Repository Performance Confirmation-12119

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ABSTRACT

Repository performance confirmation links the technical bases of repository science and societal acceptance. Among the countless aspects of monitoring, *performance confirmation* holds a special place, involving distinct activities combining technical and social significance in radioactive waste management. Discussion is divided into four themes:

1. A distinction is drawn between *performance confirmation* monitoring and *other* testing and monitoring objectives,
2. A case study illustrates confirmation activities integrated within a long-term testing and monitoring strategy for Yucca Mountain,
3. A case study reviews compliance monitoring developed and implemented for the Waste Isolation Pilot Plant, and
4. An approach for developing, evaluating and implementing the next generation of performance confirmation monitoring is presented.

International interest in repository monitoring is exhibited by the European Commission Seventh Framework Programme “Monitoring Developments for Safe Repository Operation and Staged Closure” (MoDeRn) Project. The MoDeRn partners are considering the role of monitoring in a phased approach to the geological disposal of radioactive waste. As repository plans advance in different countries, the need to consider monitoring strategies within a controlled framework has become more apparent. The MoDeRn project pulls together technical and societal experts to assimilate a common understanding of a process that could be followed to develop a monitoring program. Experience from two repository programs in the United States sheds light on how performance confirmation has been executed. Lessons learned can help the next generation of performance confirmation.

INTRODUCTION

Conducting science and developing a highly regulated facility necessitate an awareness of design, licensing, construction, and operations, as well as external influences. The long-term strategy must continue to effectively defend the licensing bases, incorporate societal input, provide for a responsive performance confirmation program, and continue appropriately scoped elective scientific investigations to advance general technical understanding. A long-term testing and monitoring strategy for repository science will continue for the life of the repository project as an integral part of the licensing processes consistent with statutory and regulatory constraints. Elements of the science program that are directly incorporated into a license application and demonstrative of the safety case, such as performance confirmation, are a critical part of the broader science program.

The performance confirmation program develops along with the maturing of the other components of the science program. Upon licensing, performance confirmation objectives become *de facto* monitoring requirements because parameters will be predicated on the most influential elements of the safety assessment. Elective science by contrast includes research elements deemed appropriate to enhance the repository baseline information, to evaluate barrier performance, to address remaining uncertainties, or perhaps to reduce conservatism in some models.

Performance confirmation testing and monitoring are 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. Two key aspects of a successful performance confirmation program are: (1) the selection of the parameters to be measured or monitored, and (2) the determination of the conditions for which the regulatory authority would be notified regarding measured and monitored information that differs from the technical baseline. Performance confirmation is a binding commitment to the regulator that is consummated in the licensing process.

DEVELOPMENT, IMPLEMENTATION AND EVALUATION

A hierarchy for developing a performance confirmation program is sketched in Fig. 1, which describes similar strategies developed in Belgium and the USA [1]. First, the national statutory and regulatory framework governs strategic choices. The high-level policies are often called “boundary conditions,” as reflected in Fig. 1. Strategic choices for each country context would include the geologic formation, the waste inventory and the concept of disposal. As illustrated in Fig. 1, inputs at higher levels dictate many of the specific requirements, which after evaluation are implemented into performance confirmation activities. After the requirements are established, the methods of implementation, evaluation and feedback are defined at increasing levels of detail. The figure illustrates how requirements were evaluated and implemented for performance confirmation of Yucca Mountain in the United States. In Fig. 1, the *assessment basis* that might be used in other repository programs may involve similar processes as applied in the Yucca Mountain assessments shown in the lower right as feeding back to the requirements.

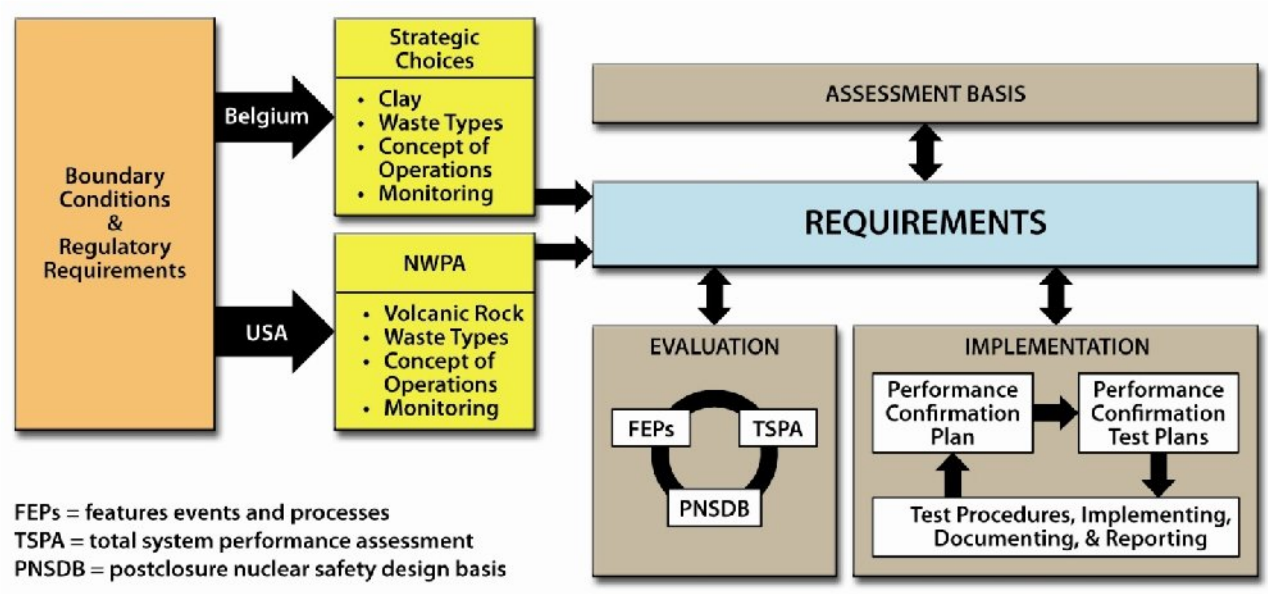

Fig. 1. Hierarchy for developing and assessing performance confirmation

Confirmation parameters for any repository program will involve appreciable technical input, which must be objectively justified. Test parameters to be monitored or measured for performance confirmation derive from sources such as illustrated in Fig. 2. Note these parameter sources are the same as used for the technical assessment and evaluation illustrated in Figure 1. In Fig. 2, the performance assessment sequence shown on the left-hand side identifies many of the most important parameters influencing risk and dose. Similarly, the design basis for postclosure safety as shown on the right-hand side identifies parameters and characteristics of features and components important to barrier capability. If it is possible to test or monitor these quantities, they could become candidates for inclusion in the confirmation program. Candidate confirmation parameters are selected from the results of the performance assessment and the FEPs analysis of the barriers as shown in Fig. 2.

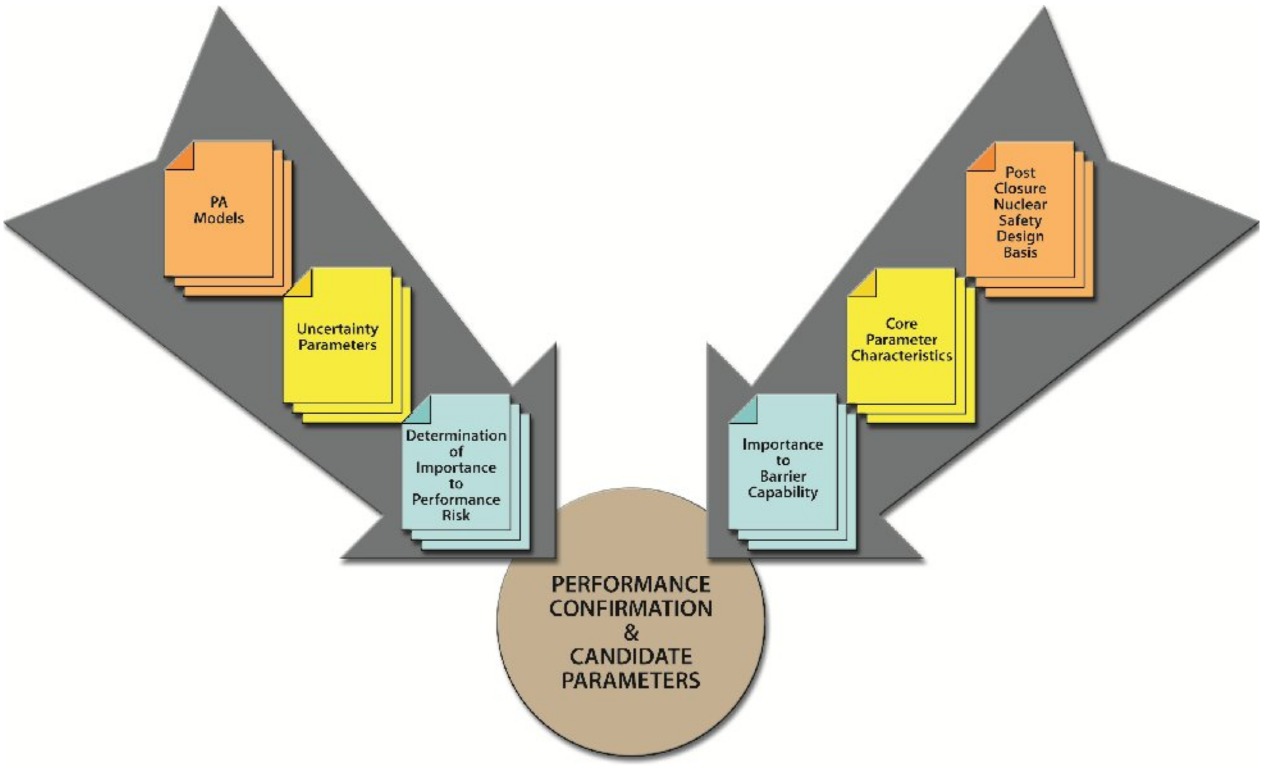

Fig. 2. Sources used to identify performance confirmation parameters

The Electric Power Research Institute [2] outlined an eight-stage approach for performance confirmation:

1. Select performance confirmation parameters and test methods
2. Predict performance and establish a baseline
3. Establish bounds and tolerances for key parameters
4. Establish test completion criteria and variance guidelines
5. Plan activities and construct and install the performance confirmation program
6. Monitor, test, and collect data
7. Analyze and evaluate data
8. Recommend corrective action in the case of variance.

The eight stages of the EPRI performance confirmation approach rely on the selection of parameters subject to testing based on the sensitivity to performance. It is imperative to recognize the enormous amount of work that needs to be completed *before* parameters are selected for performance confirmation activities. Along with parameter selection are data quality objectives, trigger values, and objective justification, which are taken up as part of implementation and evaluation.

Implementation of performance confirmation activities is an iterative process of test plan development, deployment, acquisition of data, evaluation of the data relative to the licensing bases, and then using results to guide further activities. The overall testing and monitoring program is expected to develop jointly with stages of repository advancement and refinement of the understanding of the repository system.

Performance confirmation testing and monitoring are implemented using a specific test plan, which is usually initiated and justified by a principal investigator. Based on the safety case, the principal investigator(s) will establish parameters, data quality objectives, and ranges for confirmation testing and monitoring. The diagram shown in Fig. 3 incorporates the eight steps identified by EPRI [2] in the implementation process. Fig. 3 further illustrates the iterative assessment process associated with performance confirmation implementation. Individual PC test plans are developed, reviewed, authorized, and implemented. These requirements are then translated into a structured set of testing and monitoring needs that address long-term repository performance and support the decision-making process. Detailed requirements for individual monitoring or testing activities describe the parameter's importance to barrier capability, specify an acceptable (expected) parameter range, and describe the procedure and actions required for handling results outside of the expected range.

Performance confirmation programs are developed and implemented under the provisions of strict quality assurance requirements. Specific requirements for testing and data management are developed in PC test plans and implementing procedures. These test plans contain sufficient detail to conduct the test, as well as describe applicable functional and test-specific requirements. Approved plans provide the primary means to reach a documented consensus on all aspects of a test or experiment, including design, cost, schedule, interface controls, and data management. These plans are used for review and documentation of the test effort and serve as an agreement between the principal investigator, the test implementing organization, and the authorizing management.

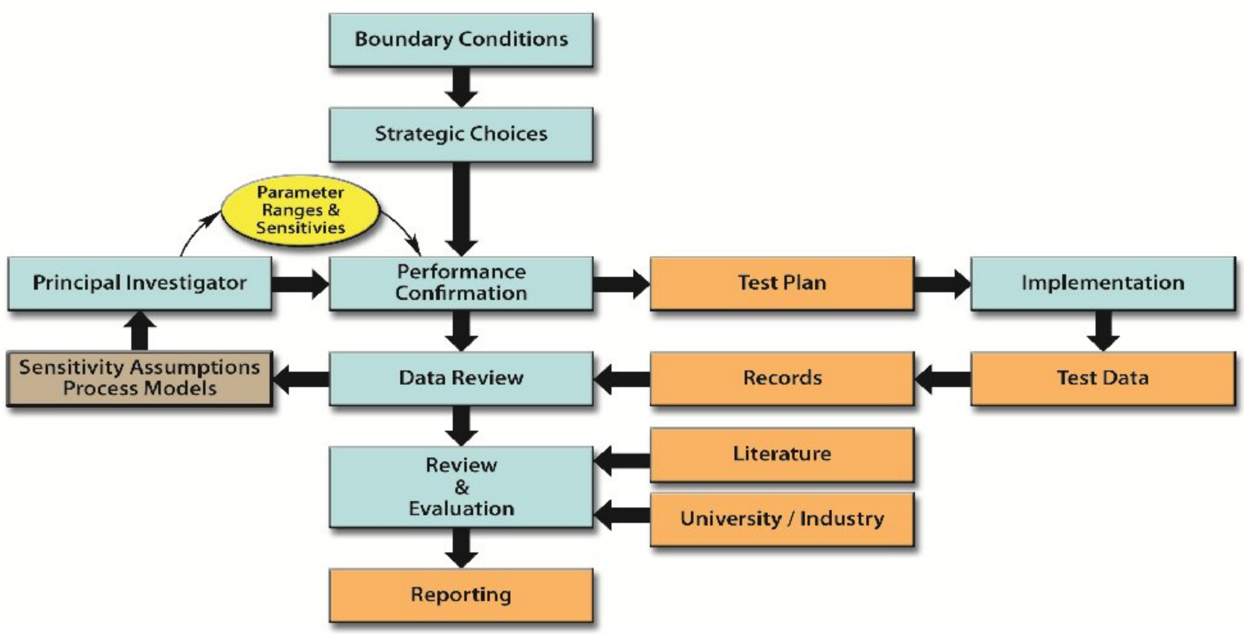

Fig. 3. Implementation of a performance confirmation program

Enhancing the technical baseline by testing and monitoring can confirm or challenge assumptions made in performance predictions supporting the licensing submittal. Results that call into question the adequacy of assumptions, data, or analyses in the baseline information will initiate additional examination and evaluation. The repository program will adapt to inevitable changes, which are anticipated from technical advances, possible design alternatives, or similar circumstances. An evaluation of changes with respect to the postclosure technical basis and performance assessment is a recognized part of change control management. The testing and monitoring program includes a process to reevaluate, reexamine, and modify activities in a flexible and responsive manner.

PERFORMANCE CONFIRMATION FOR YUCCA MOUNTAIN

The extensive process involved with development of the safety case for Yucca Mountain provided opportunity to approach performance confirmation in assorted ways. The fundamental premise was always understood: confirmation evaluates information used as input to models, or evaluates whether observed behavior is consistent with expected or modeled performance. Before the move to rescind the Yucca Mountain license application, the enduring confirmation program was reviewed, evaluated, and updated as needed to reflect new technical, programmatic, and regulatory information and maintain consistency with the licensing bases. Development of the performance confirmation process and its accomplishments over the life of the Yucca Mountain project provide an informative case study.

The license application submitted in 2008 contains an updated total system performance assessment (TSPA), which includes the latest assumptions and technical information available to the project. The basis for the safety case as supported in the TSPA identifies the influential parameters for potential monitoring. To ensure consistency between the confirmation program developed by the decision analysis techniques and the TSPA supporting the license application, an evaluation was performed at the time of the license application submittal. The adequacy of the confirmation activities described in the PC Plan is summarized in the Yucca Mountain Safety Analysis Report (SAR) [3], which can be found on the web (http://www.nrc.gov/waste/hlw-disposal/yucca-lic-app/yucca-lic-app-safety-report.html). This evaluation confirmed that the existing performance confirmation activities provide a breadth of investigations sufficient to evaluate the performance basis of the license application and provide for continued evaluations into the future. Later in this paper, we describe how the performance confirmation planning would update the activities to capture the most important parameters with respect to appropriate performance metrics.

The approach that ultimately identified the performance confirmation activities used risk information to focus attention on issues important to public health and safety. The evaluation methodology is described elsewhere, such as the PC Plan [4] or SAR [3]. The process will be summarized here to set the stage for a more appropriate methodology discussed later in this document. The so-called risk triplet (*What can go wrong? How likely is it? What are the consequences?*) was applied to a set of parameters identified by subject matter experts[1]. The decision analysis process thereby initiated with subject matter experts identifying key individual natural system and engineering parameters of interest to the definition of performance confirmation, together with methods of data acquisition.

The performance confirmation basis that was included in the license application submitted to NRC for the repository construction authorization [3] relates the elements of the performance confirmation program to the regulatory requirements. We have briefly reviewed the multiattribute decision analysis process for selection of performance confirmation activities. In retrospect, although it is described in detail and documented in reports, the selection process was subjective in many respects, and perhaps not as objectively transparent as desired from a technical or stakeholder perspective. Nonetheless, the performance confirmation activities were subsequently evaluated on the eve of the license application to ensure consistency between the activities described in the PC Plan and the content requirements of the SAR. The existing performance confirmation activities support the technical basis for postclosure performance assessment of the natural and engineered barriers and provide adequate coverage to confirm the licensing basis [4].

In September 2011NRC released its findings on the performance confirmation section of the SAR. The NRC Technical Evaluation Report on the Content of the U.S. Department of Energy's Yucca Mountain Repository License Application Administrative and Programmatic Volume is publicly available on the NRC website (pbadupws.nrc.gov/docs/ML1125/ML11255A152.pdf). The NRC finds that the performance confirmation program is consistent with the NRC's Yucca Mountain Review Plan (YMRP).

> The SAR includes a description of the Performance Confirmation Program, which evaluates the adequacy of the supporting assumptions, data, and analyses in the SAR…On the basis of the NRC staff's review of the SAR and other information submitted in support of the SAR, the NRC staff notes that DOE has provided a reasonable description of its Performance Confirmation Program that is consistent with the guidance in the YMRP.

PERFORMANCE CONFIRMATION FOR WIPP

As discussed above, an overall monitoring program is based on assumptions and regulations for the disposal concepts and waste types. Monitoring requirements logically derive from the functional, operational, and postclosure goals. Monitoring a radioactive waste disposal facility ensures protection of the public and environment from current and potential future hazards. This is accomplished by undertaking activities that

[1] Note the process begins in this instance with selection of parameters by subject matter experts. As will be discussed, a more formal and transparent process for selection of confirmation parameters based on the results of performance assessment may serve to establish the relevance of the parameter to performance metrics and reduce the number of parameters.

confirm compliance with applicable protective regulations and through activities that confirm critical aspects of the expected performance of the repository.

Because monitoring is a confirmatory activity, information gathering occurs before and during operations, and could continue after the facility is closed. Similar to Yucca Mountain, the WIPP monitoring spectrum includes different categories that apply to a disposal system, which in the relevant documentation are termed environmental monitoring, operations monitoring, and performance confirmation defined as follows:

- *Environmental monitoring* includes sampling and evaluation of air, surface water, groundwater, sediments, soils, and biota for radioactive contaminants. This type of monitoring determines public and environmental impact of the site. Comparisons are then possible between baseline data gathered before site operations and data generated during disposal operations.
- *Operations monitoring* is defined here as monitoring activities used to comply with regulatory requirements for general siting, facility operations, and decommissioning. These requirements are identified in existing regulations, state agreements or organizational agreements.
- *Performance Confirmation* constitutes a program of tests, experiments, and analyses that is conducted to evaluate the adequacy of the information used to demonstrate compliance with the site specific preclosure and postclosure performance objectives. In the WIPP case, some performance confirmation monitoring started during initial site characterization.

Thus performance confirmation is distinct from the many other monitoring practices involved with environmental permits and repository operation. The WIPP documents refer to performance confirmation as “compliance” monitoring. Periodic review of these monitoring parameters is necessary to meet the intent of the EPA’s assurance requirements applicable to WIPP, 40 CFR 191.14(b):

> Disposal systems shall be monitored after disposal to detect substantial and detrimental deviations from expected performance. This monitoring shall be done with techniques that do not jeopardize the isolation of the wastes and shall be conducted until there are no significant concerns to be addressed by further monitoring.

The DOE oversees and directs the monitoring program to ensure compliance with the EPA monitoring and reporting requirements. Observations beyond the acceptable range of trigger values represent a condition that requires further evaluation. This approach ensures that conditions that challenge expected repository performance are recognized as early as possible. These conditions may include data inconsistent with the conceptual models implemented in performance assessment or invalidation of assumptions and arguments used in screening FEPs.

Technical decisions for selection of parameters to be monitored and analyzed should be made accounting for regulatory requirements, modeling assumptions, features, events, and risk information derived from performance assessment results. Uncertainty and sensitivity analyses often quantify the importance of the parameters that are candidates for monitoring in the performance confirmation plan. Such statistical analyses are likely to provide a sufficient set of diagnostics to justify parameters selected as well as the parameters not selected for performance confirmation monitoring.

Preclosure and postclosure monitoring at WIPP was described in detail in Appendix MON of the Compliance Certification Application (CCA) [5]. Significant and measurable parameters were screened by summarizing the regulatory requirements (40 CFR 191.14(b) and the criteria in 40 CFR 194.42). The five screening criteria applied to the parameters individually were:

- Addresses significant disposal system parameters,
- Addresses an important disposal system concern,
- Obtains meaningful data in a short time period,
- Does not violate disposal system integrity, and
- Complements Resource Conservation and Recovery Act programs.

The WIPP CCA also suggests postclosure monitoring of subsidence and application of other possible geophysical techniques. Monitoring and measurement activities include the determination of values that are directly and indirectly related to parameters that have survived a screening process which includes the criteria described above. These ongoing monitoring programs include geomechanics/geotechnical, groundwater, environmental, volatile organic compounds, and subsidence surface surveys. The connection—or lack of one—between these parameters and FEPs embodied in performance assessment is addressed in the next section.

In general, the screening practices noted above were *not* predicated on a direct or indirect correlation to system performance metrics, as was the case for Yucca Mountain performance confirmation parameters. The WIPP project continues to monitor these ten parameters diligently and report annually in what are called compliance monitoring parameters reports, or COMPs. Although the screening criteria for WIPP parameters appear to be rather subjective, the monitoring program has proven to be effective both for the technical purposes and the societal or public assurance purposes. Relevance of each activity and associated monitoring parameter are given below:

- **Creep Closure and Stresses**—Closure rate increase signals potential de-coupling of rock.
- **Extent of Deformation**—Coalescence of fractures at depth in rock surrounding drifts will control panel closure functionality and design, as well as discretization of performance assessment models.
- **Initiation of Brittle Deformation**—A qualitative parameter and not related to performance.
- **Displacement of Deformation Features**—Lateral displacement of boreholes allows global interpretation of rock mass behavior.

- **Culebra Ground Water Compositions**—Provide validation of the various conceptual models, potentially significant with respect to flow, transport, and solubility and redox assumptions.
- **Change in Culebra Ground Water Flow**—Provides validation of transmissivity models and the groundwater basin model.
- **Drilling Rate**—Direct-release calculations are influenced by drilling rate changes.
- **Probability of Encountering a Castile Brine Reservoir**—EPA conducted analyses that indicate a lack of significant effects on performance from changes in this parameter.
- **Subsidence Measurements**—Predictions are of low consequence to the calculated performance of the disposal system.
- **Waste Activity**—May affect human intrusion scenarios, so a substantial change in average activity of intersected waste is potentially significant.

As pointed out by Hansen and Stein [6], there are several important characteristics of the WIPP underground that can be modeled more accurately and that perhaps could be monitored. However, the original parameters remain unchanged.

Monitoring requirements and possible improvements have been revisited since disposal operations commenced, and have concentrated on major uncertainties in the existing performance assessment, and on known differences between the performance assessment models and the actual conditions existing or expected within the waste room. Of specific note with respect to monitoring is a report by the National Academy of Sciences National Research Council Panel, entitled *Improving Operations and Long-Term Safety of the Waste Isolation Pilot Plant* [7]. The Panel report in 2001 was the first such review following the certification of the facility by the EPA in 1998. The Panel was tasked: (1) to identify technical issues that can be addressed to enhance confidence in the safe and long-term performance of the repository and (2) to identify opportunities for improving the National Transuranic (TRU) Program for waste management, especially with regard to the safety of workers and the public. The NAS panel report [7] makes specific recommendations tying monitoring to performance indicators:

> The CCA relies on a model, called a "performance assessment," that calculates the probability and consequence of several scenarios by which radionuclides could be released into the environment. The performance assessment also identifies the major uncertainties and their impact on the overall performance of the system. To reduce some of the uncertainties in the performance assessment and to add confidence in the containment performance of the repository, *the committee recommends taking advantage of the long (35 to possibly 100 years) preclosure operating period to monitor selected performance indicators.*

Notwithstanding these worthy comments from an outside advisory Panel, none of these recommendations led to addition or deletion of the compliance monitoring parameters for WIPP. Today, the original ten parameters are monitored.

DISCUSSION

Prioritization of parameters for the monitoring program should be traceable back to the safety and feasibility statements (and hence, the FEPs of the disposal system) in terms of their importance to barrier capability and waste isolation. These relationships can be derived by statistical postprocessing of the computations comprising the safety performance assessment. Earlier sections stressed the concept that performance confirmation parameter identification is a result of several prerequisite analyses. The decision analysis methodology applied early in Yucca Mountain generated over 300 parameters, activities, and data acquisition methods. Based on these experiences, the technical essence of performance confirmation is now reviewed in the context of performance assessment. This process illustrates how rigor and attendant transparency can improve the process for set-up of repository performance confirmation in days ahead.

A performance confirmation program evaluates information used as input to models, or evaluates whether observed behavior is consistent with expected or modeled performance. It is understood that a performance confirmation program should remain as consistent as possible with the license application baseline information. To achieve that goal, the performance confirmation plan would continue to be reviewed, evaluated, and updated as needed to reflect new technical, programmatic, and regulatory information. The following blueprint describes possible steps for confirmation parameter selection.

All repository postclosure analyses will have a number of models developed on the basis of FEPs. Models, parameters, and processes used for the Yucca Mountain license application were evaluated in advance of the license application. Parameters were identified whose uncertainties have significant effect on dose to the reasonably maximally exposed individual over the regulatory periods. The parameters in TSPA models that are most significant were identified and then weighed against planned performance confirmation activities [4]. TSPA model results derive from particular parameter distributions and other assumptions. Therefore, the testing and monitoring details, including justification, parameter ranges and condition limits, can be gleaned from the TSPA baseline. Front-end analyses for these purposes are available, including uncertainty and sensitivity analyses for expected dose and other statistics [8, 9]. These and other analyses provide the bases for a transparent selection of confirmation parameters.

Values for standard rank regression coefficient (SRRC) were used to guide qualitative evaluations. The SRRC values were available from Appendix K of the TSPA analysis model report [8]. The evaluation and ranking of each TSPA model was summarized model-by-model to identify the performance confirmation activity or activities that apply. In this manner, it was determined that influential TSPA models had identifiable performance confirmation activities in the license application documentation. A complete listing of the process models used in TSPA was compiled, including the input parameters and the output parameters. Uncertain parameters for each model were ranked by level of importance based on sensitivity analysis of total calculated dose. Qualitative evaluations of model parameters and processes were based on TSPA results and knowledge of the processes contributing to dose. The models and parameters used in TSPA were compared to the activities and candidate parameters included in the PC Plan. A comparison of sensitivity analysis results can be based on correlation coefficients, which provide an estimate of the monotonic relationship between input variables and the output variable under consideration.

Evaluation of parameters involves getting into the details of the models. Insight regarding the most significant parameters is consistent with technical documentation used for the license application safety case. In Appendix K of the TSPA analysis/model report [8], stepwise rank regression is used to identify those parameters that make the largest contribution to dose uncertainty. In a stepwise rank regression, the single independent variable that makes the largest contribution to the uncertainty in the dependent variable is selected in the first step. Then, at the second step, the single independent variable that, in conjunction with the first variable, makes the largest contribution to the uncertainty in the dependent variable is selected. This process then continues until no additional variables are found that make identifiable (i.e., significant) contributions to the uncertainty in the dependent variable; at this point, the stepwise selection process terminates. In the context of stepwise regression analysis, variable importance is indicated by the sign and magnitude. A positive SRRC indicates that the independent variable and dependent variable tend to increase and decrease together, whereas a negative SRRC indicates that the independent and dependent variable tend to move in opposite directions. Values of SRRC were compared to the sensitivity analysis results in Appendix K of the TSPA analysis/model report [8].

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 principal investigator 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 allow for natural or measurement-related variability and include values used for the performance assessment analyses. These considerations assure that the performance assessment results remain acceptable if the performance confirmation values remain within these ranges. A substantial margin is likely to exist between condition limits outside the expected range and values influencing barrier functionality or compliance with performance objectives. The condition limits are based on the performance assessment model, validity conditions, importance to barrier capability, the results of uncertainty and sensitivity analyses, and evaluation of available data.

CONCLUSION

There are many categories of testing and monitoring programs required to design, construct, operate, and close a nuclear waste repository. These include: performance confirmation testing and monitoring; design construction and operations testing; licensing specification testing; security, safeguards, and emergency testing; regulatory directed testing; natural and engineered systems testing and evaluation; health and safety effluents monitoring; and elective science and technology testing. Documented results of many of these testing and monitoring programs will be required to satisfy the regulatory requirements for the repository. The criteria by which activities will be evaluated for inclusion into a given category of the testing and monitoring programs, the functions each category addresses, and the current list of activities in each category will be developed at the appropriate time and for the intended purpose. Performance confirmation is a specific element among these many other programs.

The performance confirmation plan for Yucca Mountain is used as the primary example of how the next generation of such plans can be accomplished. In a general sense, the performance confirmation plan addresses uncertainties within the performance assessments used for estimating long-term safety and is intended to increase confidence that the performance objectives designed to protect public health and safety are satisfied. Specific performance confirmation activities are expected to evolve and the plans will be updated accordingly. This progression could be based on statistical studies of the TSPA data that identify parameters most significant to performance metrics.

As the licensee for both WIPP and Yucca Mountain, DOE supplied the technical basis for the models used in the performance assessment. In turn, the performance assessment constitutes much of the safety case for compliance certification or license approval for WIPP and Yucca Mountain, respectively. Performance confirmation provides data to verify the adequacy of the information presented in the certification or license application. Despite the differences in mission, geologic setting and regulatory authority, the basic workings between the safety case performance assessment and performance confirmation are analogous. In the case of the WIPP repository, the compliance monitoring program has been successfully implemented and is evaluated and reported annually. If the license review of the Yucca Mountain proceeds successfully, a transparent and technically objective course forward has been identified for its performance confirmation program.

Experience with the WIPP and Yucca Mountain nuclear waste repository programs involved dissimilar media, EPA versus NRC regulators, unlike waste inventories and differing disposal concepts. However, both programs embrace a performance confirmation strategy and from these experiences guidance can be rendered for future performance confirmation considerations:

- Performance confirmation parameters should be demonstrably linked to the safety assessment.
- In some manner, performance confirmation begins during site characterization but formally becomes a commitment when it is included in a license submittal.

- Because PC test plans require detail including acceptable ranges and relevance to performance assessment, care should be exercised in development of and commitment to each PC test plan.

The phased nature of repository development allows progressive development of performance confirmation approaches. The overall Yucca Mountain testing and monitoring program envisioned at the point of license application was flexible relative to the stage of repository development such as construction or operations, regulatory requirements, and the continuing refinement of the understanding of the repository system. Elements of the performance confirmation program start during site characterization and are expected to be continued over the life of the project. The regulatory nature of specific PC test plans necessitates that sound technical bases be consulted for their definition, particularly with regard to selected parameters, ranges, and reportable conditions. A parallel and complementary elective testing program will be instrumental in quantifying the appropriate parameters for some confirmation activities.

Performance confirmation adds to public confidence because it demonstrates that the repository is responding as expected and as represented in the licensing basis, or, in the event that performance confirmation reveals problems, it demonstrates transparent and responsible program management, assuming corrective actions are prompt and effective. A goal for a successful performance confirmation program includes transparent public outreach and includes a process to reevaluate, reexamine, and modify activities as the state of understanding changes. These are vital points to consider, because the WIPP experience suggests change to a confirmation practices is not readily embraced.

The U.S. repository programs have been conducted openly and transparently for many years. WIPP has enjoyed a successful compliance monitoring history since operations started, while the performance confirmation plan for the Yucca Mountain license application was found reasonable and consistent with regulatory expectations. In the process of analyzing and compiling the license application for the Yucca Mountain repository, a clear path for performance confirmation within a long-term testing and monitoring strategy emerged. The experience and appropriate tools exist to readily reengage performance confirmation if the Yucca Mountain licensing process is resumed[2]. Experience developing performance confirmation in a licensing framework for two mature geologic repositories in the United States has the potential to guide other such work if the lessons are indeed learned and applied.

[2] The proposed FY 2012 budget provided no funding for contracts and federal staff hours for the High-Level Waste Repository licensing activity. Repository licensing for Yucca Mountain program activities came to a halt on September 30, 2011.

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