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U. S. Department of Energy
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SUBJECT: PERFORMANCE ALLOCATION IN SCP

Given to OCC on 6/12/87

For more than a year, in a serious attempt to comply with the agreement between your office and the NRC staff, NNWSI participants have given a great deal of thought, time, and effort to the process of performance allocation. For the most part, the attempt has been constructive in the hope that the process would indeed lead to clarification and prioritization of information required from the site-characterization program at Yucca Mountain, thus providing clear and efficient direction to this program. Those charged with the responsibility for site characterization recognize the ultimate need to assure the NRC, the scientific community, and a skeptical public that predictions of repository performance will be based on appropriate and adequate site information. They are equally sensitive to the need to focus project efforts on the important technical issues and to make the best possible use of available funding and time.

In November, 1986, the SCP effort in NNWSI shifted from project-level review of the information sections to completing development of the planning sections. There has been an intense and diligent effort on the part of all NNWSI technical and regulatory participants, fully supported by NNWSI management, to respond positively to OGR directives for full implementation of performance allocation in planning the characterization program. However, enthusiasm and dedication are rapidly giving way to frustration, for reasons that are only now becoming evident. There has been a growing recognition that the difficulties and many impasses encountered during the performance allocation activities have not been caused by lack of understanding or commitment on the part of the participants -- rather, that they are caused by the attempted application of a concept that is fundamentally inappropriate to characterization of the natural conditions and processes that occur at a proposed repository site.

The concept underlying performance allocation is basically a design technique, a means of systematically identifying and controlling the required characteristics of the components of a system in order that the sum of these components, acting together, will behave in a prescribed manner. This prescribed manner could be termed "system operating specifications", "performance objectives", or "performance goals". Regardless of whether the design is simple or complex, it must have certain characteristics if the allocation process is to be successful:

(1) There must be a finite number of discrete components that affect the behavior of the system.

(2) The characteristics of these components must be independent variables, or must be interrelated by known mathematical functions.

(3) The values (or range of values) of each characteristic of each discrete component must be subject to control during fabrication or, if not subject to control, must be measurable.

(4) Although some steps may be iterative, the design process proceeds in almost all cases from the body of known or controlled characteristics (independent variables) to the calculation of a set of resulting system characteristics (dependent variables). If the system characteristics do not meet the operating specifications, controllable variables are changed and the process is repeated. Only in the simplest of systems can the calculations be done in reverse to arrive at required values for controllable independent variables.

In contrast, consider the characteristics of the same four factors in the context of trying to analyze the system in reverse when the principal components are the natural conditions and processes of the earth's crust:

(1) For practical purposes, the spatial distributions of natural earth characteristics affecting any aspect of design or performance are infinitely complex. These characteristics vary through a complexly interrupted continuum rather than being associated with discrete components. To be sure, we generalize their identities and spatial distribution into artificially discrete cells in modeling and even, in some models, attempt to describe their chronological variation with simplified functions. However, we should not delude ourselves into believing that we have successfully described the real world, in either its existing or its changing aspects.

(2) Most of the variables of significance (e.g., permeability, porosity, degree of saturation, mineralogy) are independent. Some characteristics of a given microcosm of the earth's crust are quasi-interdependent because they have resulted from a common origin and common subsequent processes that have acted on

that microcosm. Relationships among these logically should exist, but they are poorly known at best and they do not adhere cooperatively to functions that can be expressed analytically. To some extent, these relationships can be expressed empirically with large degrees of uncertainty, even within the actual range of observations, but extrapolation in time or to another microcosm leads to much greater uncertainty. In effect, we must treat each characteristic of each microcosm as an independent variable.

(3) The characteristics are certainly not subject to control -- they are what they are, and they will be what they will be -- which leads us to the requirement that they be measurable. Few, if any, design or performance-assessment models presently under consideration use, as direct input quantities, earth-crustal characteristics that are directly measurable. A few variables (e.g.,, porosity of the rock matrix) can be measured within reasonable tolerance limits, though only on a somewhat disturbed sample that is truly characteristic only of a given microcosm. The vast majority of characteristics are derived by inferences -- i.e., by measuring one or a set of characteristics that is related by imprecise empiricism to the quantity of interest, and then by applying professional judgment to arrive at a "reasonable" value or range for the quantity. Even measurement of related characteristics is generally restricted to one end of a spectrum of applicability -- of a microcosm too small to be of direct interest, or of too large an integrated volume to provide the necessary spatial resolution. Because of these limitations, much -- perhaps most -- of a reasonable site-characterization program is directed <u>not</u> toward the direct measurement of parameters significant to performance prediction, but rather toward improving the empirical usefulness of related characteristics, the development of a statistically significant data base, and the search for supporting but non-quantitative indicators that guide the most important element of the process -- professional judgment.

(4) Rather than applying known functional relationships to known or controlled independent variables to arrive at the dependent variables, the performance allocation process that has evolved in the repository program attempts to use a sequence of single mathematical relationships to back-calculate required values or ranges for sequential sets of independent variables. Algebraic logic requires that there must be as many independent relationships as there are independent variables in each step of the sequence. No combination of prescribed tables, obscure terminology, and wishful thinking will allow us to overcome this reality. Further, the most important factor contributing to the selection of the value for each variable is <u>professional judgment</u>, which the process is designed to circumvent.

Sensitivity analysis, a close cousin to performance allocation, is indeed an important tool for guiding judgment for both program design and evaluation of sufficiency. However, even this must be a servant rather than the master in earth-science programs, used in the broad sense to include both engineering design and performance predictions that are based on characteristics of the earth.

Similarly, we agree that the concept of an issue-resolution strategy is essential in demonstrating that the project has a clear understanding of the requirements for licensing and of the pathway for meeting those requirements, to the extent that the latter can be defined in advance. Our principal areas of disagreement are in the means of expressing these understandings and in the requirements to express greater confidence in the pathway than can be justified realistically. In particular, specifying quantitative goals and their associated confidence levels for most site characteristics is unrealistic, misleading, and unsupportable from either scientific or engineering perspectives. Consequently, it sets the stage for successful legal challenges to the results of the characterization, design, and performance-assessment programs.

Different problems require different approaches to resolution. The present rigor that is being directed in the format of the SCP issue-resolution text and tables suggests a management perception that we are repeating the same experiment over and over again, changing only the reagents. Uniformity of approach to all issues will not demonstrate to the technical community that the project is well managed and cohesive; instead, it will demonstrate that the project does not understand the complexity of the problem.

Expression of a greater level of confidence than is justified in defining the approach to issues resolution also will be quickly recognized as naivety or, worse, as a presumption of success. The scientific community would be far more comfortable, and more willing to comment constructively, with expressions of honest uncertainty as to approach in the early stages of an investigation, followed by better definition as the study progresses.

A common misconception among many in the field of engineering is that the same principles that apply to successful design, applied in reverse, will assure that they will receive from site-characterization tasks the appropriate design input, both in the format and with the degree of precision that they specify. A more effective management technique would be to ensure continuing dialogue between the producers and users of the information -- not only so that the producers understand the needs of the users, but also so that the users understand what realistically can be produced. The perception of reality will necessarily change as data are acquired during characterization, causing changes in design or assessment approaches or adjustments in the characterization program. This should be the basis of an evolving issues-resolution strategy. Unfortunately, reliance on performance allocation, particularly when applied in a uniform and inflexible manner that focuses more on process and format than on results, is serving principally to weaken the lines of communication and to polarize the users and the producers.

I strongly encourage you to direct an end to the performance-allocation activities in their present concept. As an alternative, I suggest the following:

(1) In the strategies for resolution of the design and performance issues, identify the possible models and/or techniques that are under consideration for use in testing compliance with the performance objectives of 10 CFR 60.

(2) For each model/technique, identify the input parameters that are expected from characterization tasks and, to the extent presently possible, the sensitivity of the analyses to the ranges and uncertainties that are credible for these parameters.

(3) For each input parameter (or logical grouping thereof) describe the approach to providing the information needed for analysis; to the extent realistically possible, list the actual measurements or observations that are planned and their relevance to determining the input parameter or to enhancing confidence in that determination. In cases for which the approach cannot yet be defined, discuss alternatives that might be applied at various stages of the investigation.

(4) Insist that, and foster the environment to ensure that, 1 through 3 are developed with the necessary interactions of the user and producer technical staffs.

(5) Allow and encourage flexibility in the accomplishment of 1 through 4, so that approaches can be tailored appropriately for each issue and investigation, and so that they can be modified as dictated by growth of understanding.

(6) Accept preliminary, less comprehensive, and less specific sections where necessary, rather than attempting to demonstrate a greater uniformity of program-planning maturity than actually exists. This acceptance is necessary also to comply with the schedule for SCP release -- if the product that is released is also to be credible.

The objectives of the first four elements are not substantially different from those that presently exist. However, the latter two offer, in my opinion, the means to restore a constructive and scientifically sound approach to preparing this important program plan.

W. W. Dudley, Jr.

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Dear Dr. Dudley:

We have carefully reviewed your letter of April 16, 1987, on performance allocation in Site Characterization Plans, and we appreciated the opportunity to discuss the topic in greater detail with you and Assistant Director Devine at our meeting of May 6 at the Department of Energy (DOE) in Washington, D.C.

I am pleased that we reached agreement that the objectives of our approaches to planning site characterization are the same; that the concept of an issue-resolution strategy is not at issue; that the sensitivity of performance measures to site characteristics is an important consideration in program design; and that identification of site-characterization measurements and observations, and their application to site evaluation, are useful in focusing the site program. I understand further that, in your interactions with Don Alexander after our meeting, you agreed that the allocation or assignment of primary reliance to specific, independently acting subsystem elements is also helpful in prioritizing site characterization efforts. Therefore, it appears that most of the effort of the recent series of NNWSI workshops has been fruitful and that the only serious issue is the level of explicit detail at which the performance allocation process is being applied as a part of the Issue Resolution Strategy.

As you are aware, application of performance allocation in developing the Site Characterization Plan (SCP) was an item of agreement reached by my staff with the Nuclear Regulatory Commission (NRC) staff in September, 1985. We agree that application of this agreement has been difficult and the DOE will critically examine the results of applying performance allocation in its review of the upcoming SCP draft. We acknowledge that approaches defined early in the process may require adjustment as we attempt to apply them in detail. It was the intent of DOE and NRC in the September 1985 agreement to allow for the design of a site characterization program to be adequate, and properly directed by allowing for flexibility in the application of

performance allocation.

Specifically, I have asked Don Alexander to form a task group to consider whether terminology such as "current estimate" or "expected range/value" may describe more accurately than "goals" our intentions particularly with respect to the natural characteristics of the Nevada site. During our discussions of Don Alexander's recently prepared examples, you and Assistant Director Devine appeared to support these revisions of concept and terminology.

During the upcoming reviews it is important that all participants assure that flexibility of approach is maintained to the degree possible and that the differing degrees of maturity of task plans are recognized and expressed in the SCP.

This review will allow us an opportunity to discuss these issues as necessary. Specifically, the Project Overview Committee will be the formal vehicle to resolve, at an upper level, significant concerns about the implementation of the performance allocation process on a case-by-case basis. I assure you that in our reviews with project representatives our common objective is to develop a clearly expressed and credible SCP.

If you have further concerns or if you wish to discuss this issue in more detail, please contact Don Alexander (FTS 896-1238) or myself (FTS 896-5355).

Sincerely,

Ralph Stein

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Engineering & Geotechnology
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cc: J. F. Devine, Jr., USGS, Reston, VA
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