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Dr. Colin Heath
U. S. Department of Energy
Washington, D. C. 20545

Dear Dr. Heath:

Since publication of the proposed procedural rule for public comment in December 1979, there have been a number of questions raised by your staff regarding the intent of exploratory excavation and large scale in-situ testing as part of site characterization. Some of the major questions which have been brought up include:

(1) What is the purpose of underground exploration and testing? Is it for judging site suitability or determining design parameters?

(2) If the purpose of the tests is for judging site suitability, what features might be found that could not be designed around and would be fatal to the site?

(3) What sorts of tests and how much testing is necessary underground?

(4) What level of detail of engineering design information will be necessary as part of DOE's site characterization plans?

This letter presents our thoughts on these questions and identifies our current activities in the preparation of specific guidance documents which will address them more fully.

Purpose of NRC's Review of Site Characterization Plans

Before turning to the specific questions, I would like to restate our purpose in reviewing DOE's site characterization plan. Site characterization is the means by which the information needed to support a license application will be obtained. We expect that when a license application is submitted, the supporting information for the proposed geologic repository and several alternatives will be sufficiently complete that we will be able to begin our review of the application. Therefore, the review of a DOE site characterization report will determine whether (1) based on surface studies, geophysical measurements, exploratory borings, laboratory testing, and NEPA considerations, the site(s) selected for detailed site characterization and the process by which it was selected appear reasonable; (2) the DOE has preserved the integrity of the site during previous investigations and has identified appropriate measures for maintaining the integrity during underground testing; (3) the major geoscience issues regarding the suitability

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of the site and engineering design have been identified and a program for their resolution described; (4) there is reasonable expectation that the program of site characterization will provide sufficient information to resolve remaining issues, questions and areas of uncertainty; and (5) the site characterization program will provide the information needed to compare the site with other sites to be characterized in a variety of geologic media, and to permit the staff to perform its review of a license application, when submitted.

Purpose of Underground Exploration and Testing

The primary purpose of underground exploration and testing is to provide data for assessing the suitability of the site. A site suitability assessment will include both an evaluation of the ability of the site to perform as a major barrier and its ability to host a repository. Exploratory excavation and in-situ testing will provide data on nearfield geologic conditions. Such data will be needed to determine the extent and nature of the volume of rock that would be affected either by construction of a repository or the heat generated by the waste. Finally, exploratory excavation and in-situ testing can provide the data needed to evaluate the impact of site conditions on the repository design.

Site Qualification

With respect to the second question, there may indeed be features, characterized by underground exploration and testing, which may have a decisive influence on the suitability of a site. The ability of the host rock to isolate the waste would be questionable should isotopic analysis of groundwater, mineralogic analyses of joint-fill materials or oxidation of the rock mass indicate relatively active groundwater circulation. Relatively high fracture permeability, as indicated by large-scale rock mass permeability measurements or tracer tests, would also raise questions as to the ability of the host rock to isolate the waste or the ability to model the groundwater flow and transport, particularly given the thermal load of the emplaced wastes.

With respect to repository design, site conditions as determined by exploration and testing may be found to be so complex as to require complicated and unique engineering fixes to assure stable underground openings. The more complex the design of a repository or the more fixes necessary, the more uncertain we will be about how the repository will perform. The site characterization program should resolve such issues as early as possible. If they cannot be favorably resolved, it is unlikely a repository could be located at the site.

In summary, the underground exploration and testing program provides a means of identifying subsurface conditions early-on and significantly reduces the likelihood of finding either adverse or other unexpected conditions later on during the construction of the geologic repository. The underground test program, therefore, will increase confidence in the adequacy of the site, the engineering design, and the performance of the repository, and will decrease the number of remedial actions which may be needed during construction. It will also reduce the potential for the

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need to reopen hearings on licensing decisions.

Requirements of Underground Exploration and Testing

With respect to the third question, the design of an exploratory excavation and in-situ testing program should be tailored to the specific site under investigation. The extent of the excavation of exploratory drifts should be sufficient to provide representative exposure of the rock and groundwater system, permit sufficient access for drilling, and to permit in-situ experiments of sufficient scale to provide representative test results.

The dimensions and configuration of exploratory drifts should be compatible with the conceptual design for a repository at the site since the response of the rock and groundwater system will be dependent on such design features. In-situ tests should be designed to confirm or supplement information obtained from previous surface studies, borehole testing, or laboratory testing of rock core and groundwater samples. Fundamental properties which need to be defined for a given site include bulk hydrogeological, geomechanical, and geochemical properties and their response to the anticipated thermal loading. Particular attention should be given to evaluating the complex geochemical interactions which may take place between the waste, backfill, rock, and groundwater in the nearfield. In-situ testing will also be needed to evaluate the effectiveness of proposed borehole and shaft seal and other design concepts.

As your specialists are aware, a wide variety of characterization and testing techniques are available for determining the fundamental properties of the site. For example, measurement of rock deformation as the excavation proceeds will provide indirect information on-in-situ stresses. The effects of excavation techniques on the rock can also be examined in this regard. Periodic inspection and mapping of excavation faces can assist in fracture characterization studies. Exploratory boreholes from within the excavation coupled with the use of geophysical in-hole measurements can also assist in fracture characterization and in the resolution of rock mechanics problems. Large scale permeability and tracer tests may be used to define groundwater velocities (interstitial and fracture) under varying head conditions. Also, heater experiments may be used to define the volume and measure the response of the rock that would be affected by the heat generated by the emplaced waste.

Civil Engineered Structure

With respect to the fourth question, the NRC staff views the repository as a civil engineered structure. By this we mean a structure that is designed and constructed to meet the specific criteria and performance standards that accomplish the purpose of a geologic repository. We have emphasized this point to clearly distinguish geologic repositories from conventional mines. A repository must isolate waste for long periods of time; therefore, its design and construction should be significantly different than that for a conventional mine. The design of a repository that will meet the appropriate criteria and performance standards will be site dependent. Therefore,

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site related design considerations must be taken into account during site characterization. At each stage of repository design, we expect to review design information to the level of detail that can be developed at that stage. Thus, we will review progressively more complete design information, proceeding from the preconceptual design stage to DOE's application for construction authorization.

Because of the interrelationship of design and site suitability, there are many aspects of design which need to be defined before a site characterization plan may be established. We have identified a need to review design information which is directly related to site characterization and which will dictate the design of in-situ experiments; e.g. the location of the repository, the layout, configuration and dimensions of underground openings, the anticipated location and dimensions of shafts, support systems for shafts and tunnels,type and gradation of backfill material, planned treatment of rock, plans for testing of borehole and shaft seals, and construction procedures proposed for the test facility. Site characterization plans should identify these and other site specific design features which led to the proposed in-situ program.

We will continue to provide additional guidance on site characterization as our program develops. A draft of the standard format and content guide for the site characterization report should be ready for review by the end of the year. During FY81, we plan to prepare generic guidance for underground exploration and in-situ testing. In subsequent fiscal years, we plan to provide additional guidance for specific geologic media. In the meantime, if you have any specific questions that require further clarification, please direct them to me or to Mr. Lawrence A. White of my staff, FTS 427-4177.

Sincerely,

Original Signed by
MICHAEL J. BELL

Michael J. Bell, Chief
High-Level Waste Technical
Development Branch
Division of Waste Management

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