared with the original design bases and assumptions. If significant differences exist between the measurements and observations and the original design bases and assumptions, the need for modifications to the design or in construction methods must be determined and these differences, their significance to repository performance, and the recommended changes reported to the Commission.
- (e) *In situ* monitoring of the thermomechanical response of the underground facility must be conducted until permanent closure, to ensure that the performance of the geologic and engineering features is within design limits.

### 10 CFR 63.133, Design Testing

- (a) During the early or developmental stages of construction, a program for testing of engineered systems and components used in the design, such as, for example, borehole and shaft seals, backfill, and drip shields, as well as the thermal interaction effects of the waste packages, backfill, drip shields, rock, and unsaturated zone and saturated zone water, must be conducted.
- (b) The testing must be initiated as early as practicable.
- (c) If backfill is included in the repository design, a test must be conducted to evaluate the effectiveness of backfill placement and compaction procedures against design requirements before permanent backfill placement is begun.
- (d) 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.

### 10 CFR 63.134, Monitoring and Testing Waste Packages

- (a) A program must be established at the geologic repository operations area for monitoring the condition of the waste packages. Waste packages chosen for the program must be representative of those to be emplaced in the underground facility.
- (b) Consistent with safe operation at the geologic repository operations area, the environment of the waste packages selected for the waste package monitoring program must be representative of the environment in which the wastes are to be emplaced.
- (c) The waste package monitoring program must include laboratory experiments that focus on the internal condition of the waste packages. To the extent practical, the environment experienced by the emplaced waste packages within the underground facility during the waste package monitoring program must be duplicated in the laboratory experiments.

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- (d) The waste package monitoring program must continue as long as practical up to the time of permanent closure.

It should be noted that these requirements call for performance confirmation data to be collected "where practicable." The Commission recognizes that it will not be practicable to obtain performance confirmation data in all cases. DOE has the responsibility to identify items important to repository performance but not amenable to direct observation and will require indirect performance confirmation (e.g., analog studies, laboratory testing, and such). If DOE finds there are key performance factors not addressable through performance confirmation activities, DOE is expected to identify such factors and the means by which DOE proposes to manage them (e.g., by safety margins).

### 3 STATUS OF PERFORMANCE CONFIRMATION ACTIVITIES

At the writing of this plan, DOE has not yet formalized their performance confirmation activities. DOE has published a draft Performance Confirmation Plan (DOE, 2000) that provides insight into their proposed approach. That plan is expected to be revised taking into account clarifications provided by NRC in the final 10 CFR Part 63 and other considerations.

The Electric Power Research Institute published a report in December 2001 that summarizes the results of a workshop they organized to encourage timely discussion of performance confirmation (Electric Power Research Institute, 2001). Workshop participants included DOE, NRC, and the public. Discussions at the workshop and in the summary report indicate there is no consensus within the DOE about those activities that will be part of their performance confirmation plan versus those activities that will be part of other DOE long-term research and development activities. There also appears to be no consensus about the details of how DOE will identify and prioritize their performance confirmation activities. The existing DOE performance confirmation plan identifies a proposed set of activities based on the DOE "principal factors," but DOE does not have a fixed set of criteria for defining their performance confirmation program. The performance confirmation period begins during site characterization, and there is general recognition among the DOE representatives at the workshop that many of the ongoing site characterization activities at Yucca Mountain will provide baseline data for use in the performance confirmation program. Nevertheless, at this time, no specific DOE activities have been identified as part of their performance confirmation program.

### 4 ACTION PLAN OBJECTIVE

The objective of this plan is to establish a framework for NRC performance confirmation activities that will facilitate NRC responsibilities to

- Maintain public confidence that public health and safety are protected by providing consistency of regulatory oversight and establishing the NRC requirements and responsibilities for performance confirmation. A related task is to

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- Develop and implement an NRC performance confirmation action plan.
- Develop the NRC capability to review, inspect, and evaluate the DOE performance confirmation program both in the near-term and over the life of the program to assure safety and long-term performance as required by 10 CFR Part 63. Related tasks include
  - Specify those conditions, phenomena, and design and operating parameters most important to repository performance.
  - Based on risk insights, identify those DOE plans, assumptions, and conclusions that warrant particular attention of the NRC to allow reasonable and timely response when new information becomes available.
  - Develop relevant inspection plans.
  - Develop performance evaluation plans.
  - Develop safety question evaluation plans.
  - Develop design evaluation plans.
  - Finalize the performance confirmation section of any future Yucca Mountain review plan.
- Maintain an independent knowledge base over the necessary range of technical areas and improve existing understanding of the natural and engineered systems. Related tasks include
  - Define the breadth of the NRC performance confirmation activities (both proactive and reactive) necessary to probe the DOE plans, assumptions, and conclusions.
  - Prioritize the NRC performance confirmation activities based on risk insights and importance to performance.
  - Identify the technical expertise required to meet the NRC responsibilities.
  - Estimate resources required to support the NRC performance confirmation activities over both the near term and long term.

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**5 PLANNING ASSUMPTIONS**

In developing this plan, the staff assumed that

- The DOE will comply with the requirements of 10 CFR 63.32, 63.74, 63.75, 63.131, 63.132, and 63.133.
- The DOE will implement a performance confirmation plan similar to that described in the DOE May 2000 performance confirmation plan (under revision), such as activities to confirm models of
  - Corrosion of the waste package
  - Degradation of spent nuclear fuel cladding
  - Dissolution of spent nuclear fuel and high-level waste glass
  - Thermal effects on water chemistry in repository drifts
  - Seepage of water into repository drifts
  - Flow rates in the saturated and unsaturated zones
  - Retardation mechanisms (e.g., chemical sorption) in the unsaturated and saturated zones
  - Drift stability
- The NRC will continue to interact with the DOE through audits, inspections, technical exchanges, and other venues to evaluate the performance confirmation program.
- Licensing conditions and technical specifications will be established, as a minimum, in the areas required by 10 CFR 63.42, 63.43, 63.44, 63.45, and 63.46.
- A Yucca Mountain review plan will be finalized.
- The DOE will submit the license application for construction authorization in late 2004 or early 2005.
- The NRC will implement a 3-year license application review.

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### 6 ACTIVITIES DURING EACH STAGE OF THE REGULATORY PROCESS

#### 6.1 Site Characterization Stage (Prelicensing)

There are two major goals for NRC performance confirmation activities during the site characterization stage: (i) ensure that adequate baseline data are gathered by DOE, and (ii) establish procedures and plans to evaluate DOE performance confirmation activities in advance of construction authorization. Activities include

- Review the DOE performance confirmation plan using a Yucca Mountain review plan.
- Review existing DOE baseline information for performance confirmation (e.g., geologic conditions and ranges of parameters for the Yucca Mountain site and surrounding region, performance of engineered materials, and such).
- Evaluate existing and ongoing DOE activities to develop baseline information for performance confirmation:
  - Review DOE field and laboratory tests and experiments supplying baseline information for performance confirmation.
  - Review DOE modeling activities supplying baseline information for performance confirmation.
- Conduct a technical exchange with the DOE to clarify any remaining uncertainties in the 10 CFR Part 63 requirements and elicit DOE views on their development of baseline information for performance confirmation.
- Identify and prioritize NRC performance confirmation tasking [highest priority given to (i) items for which the sensitivity of long-term performance is high and (ii) those items that warrant particular attention to allow reasonable and timely response should new information that was unanticipated become available].
- Develop inspection procedures for the DOE performance confirmation related activities.
- Develop and implement performance evaluation plans.
- Develop safety question evaluation plans.
- Develop and implement design evaluation plans.
- Participate in quality assurance audits of the DOE related to performance confirmation related activities.

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The following sections provide the framework for the NRC activities after the site characterization period.

### **6.2 Construction Stage**

The DOE performance confirmation activities should be designed for the life of the repository as required by Subpart F (e.g., long-term testing, accelerated testing, long-term field and lab experiments for slow geologic, hydrologic, geochemical, engineered material degradation, and other processes). NRC will review the final DOE design to ensure performance confirmation activities are integral parts of the design and they do not negatively affect repository performance. Performance measures for performance confirmation defined by DOE will be reviewed. DOE is expected to develop plans for actions in the event that performance parameters are found to be out of bounds. DOE models with coarse temporal discretization used for the initial license application may be of limited use for estimating performance for the first few decades and will need to be modified. The DOE total system performance assessment is expected to be revised to reflect new information and interpretations. The DOE may propose changes to designs or operations to optimize repository construction and operation. As part of the license application, the DOE will have developed plans to address unresolved safety questions (10 CFR 63.21 and 63.32). The DOE will have initiated testing activities under 10 CFR 63.74. Inspections will have been initiated under 10 CFR 63.75. The license will have various conditions and specifications under 10 CFR 63.42, 63.43, 63.44, 63.45, and 63.46 that will affect the scope of the NRC evaluation activities. NRC oversight of these DOE activities will encompass reviews and evaluations, inspections, and independent investigations of both confirmatory and exploratory natures.

### **6.3 Period Between Construction and License to Receive and Possess Nuclear Materials**

Considerations: New information will become available during construction and as a result of continued DOE performance confirmation activities (field and laboratory testing, computer modeling, analog studies, and such). New results will emerge from the DOE research and development programs conducted to address safety questions, if any. The construction authorization will include a safety analysis report with a detailed design and analysis of the performance of the repository derived from the baseline performance confirmation information. Considering the new information the DOE may make changes to the repository design or operations. The DOE total system performance assessment is expected to continue to be revised to reflect new information and interpretations. The DOE may propose to relax earlier conservatisms as new information is acquired. Uncertainties in performance calculations will persist despite years of additional DOE work, and reasonable assurance must still be demonstrated. NRC oversight of these DOE activities will continue to encompass reviews and evaluations, inspections, and independent investigations of both confirmatory and exploratory natures.

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### 6.4 Operations Stage

Considerations: The repository design and performance assessment in the Safety Analysis Report will have been updated further based on new information obtained during construction. Operational experience may also result in previously unanticipated requirements. Additional results will emerge from the DOE research and development programs conducted to address safety questions. Because of the new information, the DOE may make changes to repository design or operations. The DOE total system performance assessment should continue to be revised to reflect new information and interpretations. DOE may propose to relax earlier conservatisms as new information is acquired. Uncertainties in performance calculations will persist despite years of additional DOE work, and reasonable assurance must still be demonstrated. NRC oversight of these DOE activities will continue to encompass reviews and evaluations, inspections, and independent investigations of both confirmatory and exploratory natures.

### 6.5 License Amendment for Permanent Closure

Considerations: The NRC must evaluate the suitability of the repository for final closure. A final update to the safety analysis report will have been prepared based on new site information obtained during operation and from data collected on the performance of the engineered barrier system. Uncertainties must be acceptably resolved for those features, events, and processes known at the time of earlier applications and those that become known during the operations stage. Computer hardware and software will have fundamentally advanced. Scientific knowledge and understanding of phenomena and processes will have fundamentally advanced. A program for postpermanent closure monitoring is required.

## 7 REFERENCES

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