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U.S. DEPARTMENT OF COMMERCE

8/13/87

To : Everett Wick

From: Chuck Interrante

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Chapter 8

Section 8.2

ISSUES

DRAFT
Site Characterization Plan

Yucca Mountain Site, Nevada Research and Development Area, Nevada

August 17, 1987

U.S. Department of Energy
Office of Civilian Radioactive Waste Management
Washington, DC 20585

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Site Characterization Plan

Yucca Mountain Site, Nevada Research and Development Area, Nevada

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8.1 RATIONALE FOR THE SITE CHARACTERIZATION PROGRAM

The site characterization program and Chapter 8 follow two organizing principles. The first is the issues hierarchy, which states the questions the DOE feels must be resolved about the performance of the mined geologic disposal system (i.e., the waste package, the engineered repository, and the natural system at the site) 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. This general strategy can be used to develop a specific strategy for the resolution of each issue. One step in the application of the specific strategies results in the identification of the site information needed to support the resolution of the issues. 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 questions 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, 1985). The discussion that follows explains the derivation, structure, scope, and objectives of the issues hierarchy. More information can be found in the Issues Hierarchy for a Mined Geologic Disposal System (DOE, 1986d).

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, which 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 still more detailed sets of information called the "information needs"--one set for each issue. 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. It also distinguishes the key issues and issues from requirements for the basic information needed to resolve the issues.

The issues hierarchy, then, defines issues that must be resolved to demonstrate compliance with key regulatory requirements. Other, detailed requirements that the disposal system must satisfy, such as functional requirements, are included in the specifications given in the Generic Requirements for a Mined Geologic Disposal System (DOE, 1986c), the Waste Management System Requirements and Descriptions (DOE, 1986f), and in the requirements document that will be issued for a repository at the Yucca

Mountain site. As the definition of requirements progresses, the requirements and the issues hierarchy will be compared and correlated to ensure consistency and completeness in each. The role of the system requirements and descriptions in the issue resolution strategy is 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 Yucca Mountain 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 Yucca Mountain site is presented in Section 8.2.1.1. Although care has been taken to ensure 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 answered affirmatively if a site is to be found suitable for development, selected, and licensed. The key issues are derived from the four system guidelines of the DOE siting guidelines promulgated in 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 environmental, socioeconomic, and transportation impacts of the repository; and (4) the 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. 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 Subpart B of 40 CFR Part 191 (EPA, 1985), and the criteria adopted by the Nuclear Regulatory Commission (NRC) in Subpart E of 10 CFR Part 60 (NRC, 1983).

Key Issue 2 (preclosure radiological safety) is derived from the preclosure system guideline (10 CFR 960.5-1(a)(1)). It requires compliance with the applicable requirements of the EPA standards in Subpart A of 40 CFR Part 191, 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 (SCP). Little information from the site characterization program is required for the resolution of Key Issue 2. Instead most of the information needed to resolve this issue will be obtained from design studies for the repository and the waste package and from studies conducted concurrently with site characterization. (Plans for such studies will be presented in an environmental program plan and a repository design plan for the Yucca Mountain site.)

Key Issue 3, which is concerned with the environmental, socioeconomic, and transportation impacts associated with a repository, is derived from the preclosure system guideline (10 CFR 960.5-1(a)(2)). The resolution of this issue does not directly depend on information from site characterization activities and therefore this key issue is not addressed in the SCP. 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, prepared concurrently with the SCP.

Key Issue 4 (the ease and cost of repository siting, construction, operation, and closure) is derived from the preclosure system guideline (10 CFR 960.5-1(a)(3)). The requirements of this issue are derived 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. The resolution of this issue depends in part on site conditions and in part on information that can be developed independently of the description of site conditions. Plans to acquire this independent information will be presented in a repository-design plan; these plans are not presented in this SCP, because the activities they describe do not fall within the definition of site characterization in the Nuclear Waste Policy Act.

Matrices that correlate each 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--for example, those proposed by the NRC in the draft issue-oriented site technical positions.

Issues

The issues defined for each key issue are also stated as questions (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 to 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 accommodate the structure and the intent of the regulations in 10 CFR Part 60 and 10 CFR Part 960, the issues are divided into performance issues and design 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 performance issues generally address questions about compliance with regulatory requirements for the performance of the disposal system. They are generally related directly to the highest level of regulatory requirements to be satisfied. 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 requirement to make higher-level findings for the postclosure guidelines and for each set of preclosure guidelines in 10 CFR Part 960.

The design issues address questions about the design of the repository, the shaft and borehole seals, and the waste package. They 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.

The resolution of both the performance and the design issues requires information about the site, and to provide this information the site program described in Section 8.3.1 has been developed. This program will evaluate the site characteristics, processes, and events that may affect the design and the performance of the waste package and the repository; the results will provide the detailed site information that will be used to develop site descriptions and to support the resolution of design and performance issues, including the demonstration of compliance with the siting guidelines. The site program is organized by technical discipline (e.g., geohydrology, geochemistry, and rock characteristics), and it provides a means of controlling and integrating the investigations in each technical discipline.

The relationship among the two categories of issues and the site program can be summarized as follows: The performance and the design issues establish requirements and priorities for the site program, while the site program produces data for the analyses needed to address design and performance issues. An investigation or other type of activity in the site program will take place only if it is necessary to provide information needed to resolve a design or a performance issue.

Information needs

On the third tier of the issues hierarchy is a set of statements called "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 the categories of 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 for the Yucca Mountain site have been identified and are listed 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 SCP because it is 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 SCP. 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 in the issues hierarchy. The defining of these issues was itself a part of the issues-based approach to site characterization described in this section 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 before specific plans for the resolution of each issue can be formulated, detailed description of the disposal system is needed (step 1a). This description for the Yucca Mountain site will be presented in site-specific 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. (In the issue resolution strategy the term "performance allocation" refers only to the four steps (steps 3 through 6) shown in Figure 8.1-1). 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 and documented in a written agreement between the DOE and the NRC.

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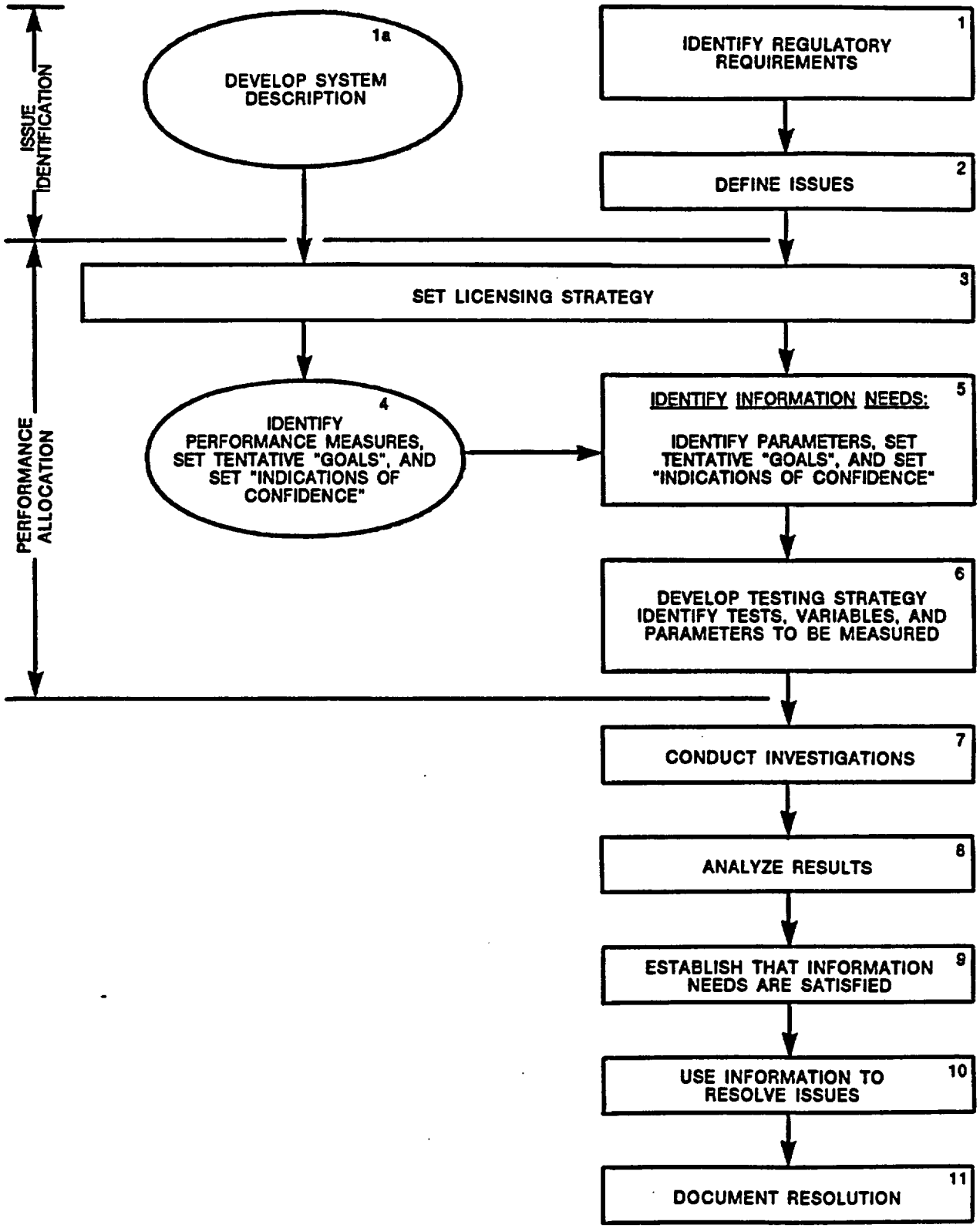

Figure 8.1-1. Issue resolution strategy.

The steps in performance allocation were defined with several objectives in mind: to provide uniform guidance for site characterization at all candidate sites, to ensure Program-wide consistency in implementing the process of performance allocation, and to provide specific kinds of information requested by the NRC.

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 statement is 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 additional information becomes available, the licensing strategy may be revised, and the performance allocation may be changed. The licensing strategies described in this document are likely to change before the submission of the license application to the NRC; for the purposes of this SCP, they are simply the basis for initial planning.

For guiding the development of the SCP, 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 the statement of disposal-system components for use in later steps as a basis for deciding what specific information is needed for resolving the issue.

Performance measures and tenative goals

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

For each performance measure step 4 establishes a tentative "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 tentative 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 goal is identified, the reasoning that led to its selection is also presented.

As a further guide for testing, step 4 accompanies each tentative 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 goal has been attained.

For some goals, it is possible to use statistically rigorous numerical values as indications of confidence; for most of them, however, 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 goals and indications 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.

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 Yucca Mountain site are listed in Section 8.2. Section 8.3 explains how these information needs were derived 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. Often, however, they can be expressed by an equation in which quantities that can be measured more directly appear as parameters (e.g., hydraulic conductivity). Step 5 furthers the development of plans for testing by listing these parameters. Sometimes the performance measures cannot be expressed simply as an equation containing associated parameters; then in step 5, by an extension of the notion of mathematical parameters, lists are made of whatever quantities must be measured to demonstrate that the goal associated with the performance measure has been met. The performance allocations reported

in later sections of this chapter call these quantities, as well as the quantities derived from rigorous equations, "parameters". Parameters derived for the resolution of design issues are usually called "design parameters"; those for performance issues are "performance parameters."

In step 5 a tentative goal is assigned to each parameter. Like the goals for performance measures, these goals are not values that must be achieved by the disposal system. They are simply quantitative statements about the values that the licensing strategy expects to use for the parameters in showing that the issue has been resolved. Frequently, the goals are expressed as inequalities because the licensing strategy may require only that the value of a parameter be shown to lie within a stated range or to be greater or smaller than some stated value.

If the results of site characterization can successfully demonstrate that the tentative goal has been met, the DOE plans for getting a license will be fulfilled as far as that parameter's contribution to the associated performance measure is concerned. The demonstration will not, of course, guarantee a successful license application because many other parameters will enter the calculations in support of the license. Moreover, failure to meet the goal would not be reason to suspect that the license application will be unsuccessful because the goals are not values that, by themselves, are essential to the performance of a disposal system. The reason for setting the goals is simply to guide the specification of tests in the characterization program--to tell quantitatively what information will lead to the resolution of the performance and the design issues.

As a further guide to the detailed specification of tests, step 5 also specifies two indications of confidence for the goal assigned to each parameter. Like the indicators for goals for performance measures, these indicators are not numerically rigorous but are expressed in qualitative terms: high, medium, and low.

The first of these two indications, called "needed confidence" in the performance allocation tables in this chapter of the SCP, answers the following question: When the DOE presents its license application, how confident must it be that the goal has been met? In other words, what confidence does the licensing strategy require for the demonstration that the goal has been met? In assigning the indicators of needed confidence, the DOE is guided primarily by two considerations:

1. Importance. How important to the licensing strategy is the associated goal? Usually the goal is so important that a value of "high" is assigned to the needed confidence. When the goal is a request for information that is not crucial to the license application, an assignment of low or medium confidence is usually appropriate.

2. Sensitivity of the parameter associated with the goal. In addition to considering the importance of a goal, the DOE may examine the sensitivity with which the associated parameter contributes to performance measures and other parameters. If a performance measure or

another parameter is highly sensitive to the likely or expected variations in the parameter for which a goal is assigned, the needed confidence may be higher than it would be for a parameter whose variations make little difference.

The second indication of confidence, called "current confidence" in the performance allocation tables, answers the following question: If the DOE were to present its license application today and could use only currently available data in the presentation, how confident would it feel that the associated goal has been met? In assigning the indicators of current confidence, the DOE is guided by considering the amount and the quality of the available data.

Step 6 in Figure 8.1-1 uses the information needs, expressed in the terms adopted during step 5, to define the work that will produce the needed information. The parameters derived in step 5 are usually not directly measurable quantities, but must be derived from other quantities that can be measured through testing. For example, hydraulic conductivity, mentioned previously as a possible parameter for calculations of ground-water travel time, is not directly measurable in a field test. Step 6, then, identifies additional, more directly measurable, quantities that can contribute to determining values for the performance and design parameters derived in step 5. These additional quantities are generally called "characterization parameters." Some of the SCP sections describing the site program also use other kinds of parameters, called by different names, in explaining how characterization parameters are being developed.

Step 6 also defines a "testing basis," whose purpose is to give further information about the way in which the characterization parameters need to be measured. Some of the testing bases appearing in the later sections of this chapter describe the accuracy with which the associated characterization parameters need to be measured; some describe the confidence that the measurements should produce for licensing. As the later sections explain, the particular descriptions of a testing basis are tailored to the parameters they explain and to the development status of those parameters.

The parameters, confidences, and testing bases are the foundation for the strategy detailed in Section 8.3 in the descriptions of the planned site characterization work. That section describes the planned tests; it identifies the experimental variables and the parameters (from steps 5 and 6) that the tests will measure. It also describes plans for developing the needed analytical models and design information.

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 design issues may differ from the strategy adopted for performance issues. And although the goals assigned to performance measures for 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 briefly summarizes the rationale behind the indicated allocation for each issue, and Section 8.3 the complete performance allocation.

8.1.2.3 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 and the studies they encompass (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).

8.1.2.4 Application of the issue resolution strategy

The entire issue resolution strategy is intended to be an iterative process. As explained previously, the licensing strategy, as well as the tentative goals and the indications of confidence for the performance measures and related parameters, may be changed to reflect new information or in response to comments about plans or test results. 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 the rethinking of earlier steps. Any of the steps may, in fact, lead to revisions of earlier steps. Sections 8.2 and 8.3, in presenting DOE plans for issue resolution and site characterization, report the current status of the issue resolution strategy.

This iterative process will furnish a vehicle by which the DOE will communicate to the NRC and the State the approaches that it intends to use in resolving the issues in the issues hierarchy. As already mentioned, the current versions of the strategies are preliminary and intended simply as a basis for initial planning; they are expected to be the primary focus for comments and discussions between the DOE and the reviewers of the SCP.

The rationale for future changes to the issue resolution strategies (e.g., revised licensing strategies and performance allocations) will be documented in the site characterization progress reports, which will also report the results of site characterization studies. The reviews, interactions, and reports will continue until the license application is submitted to the NRC.

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PART B (Chapter 8)

SITE CHARACTERIZATION PROGRAM

DRAFT
Site Characterization Plan

Yucca Mountain Site, Nevada Research and Development Area, Nevada

August 17, 1987

U.S. Department of Energy
Office of Civilian Radioactive Waste Management
Washington, DC 20585

Chapter 8

Section 8.0

INTRODUCTION

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Site Characterization Plan

Yucca Mountain Site, Nevada Research and Development Area, Nevada

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Chapter 8

Section 8.1

RATIONALE

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