Department of Energy
Washington, DC 20585

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John J. Linehan
Division of Waste Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Mail Stop 623-SS
Silver Spring, MD 20555

Dear Mr. Linehan:

On March 3 and 4, 1987, the Nuclear Regulatory Commission and the Department of Energy will meet to discuss the Issues Hierarchy for the Site Characterization Plan (SCP). The meeting will be held in the Forrestal Building in Room 6E069 beginning at 8:30 AM.

Attached to this letter is an agenda for this meeting, a draft of SCP Section 8.1, a copy of the Issues Hierarchy for a Mined Geologic Repository Disposal System, and a Guide to Performance Allocation. If you have any questions about any of the enclosures, please contact Carol Hanlon at 586-1224 or Donald Alexander at 586-1238.

James P. Knight, Director
Siting, Licensing, and Quality
Assurance Division
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Attachments as stated

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SCP Section 8.1

Rationale for the Site Characterization Program

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8.1 RATIONALE FOR THE SITE-CHARACTERIZATION PROGRAM

The site-characterization program and Chapter 8 are based on two organizing principles. The first is the issues hierarchy, which states the questions related to the performance of the mined geologic disposal system that must be resolved to demonstrate compliance with the applicable Federal regulations. The second principle is a general procedure, or "strategy," for determining how those issues are to be resolved--a strategy that can be used to develop specific strategies for the resolution of each issue. An understanding of these principles is helpful in following the discussions in the rest of this document; this section therefore discusses them briefly.

8.1.1 THE ISSUES-BASED APPROACH TO PLANNING SITE CHARACTERIZATION

The issues hierarchy states the questions that must be answered about the performance of the disposal system and identifies the information that must be known before a site can be selected and licensed. It is based on the issues-hierarchy concept presented in the Mission Plan (DOE/RW-0005, June 1985, Volume I, Part II, Chapter 1). The discussion that follows explains the derivation, structure, scope, and objectives of the issues hierarchy. More information can be found in Issues Hierarchy for a Mined Geologic Disposal System (DOE/RW-0101, September 1986).

8.1.1.1 Derivation, structure, and scope

The issues hierarchy is a three-tiered framework consisting of key issues, issues, and information needs. On the first, or highest, tier there are four key issues. The key issues embody the principal requirements established by the regulations governing geologic disposal. Each of the key issues is followed, in the second tier, by a group of several issues that expand on the requirements stated in the key issue they represent. The third tier consists of a still more detailed set of information called the "information needs." This framework provides a convenient means for distinguishing broad questions of overall performance and suitability (key issues) from more-specific questions about the characteristics of the site, the design of the repository and the waste package, and the performance of the total geologic disposal system as well as distinguishing the key issues and issues from requirements for the basic information needed to resolve the issues.

As already mentioned, the issues hierarchy defines performance-related issues that must be resolved to demonstrate compliance with key regulatory requirements. It does not address other requirements that the disposal system must satisfy, such as functional and operating requirements as well as design and operating-efficiency requirements. These requirements are included in the specifications given in the Generic Requirements for a Mined Geologic Disposal System (OGR B-2), the Waste Management Systems Requirements and Descriptions (DOE/RW-0063, January 1986) and in _____ (cite site-specific requirements document). The regulatory requirements embodied in the issues hierarchy and the system requirements and description in the generic requirements document are linked by the issue-resolution strategy and the performance-allocation process described in Section 8.1.2.

The key issues and the issues are common to all candidate sites. The information needs, though generally similar for all sites, have been developed specifically for the _____ site, taking into account the characteristics of the site and the host rock as well as the data collected to date. The entire issues hierarchy for the _____ site is presented in Section 8.2.1.1. Although it is believed that this issues hierarchy contains a comprehensive list of siting and licensing issues, it will be revised as necessary during site characterization to encompass any additional issues that may arise.

Key issues

The key issues embody the principal requirements established by the regulations governing repositories and have been adopted nearly verbatim from the key issues in the Mission Plan. They are stated as questions that must be anwered affirmatively if a site is to be selected and licensed. The key issues are derived from the four system guidelines of the DOE siting guidelines (10 CFR Part 960) and are therefore concerned with (1) the performance of the repository system after closure; (2) radiological safety before closure; (3) the environment, socioeconomics, and transportation; and (4) ease and cost of repository siting, construction, operation, and closure.

Key issue 1, postclosure performance, is derived directly from the postclosure system guideline (10 CFR 960.4-1), which defines the general long-term performance requirements for the disposal system as a whole (i.e., the waste package, the engineered repository, and the natural system at the site). These performance requirements reflect the general objectives of protecting the health and safety of the public and the quality of the environment; they are based specifically on the standards promulgated by the Environmental Protection Agency (EPA) in 40 CFR Part 191, Subpart B, and the criteria adopted by the Nuclear Regulatory Commission (NRC) in 10 CFR Part 60, Subpart E.

Key issue 2, preclosure radiological safety, is derived from preclosure system guideline 960.5-1(a)(1). It requires compliance with the applicable requirements of the EPA standards in 40 CFR Part 191, Subpart A, and the NRC criteria in 10 CFR Part 60 and 10 CFR Part 20. Because compliance with these regulatory requirements depends mainly on the design and operating procedures of the repository rather than on the geologic characteristics of the site, not all aspects of key issue 2 are directly addressed in the site-characterization plan. Most of the information needed to resolve this issue will be obtained from the design of the repository and the waste package (see Chapters 6 and 7). Other information will be obtained from data collected during environmental studies (e.g., meteorology) that will be performed concurrently with site characterization. Plans for such studies will be presented in an environmental program plan for the _____ site.

Key issue 3, which is concerned with the environmental, socioeconomic, and transportation impacts associated with a repository, is derived from preclosure system guideline 960.5-1(a)(2). The resolution of this issue does not directly depend on the geologic conditions of the site, and therefore this key issue is not addressed in the site-characterization plan. The information needed to resolve this issue will be collected during the environmental and

socioeconomic investigations performed concurrently with site characterization. Plans for these studies will be presented in environmental and socioeconomic program plans.

Key issue 4, the ease and cost of repository siting, construction, operation, and closure, is derived from preclosure system guideline 960.5-1(a)(3). The requirements of this issue are derived solely from those of the referenced preclosure system guideline, which requires that the technical feasibility and cost of repository siting, construction, operation, and closure be evaluated in light of the site characteristics and related design requirements.

Matrices that correlate each key issue with specific regulatory requirements are presented in Section 8.2.1.2, which also discusses the relationship of the issues hierarchy to other sets of issues, such as those presented in the Mission Plan or those developed by the NRC in the issue-oriented site technical positions.

Issues

The issues defined for each key issue are also stated as questions (see Section 8.2.1.1). When each group of issues was constructed, an effort was made to include in the group all the questions that must be answered to resolve the key issue. Taken together, the issues therefore provide a conceptual strategy for resolving each key issue. The issues defined for each key issue are identical in overall scope with the issues in the Mission Plan, but the structure and the wording are different. The issues are derived, in part, from the DOE siting guidelines of 10 CFR Part 960, from the NRC performance objectives and design criteria of 10 CFR Part 60, and from the EPA requirements of 40 CFR Part 191.

To reflect the structure and intent of the regulations in 10 CFR Part 60 and 10 CFR Part 960, the issues are divided into three categories: performance issues, design issues, and characterization issues. The NRC criteria in 10 CFR Part 60 clearly make a distinction between performance objectives and design criteria; though obviously related, performance objectives and design criteria have different purposes and must be addressed from different perspectives. The DOE siting guidelines in 10 CFR Part 960 provide much of the perspective for the characterization issues.

Performance issues generally address questions about compliance with regulatory requirements for the performance of the mined geologic disposal system. They are generally related directly to the highest level of regulatory requirements to be satisfied or findings that must be made. For example, there are performance issues that correspond to each of the postclosure performance objectives stated in 10 CFR 60.112. There are also performance issues that correspond to the postclosure system guideline and each of the preclosure system guidelines in 10 CFR Part 960.

Design issues address questions about the design of the repository, shaft and borehole seals, and the waste package. The design issues may address the design criteria specified in 10 CFR 60.130 through 60.134, the design-related considerations of preclosure guideline 10 CFR 960.5-1(a)(3), and information required to support the resolution of performance issues.

Characterization issues are intended to encompass the site characteristics, processes, and events that may affect the design and the performance of the repository. These issues are used to support the resolution of related design and performance issues, including the demonstration of compliance with the siting guidelines. The characterization issues provide a discipline-oriented control to facilitate the description of the geologic characteristics of the site.

The relationship among the three categories of issues can be summarized as follows: The performance and the design issues establish requirements and priorities for the characterization issues. The resolution of the characterization issues produces data for the analyses needed to address design and performance issues. An investigation or other type of activity related to an information need under a characterization issue will take place only if it is necessary to provide data for a design or a performance issue. Both the characterization and the design issues are subordinate to the performance issues.

Information needs

On the third tier of the issues hierarchy is a detailed set of information called the "information needs." Unlike the key issues and issues, the information needs are stated as requirements for technical information rather than as questions. In developing the information needs, an attempt was made to list all the information needed for resolving the issues. In principle, then, acquiring all the information called for at the third tier of the hierarchy will allow all the issues to be resolved through analyses and evaluations that use the information. If the issues are resolved affirmatively, the key issues will also have been resolved.

Site-specific information needs have been identified to reflect the characteristics of the _____ site and the host rock. They are included in Section 8.2.1.1.

8.1.1.2 Application in the site-characterization plan

The issues hierarchy, which is presented in Section 8.2.1.1, is useful in the site-characterization plan because it furnishes a framework for developing the site-characterization program described in Section 8.3 and for explaining why the proposed program is adequate and necessary. In simple terms, the site-characterization program will be adequate if it addresses all the information needs in the third tier of the issues hierarchy. And the necessity for any particular planned study can be established by determining its role in supplying an information need. For these reasons, the issues hierarchy in Section 8.2.1.1 is used as an organizing principle for many parts of the site-characterization plan. In particular, Section 8.3, which describes the characterization program, is organized around the investigations and studies that are required to satisfy the information needs defined by the issues-based approach to site characterization and the issue-resolution strategy described in the next section.

8.1.2 ISSUE-RESOLUTION STRATEGY

To resolve the issues in the issues hierarchy, the DOE has adopted a general "issue-resolution strategy" that guides the development of specific plans for resolving each issue. This general strategy is a procedure consisting of as many as 12 steps; it is outlined in Figure 8.1-1. Three of the steps, applied separately to each issue, lead to the identification of the information necessary to resolve the issue. Once the information needs have been identified, another step leads to the development of plans for acquiring that information. The reasoning used in carrying out those four steps is, then, the rationale for the particular site-characterization activities that are intended to resolve the issue. The rationale and the plans for these activities are described in Sections 8.2 and 8.3. An understanding of the general issue-resolution strategy is important for understanding these four steps and the site-characterization program presented in Section 8.3.

8.1.2.1 Issue identification

The first section of the strategy, labeled "issue identification" in Figure 8.1-1, consists of three steps. Two of these steps (1 and 2) are the development of the issues hierarchy itself. Step 1 identifies the regulatory requirements; from them the issues are derived (step 2), as explained in Section 8.1.1. Also necessary before the strategy can proceed to the formulation of specific plans for the resolution of each issue is a detailed description of the disposal system (step 1a). This description for the _____ site is presented in _____ (cite the requirements and system-description documents).

8.1.2.2 Performance allocation

The second section of the strategy, called "performance allocation," consists of the steps that provide the rationale for the establishment of particular site-characterization activities. Applied separately to each issue in the hierarchy, this section produces the principal guidance for planning the activities needed to resolve the issue. The performance-allocation concept was developed in formal discussions, documented in a written agreement, between the DOE and the NRC.

The steps in performance allocation were defined with several objectives in mind: to provide specific kinds of information requested by the NRC, to provide uniform guidance for site characterization at all candidate sites, and to ensure Program-wide consistency in implementing the performance-allocation process. For this reason, the meaning of the phrase "performance allocation" as used in the issue-resolution strategy is somewhat different from the meaning it usually has in systems engineering. Here the phrase refers only to the four steps (steps 3 through 6) shown in Figure 8.1-1.

Licensing strategy

For each issue, the first step in performance allocation (step 3 in Figure 8.1-1) is the adoption of a "licensing strategy." This step uses available information to develop, for planning purposes, a statement of the site features, engineered features, conceptual models, and analyses that the

DOE expects to use in resolving the issue. The statements are called a licensing strategy because the combined statements developed in step 3 for all the issues are the basis for the current DOE plans to show compliance with regulatory requirements. Eventually, plans developed from the current plans will support the selection of a site for development and the demonstration of compliance with NRC requirements for the construction, operation, closure, and decommissioning of a repository.

In this document, the licensing strategy is necessarily preliminary: not enough information is now available to make a definitive plan, because site characterization is only beginning. But the strategy is developed well enough to guide the preparation of the plans for tests and analyses and to make clear what activities are necessary and whether they will be sufficient to resolve the issue. As site characterization proceeds and better information becomes available, the licensing strategy may be revised, and the performance allocation may be changed. The licensing strategies described in this document are simply the basis for initial planning; they are not intended to be the basis for final site selection or for a license application.

For guiding the development of the site-characterization plans, the principal product of step 3 is a statement of the disposal-system components on which the DOE currently intends to rely in resolving the issue: if these components perform as the licensing strategy expects them to perform, the issue is likely to be resolved. The statement may also identify, for each of the components, specific features or characteristics that the DOE expects will contribute to the performance of the component and, hence, to the resolution of the issue. The performance and design issues provide this statement and use it in the later steps as a basis for deciding what specific information is needed for resolving the issue. Step 3 is not applied directly to the characterization issues: the statement of the licensing strategy that leads to the identification of the information needed for each characterization issue is provided under the performance and design issues whose resolution requires this information.

Performance measures and goals

Step 4 carries the strategy further by establishing "performance measures" for each of the components identified in step 3. These measures are physical quantities that describe the performance of the component in meeting the licensing strategy. It may be a directly measurable quantity, or it may be a quantity derived from other quantities that are more directly measurable.

For each performance measure step 4 establishes a "goal." The word "goal" is written with quotation marks in Figure 8.1-1 to show that it has a special meaning in performance allocation. The goal is not a target that the performance measure must attain if the repository is to perform properly, and therefore it does not have to be met. Instead, it is simply a guide for the development of a testing program—a guide that states the licensing strategy quantitatively and can be changed or discarded once the testing program has been established. In assigning goals to the performance measures, the DOE will specify values that are consistent with the licensing strategy for the issue. If the tests and analyses can demonstrate that a goal is attained, the licensing strategy for the issue will be satisfied, and the issue will be

likely to be resolved. The goals are, therefore, guides for deciding, in the later steps of performance allocation, what information must be provided by the testing program. Whenever a performance goal is identified, the reasoning that led to its selection is also presented.

As a further guide for testing, step 4 accompanies each performance goal with an "indication of confidence," a statement that further clarifies the role of the component in meeting the licensing strategy. The indication of confidence expresses, as quantitatively as possible, the confidence with which the licensing strategy desires the testing program to show that the performance goal has been attained.

For some performance goals it is possible to use statistically rigorous numerical values as indications of confidence; for most of them only a qualitative expression is now possible. When qualitative indicators are assigned, they are accompanied by further explanation of their intended meaning.

Because they depend on a licensing strategy that is preliminary, the performance goals and indicators of confidence are also preliminary. As site characterization progresses and more information is acquired, these goals and indicators will probably be changed to guide continued testing toward the collection of the needed information.

8.1.2.3 Information needs

The performance-allocation process now proceeds to develop specific requirements for future work. Step 5 identifies "information needs," which state, for each issue, the categories or types of information needed to resolve the issue. The information needs identified for the _____ site are presented in Section 8.2, which also explains their development from the licensing strategy developed earlier in the performance-allocation process.

Part of the development of an information need is the identification of the "parameters" needed to evaluate the performance measures. As already mentioned, many performance measures (e.g., the time of ground-water travel through a particular geohydrologic unit) are not directly measurable quantities. However, they can usually be expressed by an equation in which quantities that can be measured more directly (e.g., hydraulic conductivity) appear as parameters. Step 5 furthers the development of plans for testing by listing these parameters. Step 5 also assigns to each parameter an acceptable or desirable value, called a "goal" in Figure 8.1-1. Like the performance goals, these parameter goals are not values that must be achieved by the disposal system. They are statements of the values that the licensing strategy expects the parameters to take. As a further guide to the detailed specification of tests, step 5 also specifies where possible an indication of confidence for each parameter. Like the indicators for performance goals, these indicators are seldom numerically rigorous, but are as quantitative as possible. Also like the performance goals, the parameter goals and indicators of confidence presented in this document are preliminary; as more information is acquired, they may be changed in order to provide further guidance for continued testing. Additional information needs may be specified, including

such items as scenario probabilities and characteristics, analytical models, and design information that will be developed during site characterization.

Step 6 in Figure 8.1-1 expresses the use of the information needs, as expressed in detail in step 5, to define the activities that will produce the needed information. The lists of parameters or other information that must be obtained, together with the supporting requirements for achieving confidence in this information, are the basis for a testing or analysis strategy. This strategy is detailed in Section 8.3 in the descriptions of planned site-characterization work. That section describes the planned tests; it identifies the experimental variables and the parameters (from preceding steps) that the tests will measure. Plans for developing the needed analytical models and design information are also described.

Because the issues in the hierarchy cover widely different topics, the four steps in performance allocation are intended to be applied flexibly. For example, the strategy for resolving characterization issues is basically different from the strategy adopted for other kinds of issues. And although the performance goals assigned to engineered components can be useful in guiding design, the goals assigned to the properties of natural components cannot be altered by design. For reasons like these, the four steps cannot be applied with rigid uniformity to all issues; Section 8.2 therefore explains in detail the rationale behind the indicated performance allocation for each issue.

8.1.2.4 Investigations

After the performance allocation has produced the plans for resolving issues, the issue-resolution strategy proceeds with the investigations called for in the plans (step 7 in Figure 8.1-1). The analyses of the results of the investigations (step 8) begin as soon as the results are available and continue throughout the site-characterization period and beyond. These analyses include all the evaluations needed to resolve the issues. The collection of needed information continues until the information needs have been satisfied (step 9). The collected information is then used in a concluding set of analyses that finally resolve the issues (step 10), and the resolution is documented (step 11).

8.1.2.5 Application of the issue-resolution strategy

The entire issue-resolution strategy is intended to contain reiterations. As explained above, the licensing strategy as well as the goals and the indications of confidence for the performance measures and related parameters may be changed as new information becomes available; if they are changed, the steps that follow in the issue-resolution strategy will also be reexamined and their products revised. The analyses of the results of the investigations (step 8) may produce new understandings that require rethinking of earlier steps. Any of the steps may, in fact, lead to revisions of earlier steps. Sections 8.2 and 8.3 of this document, in laying out the DOE plans for issue resolution and site characterization, report the current status of the issue-resolution strategy.

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Performance Allocation Guide

Introduction

The NRC and the DOE have agreed to carry out a process called "performance allocation" as a method for guiding the testing programs at potential repository sites. Because the written agreement describes the process only in general terms, the DOE has translated that agreement into specific procedures that each repository project can follow.

The Performance Allocation Process

In general, the performance allocation process includes the following steps which will be described in more detail later in the text:

- Describe the system and the conceptual models that are being considered for the resolution of the issue.
- Identify those system elements that will be relied upon to resolve the issue. Both primary barriers and "barriers held in reserve" should be identified.
- Identify performance measures for these system elements.
- Specify goals for these performance measures which, in terms of the conceptual models being considered, are consistent with resolving the issue. The goals are expressed as a value and an associated level of confidence. The confidence level may be quantitative or may be qualitative (e.g. "high", "medium", or "low") as long as some quantitative indication of the meaning of these terms is given. If more than one conceptual model is being considered for a specific element or process, multiple sets of performance measures and goals may need to be specified.
- Parameters needed to evaluate the performance measures are identified. Goals for these parameters are set consistent with the goals for the performance measures. Again, the goal is expressed as a value and an associated level of confidence needed for that value. Where possible, the existing level of confidence should also be provided.

The strategy that results from the performance and parameter goals is used to guide the testing program. As information is acquired from the tests and analyses, it can be used in system performance assessments to compare with the overlying performance and design issues. These comparisons may suggest that additional testing may be needed. In this case the performance allocation process will be reapplied and a new strategy developed with a new set of performance and parameter goals.

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For example, the performance allocation for a repository system will specify the following: For each of the performance and design issues from the OGR issues hierarchy

a. The systems (i.e., the barriers, subsystems and components, or elements) that the project expects to rely on.
b. Any systems that the project expects to use as secondary or redundant systems or to hold in reserve.
c. A level of performance (a "performance goals") that the project expects to achieve for each system.
d. A level of confidence that the project expects to achieve for each performance goal.

The performance goals need to be set only for the systems that a project expects to use in licensing; they need not be set for any potential systems that the project does not intend to use in showing that the performance or design issue can be resolved. In assigning goals it is important to keep in mind that the DOE will be permitted to change the goals without permission from other agencies. They are not criteria that must be met for licensing. It is expected, however, that changes will be discussed with the NRC and noted in the 6 month SCP progress reports.

The levels of confidence called for in the above list expresses, generally speaking, a quantitative assessment of how well the associated performance goals need to be met. It may be a statistically meaningful confidence level or confidence interval; it should, in fact, be statistically meaningful whenever such an indication is feasible. More often, however, it will not be statistically rigorous, and it will not even be stated in terms of statistical parameters. When no rigorous or semiquantitative statement is possible, it may be set by expert judgment. It may be stated as "high", "medium", or "low" provided that some effort is made to explain (quantitative indication) what these terms mean.

The approach to be used for performance allocation consists of a series of steps. As explained in this guidance, six steps are needed to provide the required information to produce a performance allocation for performance and design issues. The text below discusses these steps with respect to the postclosure performance objectives.

Steps of Performance Allocation for Postclosure Performance Objectives

This section explains, in sequence, the steps that produce a performance allocation for the four postclosure performance objectives. A simple way to visualize these steps is Table 1, which lists the steps as the headings of six columns. The performance-allocation process may be thought of as simply filling in the six columns.

Step 1: Performance objectives

In this column of the performance-allocation chart the four performance objectives are listed. For simplicity in the rest of this guidance these objectives are called

1. Containment time.
2. Release rate from EBS.
3. Ground-water travel time.
4. EPA standards.

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It is important to realize that objective 4 will contain three subobjectives covering the requirements for ground-water protection, individual protection, and releases to the accessible environment.

Step 2: System elements

In this step, for each performance objective listed in step 1, the barriers--the subsystems and components, or "system elements"--that are available to be relied on for meeting the performance objective are listed. These elements are taken from the complete list that the project's system-requirements document presents as a hierarchical framework. The containment-time objective will be met by relying on the elements within the waste package; the release-rate objective, by relying on those elements plus the other elements within the EBS boundary; the travel-time objective, by relying on the elements between the disturbed zone and the accessible environment; and the EPA-standards objective, by relying on elements in the entire postclosure waste-disposal system.

In step 2 no selections are made from these available elements. They are simply listed for selection in step 3.

Step 3: License approach

Step 3 defines the license approach for each performance objective: it consists of the decisions on the system elements and the processes that are expected to be used in showing compliance with the performance objectives. The license approach has three parts.

Part 1. For each performance objective, the subsystem and components that are expected to be relied on in licensing are listed. Some of these elements can be specified as redundant, or secondary barriers; or some of the elements can be specified as barriers to be held in reserve.

Part 2 For each of the elements selected in part 1, the functions that the element are expected to perform in meeting the performance objective are specified. All the processes that will occur in the element and that could be taken into account in deciding whether the element will satisfactorily perform the expected functions should be listed.

Part 3 From the processes specified in part 2, the processes that are expected to be relied on are selected.

The choices to be made in step 3 are highly important because they set up the remainder of performance allocation and of the overall licensing strategy. Although these choices can be changed as site characterization proceeds, they should be made as carefully as possible; they should reflect rigorous thinking about potential licensing strategy. If some of the available barriers can reasonably be omitted from the license approach, the testing program and the licensing strategy may be significantly simplified. But it would be unwise to omit, at this early stage, any barriers that are likely to be needed eventually; site characterization will not last so long that its testing program can be easily revised after it is well under way.

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For the EPA-standards performance objective, it is important that the choices reflect the systems not only for meeting the regulations under expected conditions, but also for meeting them under the unexpected, disruptive conditions that may occur in the future. Therefore, the analyst must think ahead to the scenario analysis that will be done as part of licensing. It will not, of course, be possible to do that analysis as part of performance allocation. But a prudent approach to step 3 will require decisions about what barriers are likely to be relied on for compliance under both expected and unexpected conditions.

At least one further criterion for choosing elements is important: the analyst must be careful not to omit any elements that could adversely affect the performance of a barrier. If it is decided not to include a barrier in the licensing approach, the omission must not mask a potential difficulty in meeting the performance objective.

The basis for making the choices in step 3 will probably be the studies reported in the environmental assessments and other bounding and sensitivity studies that the projects have already made. Additional studies will undoubtedly be necessary as revisions to the performance allocation are made, but the schedule for producing the first edition of the site characterization plans probably will not allow many new studies.

Step 4: Performance measures

With the completion of step 3, the licensing strategy part of performance allocation is in place, and the allocation can move toward assigning goals and levels of confidence. In step 4 the terms in which the performance goals will be expressed are chosen. In other words, "performance measures" are selected. This choice should be a physical quantity that indicates the level to which a function is performed. This physical quantity may be a measurable quantity or a dependent variable. Values for performance measures are not selected in step 4; they are discussed below as part of step 5.

Step 5: Performance goals and confidence

In step 5 a value for each performance measure selected in step 4 is selected. This value is the goal whose achievement is expected through the testing program and through analytic studies that use the results of testing. Additionally, the level of confidence for each performance measure goal is selected. The level of confidence is listed in quantitative terms, if possible, or in qualitative terms, if not.

In setting the goals, the analyst should also try to achieve a reasonable redundancy among the barriers it chose in step 3. The analyst should, however, limit the redundancy to what it thinks is necessary for showing reasonable assurance in the licensing process. Unnecessary redundancy increases the difficulty of getting a license, simply because it would require more testing and analysis than a properly designed licensing strategy would require.

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The goals should be as simple as possible, and they should be as simple to evaluate as possible. They should, for example, be chosen in such a way that a reasonable testing program can show whether they have been achieved. There is little usefulness in a goal that no test can measure with confidence, or in the time available for site characterization. Further consideration of whether the goals are reasonable will occur in a later step of performance allocation, when they are compared with the expectations for proposed tests, but step 5 is best done with some looking ahead to what real experiments can do.

The goals will probably be stated, at least in the early versions of performance allocation, in terms of bounds on performance measures. If X is a performance measure, for example, its goal is likely to be stated in a form like

X is greater than (some number)

where the "(some number)" is a value that the allocator thinks will contribute strongly to meeting the performance objective to which the performance measure is attached. One reason that bounding values are likely to be appropriate is that step 5, like step 3, will probably be based on available studies, which are largely bounding analyses. Another reason is that, in providing for unexpected disruptive events, at this early stage, little quantative detailed scenario studies have been completed; however, the analyst may be able to decide that a barrier will protect against particular potential disruptions if its performance is better than some conservatively chosen bound.

Deciding on a meaningful way to establish levels of confidence will require careful thinking. No single way will be appropriate for all the performance goals. The levels of confidence should be based on quantitative analysis if they exist, or as necessary qualitative analysis. They may simply reflect a consensus of professional judgment. They may be based on a conservative bounding analysis intended to ensure that the goals will satisfactorily demonstrate that the performance objectives will be met. Whenever it is possible to base the indications on statistical evaluations, well-defined confidence intervals or confidence levels and standard statistical parameters should be used.

A performance goal for a given barrier may take different forms depending on the confidence that the allocator desires to achieve for it. If, for example, the performance measure for a particular geohydrologic unit is travel time T, an analyst might choose to set goals and indications of confidence like the following:

T greater than 1,000 years with very high confidence.
T greater than 5,000 years with high confidence.
T greater than 10,000 years with medium confidence.

Such an allocation might be appropriate for relying primarily on ground-water travel for isolation during the first 5,000 years after closure and only partially on ground-water travel at later times.

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As mentioned in the introduction to this guidance, qualitative indications of confidence, like those used in this example, must be explained (using quantative forms if possible). Ground-water travel time, because it is a derived quantity rather than a directly measured quantity, will be difficult to associate with a statistically rigorous level of confidence. In this example, the analyst could choose to use as the indication of confidence the times associated with different percentiles on a cumulative frequency distribution of travel times. For example, the analyst might choose to associate the term "very high confidence" with the 5th percentile of the distribution--to require, in other words, that 95 percent of the ground-water travel times be greater than 1000 years. It might associate "high confidence" with the 20th percentile and "medium confidence" with the 50th percentile. In making such a choice, the analyst will not, of course, be using the word "confidence" in the sense that standard statistical textbooks use it. But allocations like these can serve to communicate the project's intentions about the importance of ground-water travel time to the NRC and, in later steps of performance allocation, to the testers who will measure it.

Table 1 shows, in the column for step 5, separate columns for the two products of the step: a statement of a goal for each performance measure listed in step 4 and a statement of desired confidence (labeled "C_D") for each goal.

Step 6: Parameter needs

Most of the performance measures treated in steps 4 and 5 will not be directly measurable quantities. They can be expressed by an expression like

$$\text{Performance measure} = f(P_1, P_2, \ldots, P_n)$$

where the P_i are parameters. In step 6 the analyst translates each performance measure into the parameters on which it depends. To do so, the analyst lists two things: the physical parameters, possibly including the ranges that it expects those parameters to take, and an indication of the level of confidence with which each parameter must be known. Table 1 shows, in the column for step 6, a separate column for these two items. Any listed ranges must be chosen in such a way that they will produce a satisfactory value for the performance measure--a value that meets the goal established in step 5. The levels of confidence must be chosen so that meeting them will produce the confidence desired for the performance goal. The choice of ranges and indications of confidence may be based on professional judgment, sensitivity analyses, or statistical analyses.

Difficulties in Implementing the Performance Allocation Process

It is admittedly difficult to apply the performance allocation approach to the development of the site characterization program in the face of the large uncertainties that presently exist regarding conceptual models for system elements and processes. Nevertheless, the Department of Energy is committed to providing the rationale for its site characterization program in terms of the performance and parameter goals described above and the logical linkages among them. Therefore, it is important to address and resolve the difficulties in an appropriate and timely way.

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One difficulty is the lack of clear evidence to define all the conceptual models that might be needed for some step in the performance allocation. However, there is an urgent need to focus the testing program on those elements of the system that may be important in resolving the issues. In this case the relationships between the elements and the performance and design issues must be considered and these relationships are generally adequate for the respective allocations. It is believed that it will be possible to resolve all issues without relying on every favorable feature of the sites, but by focusing on only those few favorable characteristics for which preliminary conceptual models have already been developed.

It is believed that these preliminary models provide a basis for the characterization program and, as long as the studies include efforts to validate or improve the conceptual models, it is believed that the performance allocation approach will be useful. In some areas conceptual models are indeed too primitive to be helpful and only subjective judgment can be used to set the goals, but it is believed that for the most part the goals can be set on the basis of some conceptual models. It is recommended that wherever practical to do so, the performance allocation should rely upon the models described and utilized in the Environmental Assessment reports. The descriptions of these models, including the underlying assumptions, to the extent they are considered to still be applicable can simply be referenced in the SCP, reducing the burden of the first required step in the performance allocation process.

A second and related difficulty is the concern of premature commitment to conceptual models. There is concern, for example, that the goals may become criteria for the program that DOE must meet to select a site, obtain construction authorization, or emplace waste. This concern is legitimate. There has been a tendency on the part of parties both inside and outside the program to look at goals set as somehow binding. It must be constantly stressed that the purpose of the performance goals is purely to help formulate the testing program and that results of characterization need only be compared with the true criteria such as the performance objectives of 10 CFR 60. In particular, logic diagrams for the site characterization program should only mention performance goals in the context of development of plans for site characterization; any comparisons of test results or analyses should always be made with true criteria such as the performance objections of 10 CFR 60, never with the performance goals.

Furthermore, there is concern that commitment to a particular conceptual model may result in a characterization program that overlooks some aspect of the system, particularly those portions of the system for which a clear relationship to performance or design issues cannot presently be established. Again, this is a valid concern. There is a need to insure that potentially important areas are not overlooked. However, experience has shown that when a particular area is proposed for testing and analysis, it is possible to do the performance allocations. That is, if a particular variable is thought to be important enough to be considered in the testing program, a relationship

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between this variable and the various performance or design issues already tacitly exists and this relationship, however ambiguous, can be used to set goals. It goes without saying that variables that do not impact performance or design issues should not play a critical role in the testing program and should have low priority in the SCP.

A third difficulty is the specification of quantitative goals where in many cases quantitative methods are even less well defined than the conceptual models. This too is a valid concern. It is clear that specific values for a performance measure obtained from the characterization program will have a direct impact on the decisions and the demonstration in the future. However, experience has shown that the testing program itself is not particularly sensitive to the specific goals. While there may be some dependence, different allocations performed for the same system usually result in testing programs which are not significantly different. Therefore, while care must be chosen in specifying the values used for criteria, the values for goals would not have as strong an impact. Furthermore, in the development of studies, the program must have some idea of needed parameter values in order to orient the testing program. Prudence should dictate that the setting of numerical goals for parameters would take into account this need.

An associated problem is the specification of a needed confidence level in the performance goal value. This step in the performance allocation process is needed because there is large uncertainty in the parameters of the system due to heterogeneity in the system, incomplete knowledge, measurement inaccuracy, and other factors. It simply is not meaningful to set a goal in terms of a single point value for a parameter without regard for this uncertainty. Whenever possible, the existing confidence level for the parameter value should be specified. If the existing confidence in that value is higher than the needed confidence, then there may be few requirements on the testing program; while, if the needed confidence is higher than the existing confidence, there may be greater demands on the characterization program. Thus, the confidence levels play an extremely important role in prioritizing the testing and analysis activities in this program.

Likewise, it is important to realize that the notions of what factors contribute to the uncertainty and the confidence level will influence the testing program. If the uncertainty is due to heterogeneity, then a certain kind of testing program is dictated; if the uncertainties are associated with the conceptual model itself, then the characterization program will have to address these in a particular way. While this presents difficulties for the development of the characterization program, the performance allocation process is not the source of these difficulties. On the contrary, performance allocation is an orderly way to present the case to address this difficulty.

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TABLE-1

PARTS OF LICENSING STRATEGY			PERFORMANCE ALLOCATION		
STEP 1 Regulations: Postclosure Performance Objectives	STEP 2 System Elements	STEP 3 License Approach	STEP 4 Performance Measures	STEP 5 Performance Goals and Confidence	STEP 6 Parameter Needs for each performance goal
				Goal C_D	Parameter C_D Goal
1. Containment Time					
2. Release Rates					
3. Groundwater Travel Time					
4. Releases to Accessible Environment					

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Telefaxed fm CHanlon, DOE, 2/25/87.
cc: Coplan
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AGENDA

NRC/DOE MEETING 3/3-4/87

SCP ISSUES HIERARCHY/PERFORMANCE ALLOCATION

March 3, 1987

8:30 a.m.	Opening Remarks	Donald Alexander Seth Coplan
9:00 a.m.	Review meeting summaries from 9/26-27/85 Allocation meeting, 5/7-8/86 SCP level of detail meeting	Donald Alexander
9:15 a.m.	Overview presentation of the Issues Hierarchy and Issue Resolution Strategy	DOE
10:15 a.m.	BREAK	
10:30 a.m.	Status of SCP Section 8.1 - Rationale for the SCP Program	DOE
11:00 a.m.	Status of performance allocation (examples)	DOE
12:00 p.m.	LUNCH	
1:00 p.m.	Discussion of conceptual approach for performance allocation	DOE/NRC with State/Tribe participation
3:00 p.m.	Preparation of meeting summary	DOE/NRC
4:30 p.m.	Adjourn	

March 4, 1987

8:30 a.m.	Complete preparation and signing of meeting summary	DOE/NRC