NRC PERFORMANCE ASSESSMENT PROGRAM

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ABSTRACT

The U. S. Nuclear Regulatory Commission's (NRC) performance assessment program in-cludes the development of guidance to the U. S. Department of Energy (DOE) on preparation of a license application and on conducting the studies to support a license application. The nature of the licensing requirements of 10 CFR Part 60 create a need for performance assessments by the DOE. The NRC and DOE staffs each have specific roles in assuring the adequacy of those assessments. Performance allocation is an approach for determining what testing and analysis will be needed during site characterization to assure that an adequate data base is available to support the necessary performance assessments. From the standpoint of establishing is implementable methodology, the most challenging performance assessment needed for licensing is the one that will be used to determine compliance with the U. S. Environmental Protection Agency's (EPA) containment requirement.

INTRODUCTION

The U.S. Nuclear Regulatory Commission's (NRC) Performance Assessment Program is primarily concerned with two broad areas. These are (1) the development of an approach for independent staff review of the DOE's license application, and (2) the development of guidance to the U. S. Department of Energy (DOE) for preparation of a license application. This paper focuses primarily on the latter activity. The NRC staff has been working to develop guidance in several areas. Two of these are discussed below: Performance Allocation and Licensing Assessment Methodology. Before addressing these, however, it may be worthwhile to review the nature of the technical requirements of 10 CFR Part 60 and the roles of the NRC and the DOE in showing compliance with these requirements in the formal licensing process.

THE NATURE OF THE TECHNICAL CRITERIA

Fundamental to all aspects of performance assessment for a licensed geologic repository are the technical criteria of 10 CFR Part 60. These include six numerical performance objectives which together cover both the pre-closure and post-closure periods. The balance of Part 60 consists of non-numerical requirements and qualitative site considerations. It is the numerical performance objectives which give rise to the need for performance assessments and these are described in the paragraphs below.

The numerical performance objectives include two which address the pre-closure period and four which address the post-closure period. The first of the pre-closure performance objectives requires that releases, exposures and radiation levels in unrestricted areas be maintained within 10 CFR Part 20 limits and applicable environmental standards published by The U. S. Environmental Protection Agency (EPA). The second requires that the repository design be such that an option to retrieve waste is preserved for up to 50 years after the start of waste emplacement. This is to assure that when the commission makes its decision regarding permanent closure of a repository, it will have a viable opportunity for decision; that is to say, the repository will not have closed itself.

Turning next to the four post-closure performance objectives, two apply to the engineered barriers. The first of these requires that waste packages provide substantially complete containment for 300 to 1,000 years. The second requires that following containment, radionuclide releases from the engineered barrier system be limited to one part in 100,000 of the 1,000 year inventory. One performance objective applies to the geologic setting. It requires that the groundwater travel time to the accessible environment be at least 1,000 years. Finally, an overall performance objective places a limit on cumulative quantities of radionuclides released to the environment over a 10,000 year period. This is the containment requirement of the EPA standard (40 CFR Part 191). This last performance objective will be discussed in greater detail later in this paper.

NRC AND DOE ROLES DURING LICENSING

The respective roles that the DOE and the NRC staff must play during the formal licensing process bear on the NRC's Performance Assessment Program. These are described in this section starting with the DOE role.

To provide the basis for a licensing decision, DOE must document a full Licensing/Performance Assessment demonstrating compliance with 10 CFR Part 60. This demonstration must include a complete and quantitative identification and characterization of uncertainties. These would include the uncertainties in basic phenomena and processes, uncertainties in constitutive relationships and simplifying assumptions, uncertainties in parameters and variables as they relate to data gathering and analyses, and finally, calculational uncertainties. The DOE must then document a complete technical defense of the insignificance of these uncertainties based on hard data and facts, and on detailed consideration of alternative interpretations. Finally, the DOE must implement an appropriate Quality Assurance Program for the supporting facts and data.

The NRC staff's role compliments the DOE role and centers around its responsibility to propose findings to the Atomic Safety and Licensing Board. The staff will base its proposed findings on its independent review of DOE's license application. The staff's review will include, first, an independent data review to establish the reliability and accuracy of the data presented by DOE to support its application and, second, a review of DOE's performance assessment. The staff's review is intended to determine the completeness and adequacy of the models and model inputs used by DOE, DOE's uncertainty assessments, and DOE's analyses of alternative interpretations. As part of its review of DOE's performance assessment, the staff will do independent performance assessments in selected areas. A key point regarding the staff's role is that the staff cannot make up for license application deficiencies. The staff function is one of review. It is DOE's job to prepare and submit a complete license application.

PERFORMANCE ALLOCATION

This section focuses on performance allocation as an aid to DOE's preparation of a complete license application. In order to plan an appropriate program of site characterization studies and laboratory tests, the NRC staff considers that the DOE must establish performance goals for each of the major barriers of a repository system. The systematic assignment of performance goals to the subsystems and components of a repository has come to be called performance allocation.

More specifically, the staff's position on performance allocation is that DOE should develop a performance allocation as early as possible for each site to be characterized. The staff considers that the DOE's performance allocation should include (1) identification of the particular barriers that will be relied on to show compliance with the performance objectives of 10 CFR Part 60, (2) a desired level of performance for each barrier, and (3) a desired level of confidence at which that performance would be achieved. The staff expects that the initial performance allocation for each site will be a tentative technical/management decision that will be revised periodically to reflect information obtained during site characterization.

In the staff's view, the need for performance allocation arises from the fact that the performance objectvies of Part 60 afford DOE great flexibility in choosing which of the various barriers that comprise a geologic repository will be relied on. During site characterization, the types of tests to be conducted, the number of test locations, and the degree of precision required of each test will be determined, to a large degree, by the level of performance and confidence in that performance sought from these barriers. Without a preliminary performance allocation, the NRC's ability to comment on DOE's site characterization plans and, thus, fulfill its obligation under the Nuclear Waste Policy Act of 1982 (NWPA) will be limited. To see this, a simple example or two might help. Broadly, a repository can be thought of as consisting of natural barriers and engineered barriers. The natural barriers might, in turn, be thought of in terms of hydrologic barriers and geochemical barriers. For a hypothetical repository, the DOE might choose to place no reliance on geochemical barriers. If this were the case and if the desired level of performance of the remaining barriers would be sufficient to comply with Part 60, the staff's geochemistry review could focus on testing needed to assure that geochemical conditions at the site would not degrade the performance of these barriers. Similarly, were DOE to decide not to take credit for potential natural barriers in the near-field, the concern with hydrologic and geochemical processes in the near-field would be limited to their potential for degrading performance of the repository.

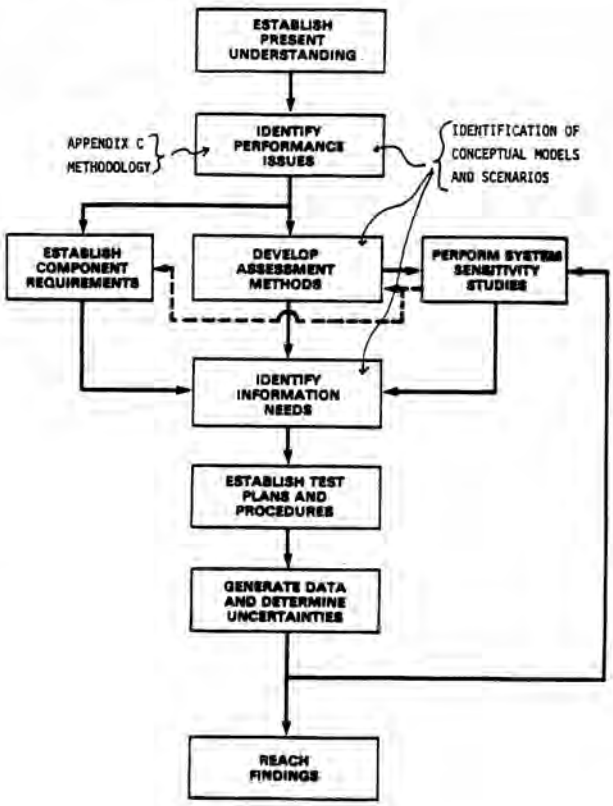

Fig. 1. Site Characterization Logic

A key point regarding performance goals and their role in site characterization is illustrated by Figure 1. Figure 1 shows a diagram of the logic which underlies site characterization. In that logic the performance goals chosen at the start of site characterization change as site characterization proceeds. This is what one would expect and will be the natural result of hard information gained from testing and other investigation replacing the judgements and educated guesses that must, in part, underlie any initial attempt at performance allocation. It is the staff's expectation that DOE will choose its initial performance goals with enough conservatism and redundancy to accommodate the uncertainty about repository performance that will exist prior to site characterization. In this way, the prospect of having to revise one or more goals significantly upward to compensate for failure of a particular barrier to meet its goal during site characterization can be reduced.

The NRC and DOE staffs have addressed the subject of performance allocation in a number of meetings since the staff first stated its position in 1983. In two meetings held in April and September of 1985, the two staffs reached agreement on the essential points regarding performance allocation. Specifically, DOE will make initial estimates of performance goals and confidence levels based on technical/management judgement. DOE will describe the bases for the goals and target confidence levels including relationships with overall system goals and test programs. Target confidence levels will likely be stated in qualitative terms. The performance goals and target confidence levels will be presented on a site-specific basis in the SCPs. NRC and DOE staff have agreed that prior to issuance of the SCPs, DOE project staff will discuss tentative performance goals and confidence levels with the NRC staff at the appropriate project-specific technical meetings (e.g., performance goals for groundwater travel time will be discussed in the hydrology meetings for each project). Also performance allocation meetings will be held with each project prior to issuance of its SCP to discuss overall project-specific performance allocation.

LICENSING ASSESSMENT METHODOLOGY

An overall licensing assessment methodology must ensure that (1) all necessary technical analyses and data needs have been identified, (2) appropriate analytical tools and test methods have been (or are being) developed, (3) these components are mutually compatible, and (4) an appropriate balance is achieved in the emphasis placed on the components of the overall methodology. The NRC staff has developed draft guidance describing the overall approach to be used by the staff for evaluation of a repository license application. Determination of compliance with the EPA's environmental standards for HLW disposal is of particular concern, and remainder of this paper concentrates on that topic.

Implementation of the EPA Standards

The EPA standards for disposal of High-Level Radioactive Wastes, were issued in final form in September, 1985 (50 FR 38066). These standards are included in 40 CFR Part 191 and include a number of specific requirements. The NRC staff expects that implementation of most of the requirements will be relatively straightforward. However, one requirement, the containment requirement of Part 191.13 is based on a probabilistic approach that is novel in the Commission's licensing experience.

In essence, the containment requirement states that cumulative releases from a Geologic Repository for the first 10,000 years after closure must have less that a 1 in 10 chance of exceeding limits prescribed by the standard and less than a 1 in 1,000 chance of exceeding 10 times those limits.

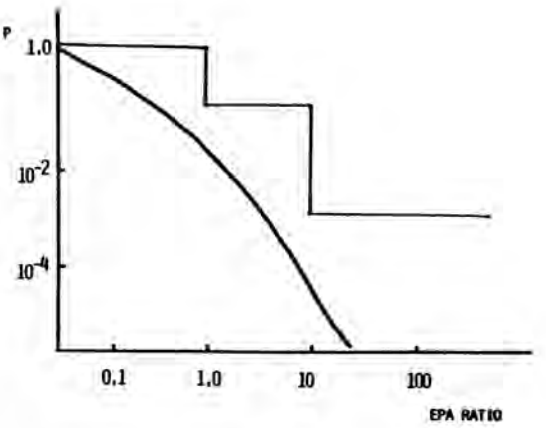

Fig. 2. Compliance with the EPA Containment Requirement

This requirement is to be implemented by incorporating estimates of releases into an overall probability distribution called the complementary consequences distribution function (CCDF) for the repository and comparing that CCDF with the limits specified in Part 191.13. This concept is illustrated in Figure 2. It should be noted that compliance with the containment requirement is exhibited by a CCDF which lies below the step function representing the limits imposed by the requirement. Implementation of this requirement will be a significant challenge for both the DOE and the NRC. This becomes apparent from Figure 3.

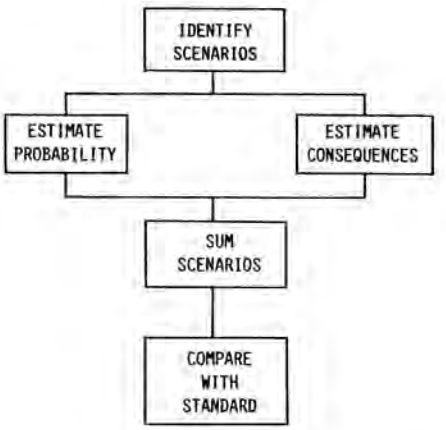

Fig. 3. Implementation of the EPA Containment Requirement

Figure 3 shows schematically what steps are involved in determining a CCDF. These steps are (1) the identification of release scenarios, (2) developing numerical estimates of the probabilities and consequences of each such scenario, including estimates of the uncertainties involved, and (3) combining the probability-weighted release for each scenario into a distribution function. Clearly, obtaining numerical estimates of probabilities and consequences for the potentially disruptive events that could affect a geologic repository over the next 10,000 years is a task involving substantial uncertainty. Fortunately, the EPA standards allow for subjective judgements, require probability and analyses only to the extent practicable, and recognize the high degree of uncertainty in implementation of the containment requirement.

The NRC staff is sponsoring technical assistance to ascertain what methods are available in the earth sciences for identifying and analyzing scenarios and intends to provide guidance in this area. Further, the staff will be working with DOE, states, tribes and others to develop a consensus on acceptable approaches for implementation of the containment requirement.

CONCLUSION

This paper has reviewed the requirements of 10 CFR Part 60 that create a need for performance assessments and the DOE and NRC staff roles in assuring the adequacy of those assessments. It has also discussed performance allocation, an approach for determining what testing and analysis will be needed during site characterization to assure that an adequate and appropriate data base is available to support the necessary performance assessments at the time of licensing. Finally, it has described what might be one of the greatest challenges in the licensing process, demonstrating compliance with the EPA's containment requirement. With adequate early planning by the DOE and NRC and consultation among the NRC, the DOE, states, tribes, other federal agencies, and members of the technical community, there is reason to expect that the challenge can be met.