UNITED STATES
NUCLEAR WASTE TECHNICAL REVIEW BOARD
1100 Wilson Boulevard, Suite 910
Arlington, VA 22209

December 12, 1990

Mr. Carl P. Gertz, Manager
Yucca Mountain Project Office
101 Convention Center Drive
Phase II, Suite 200
Las Vegas, NV 89109

Dear Carl:

I would like to thank you, your staff, the Sandia National Laboratories, and the contractors working with you for providing the Structural Geology & Geoengineering Panel with a candid and timely status review of the ESF alternatives (ESF-A) study at our Denver meeting on November 20, 1990. Panel members, consultants, and staff members were impressed with the considerable progress made by the DOE since the July 25, 1990, interim presentation. We were particularly pleased with the proposed early drifting in the Calico Hills unit, using modern mechanical excavation techniques.

At the close of the meeting, I stated that I would be pleased to offer early comments to you on our reaction to the study. The following six observations were prepared jointly by senior professional staff, consultant Professor E.J. Cording, and myself and were approved by the panel members.

1. Early access to Calico Hills. Early access to the Calico Hills unit is preferable to late access. Extensive drifting across the repository and across known faults is the most appropriate form of exploration. Not only would exploration of the Calico Hills unit be provided at an earlier date allowing an early decision on site unsuitability, but also access to initiate testing at the Main Test Level could be provided earlier, and the completion date of the entire ESF program would be advanced by perhaps one year.

2. Advantages of TBM excavation. Tunnel-boring machine (TBM) excavation offers several advantages. It (1) provides rapid advance rates in long drifts; (2) provides tunnel surfaces for mapping that are undisturbed by blasting and by drillhole circulation water; and (3) provides the same type of openings and wallrock as will be present in the repository.

3. Advantages of ramps. Ramps will not only provide early and rapid access to both the Calico Hills and repository horizons but will present additional advantages: (1) provide better information for the layers above the repository level by crossing them at an angle and by permitting short drifts or test alcoves to be excavated at points of interest; (2) permit a more representative picture of the high angle faults and fracture zones that could be critical in

evaluating groundwater flow; (3) allow the exposure of the stratigraphic layers over a large enough horizontal section to permit correlation of jointing and faulting to stratigraphy; and (4) permits mapping of the walls and roof of ramps as the TBM advances.

4. Combined ESF options. The desirable characteristics of the highest-ranked ESF options should be recombined into several new configurations. Detailed engineering cost and schedule analyses including critical paths should be developed for these new configurations, and engineering studies made of the benefits and limitations, including appropriate provisions for risk-based contingencies for each option. Experts knowledgeable in the design and construction of underground facilities and experienced in the use of current excavation technology would be essential to these engineering studies.

5. Flexibility in excavation procedures. The ESF design should provide for flexibility in grade, layout, length of drifts, choice of mechanical excavation equipment (for example, road-header, hydraulic ram, or TBM for side drifts) to accommodate changing geological conditions and new requirements for testing that might be developed, and to provide efficiency in excavation and rock support. The location and character of certain of the anticipated faults and fracture zones will undoubtedly differ to a significant degree from that anticipated prior to excavation.

6. Flexibility in testing. New configurations in ramp and tunnel layout and the prioritization of tests for site suitability provide an opportunity for increased options for testing. During the coming year Board panels will seek meetings with the DOE concerning the testing program. Emphasis will be placed on reviewing testing procedures and technology, locations and priority, and in particular, appropriateness in meeting stated objectives.

At the end of the presentation, it was stated that the remaining tasks included rank-ordering the options and selecting a preferred option that would be recommended to Dr. Bartlett in January 1991. At the interim presentation on July 25, 1990, it was stated that the more promising options were to be reconfigured to form new candidate options, and another iteration of the selection process would be conducted, prior to selecting a preferred option.

Considering the impact other ongoing DOE studies may have on the ESF-A study and the importance of this recommendation to the progress of the program, I would like to suggest that you present a preferred *set* of selected options, perhaps 3 or 4, with a final recommendation to be made later in 1991, when you have had an opportunity to evaluate the observations given above.

I have enclosed a copy of Professor E.J. Cording's consultant report on the ESF-A study. It may offer insight on the aforementioned comments.

I look forward to our proposed meeting in January 1991. If I should not see you before then, best wishes for the holidays.

Sincerely,

Don U. Deere

Don U. Deere
Chairman

Enclosure

cc:
Dwight Shelor, DOE
Robert E. Browning, NRC
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2 December 1990

Memorandum:

To: D. U. Deere
Chairman, Nuclear Waste Technical Review Board

From: E. J. Cording
Consultant to Nuclear Waste Technical Review Board

Subject: NWTRB Structural Geology and Geoengineering Panel, November 21, 1990 Technical Exchange with DOE on Exploratory Shaft Facility (ESF) Alternatives Study.

1. Introduction

On Nov 21, 1990, the NWTRB Structural Geology and Geoengineering Panel conducted a Technical Exchange in which the DOE presented preliminary results of their Exploratory Shaft Facility (ESF) Alternatives Study.

In this memorandum are summarized some of the considerations that I conclude are relevant in the selection of the final ESF options and in the design of the ESF.

2. Considerations in ESF Alternatives Study

Several changes were made to the ESF Alternatives Study subsequent to the July 25, 1990 meeting with the SG&G Panel.

Portions of a separate study, the Calico Hills Risk/Benefit Analysis, were incorporated into the ESF Alternatives Study. The Calico Hills Risk/Benefit Analysis was summarized for the Panel in the October 10, 1990 Technical Exchange. It showed the value of extensive drifting in the Calico Hills Unit, a non-welded tuff located below the proposed repository level and considered to be a primary natural barrier to groundwater flow. The results of the analysis were incorporated into the ESF Alternatives Study by modifying each of the ESF options to include access to and extensive drifting in the Calico Hills Unit.

An additional 17 options (18-34) were added to the ESF options in order to consider early access to the Calico Hills Unit. The strategy was to "proceed as quickly as possible to Calico Hills to identify potential evidence of site unsuitability, deferring tests in accesses, except those for which data would be irretrievably lost if not acquired during access construction".

In addition, the DOE noted that test strategy has been revised to emphasize site suitability tests.

3. Initial results of the ESF Alternatives Study

The initial results of the ESF Alternatives Study were presented in the November 20 technical exchange.

Options with the highest ranking were those in which excavation was carried out by mechanical means, either with two ramps excavated by tunnel boring machines (TBMs) or with a combination of a TBM ramp and a shaft excavated by shaft boring machine (SBM).

Lower ranking options were those in which two shafts were utilized, both excavated by drill and blast techniques.
Also ranked low, for obvious reasons, was the blind shaft boring technique, which introduces water and mud into the formation and does not allow the shaft walls to be visually inspected.

In the programmatic portion of the evaluation, excavation by mechanical methods was more highly ranked than in the characterization portion of the evaluation, in which a higher ranking was placed on options with a combination of a drill and blast shaft and a TBM ramp. Overall, the highest rankings were for options in which both accesses were excavated by mechanical means.

4. Conclusions

a. The conclusion reached in the Calico Hills Risk/Benefit Analysis, that extensive drifting across the repository and across known or suspected faults is the most appropriate form of exploration, is in agreement with my own conclusions and with previous NWTRB Board and Panel statements.

b. The initial results of the ESF Alternatives Analysis places high priority on mechanical excavation, principally with ramps and drifts excavated by TBM, and favors early access to the Calico Hills. I am in agreement with theses conclusions.

c. Early access to the Calico Hills Formation (such as is provided by Options 30, 23 and 24) is preferable to later access (Options 13, 6, and 7). Not only is exploration of the Calico Hills formation provided at an earlier date, allowing an early decision on site unsuitability, but access for initiation of the testing in the Main Test Level can also be provided earlier, and the completion of the entire ESF program is typically a year earlier, based on the estimates provided by the DOE in the November 20 meeting.

d. TBM tunneling of the drifts is desirable in order to 1) allow more rapid tunneling of long drifts, 2) provide tunnel surfaces undisturbed by blast damage for mapping and to provide minimal introduction of water into the formations to be tested, 3) provide openings of the same type as will be used in the actual repository so that tests will be performed in the same type of openings and wall rock as will be present in the actual facility.

(Note: The Structural Geology and Geoengineering Panel has, on several occasions, emphasized the importance of using mechanical excavation methods in exploratory drifts or shafts to avoid blast-induced fractures that would mask the existing fractures and to avoid introduction of drill water that would mask the natural groundwater conditions. My conclusions have not changed.)

e. Ramps will not only permit rapid TBM access to the repository and Calico Hills levels, but should also provide better information in the layers above the repository level than can be obtained from shafts. Further review and evaluation of testing procedures above the repository level will be required before full advantage of the possibilities for exploration and testing from the ramps is realized. (It is recommended in Item h, that testing procedures be reviewed in detail during 1991.)

The ramp permits a much more representative picture of the high angle faults and fracture zones that will affect groundwater flow. The ramps will pass through the various stratigraphic layers exposing a large enough horizontal section to permit evaluation of the relation of the high angle fractures and faults to stratigraphy. Such information will be valuable, both above and below the repository level. Detailed mapping of rock conditions exposed on the walls of the ramps can proceed as the ramps are being advanced without delaying the advance.

It may be desirable to modify the testing and exploration program in the horizons above the repository level. With rapid access to the repository level, it would no longer be necessary to use the upper demonstration breakout rooms (UDBR) as an early demonstration of test results, prior to carrying out the tests at the repository level. The emphasis should be upon evaluating those features of the upper horizons that will affect gas and fluid flow. Drifts could be driven from the ramps, above the repository level, to provide for additional exploration and testing. It may be feasible to carry out some enlargements or drifting above the repository level while the ramp is being advanced and is being used for removal of muck. However, drifting could be carried out subsequent to ramp excavation without losing significant suitability data.

f. The leading options in the ESF study should be reviewed to determine those characteristics that are most desirable in the ESF. Cost and schedule analysis of several configurations that have features of the highly ranked options should be performed. The development of these detailed engineering studies will provide a more comprehensive picture of the benefits and limitations of the highly ranked options than can be obtained from repeating the decision analysis process. Tunnel or shaft diameters should be sized for efficient construction at low risk, as well as to meet requirements for testing and potential use as part of the permanent facility.

As part of the engineering studies, a critical path analysis should be prepared. The contingencies and risks inherent in the various methods should be evaluated and considered in the schedule. If relatively untried methods or equipment are proposed, consideration should be given to prototype testing prior to ESF construction, in ground conditions similar to those expected at the site.

Engineers knowledgeable in the design and construction of underground facilities and experienced in the use of current excavation technologies are essential parts of this team.

g. Flexibility should be provided in the selected ESF design in order to adjust to ground conditions as they are revealed during construction. The location and character of certain of the anticipated faults and fracture zones will undoubtedly differ to a significant degree from that anticipated prior to excavation. Flexibility will allow the contractor performing the work to be more efficient with cost and schedule. For example, drift lengths might be increased out of one tunnel access at the expense of another if excavation from that access is ahead of schedule. It may also be desirable to retain options for more than one mining technique, such as either TBM or roadheader mining of spur drifts, in order to make schedule and cost more efficient. (It is quite common to mine TBM spurs from a main TBM drift, and this should be considered for the ESF.)

h. Within a selected ESF configuration, some flexibility needs to be built in at this stage to allow for adjustments in excavation to fit details of the test program. Much of the incorporated into new options for an iteration of the decision analysis process. In previous technical exchanges with the DOE, the possibility of including outside experts in a second iteration of the decision analysis process was discussed. I recognize that to conduct, at this time, the full decision analysis process with independent peer review panels or with outside experts added to the existing panels would require a significant expenditure of time and resources, even if a truncated set of ESF options were analyzed. Further, the benefits of such an evaluation will be limited because a full engineering cost and schedule analysis has not been performed on the leading options, and the specific characterization tests to be carried out in the ESF have not been fully reevaluated.

I conclude that, at present, the most appropriate procedure for continuing the ESF evaluation would be to review the high ranking options that provide early access to the Calico Hills and select features from those options to form several revised options, each of which has the flexibility to incorporate appropriate alternatives for test procedures, construction method and layout. These revised options should be developed by means of an engineering cost and schedule analysis, considering critical path schedules, contingencies and risk. The expertise of design and construction engineers and engineers experienced in the use of current tunneling methods and equipment should be utilized.

A significant effort should be mounted this next year to review testing priorities. The individual characterization tests to be conducted need to be evaluated and fitted to the revised and expanded ESF concepts.