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JUN 4 1986

- 1 -

Mr. Earnest Corp
U.S. Bureau of Mines
Spokane Research Center
East 315, Montgomery Avenue
Spokane, Washington 99207

Dear Mr. Corp;

Attached is a draft copy of the technical assistance task order on the topic of "Rock Support in Underground Geologic Repositories" to be performed under the existing Interagency Agreement NRC-02-08-075. The NRC would like you to review the task order, and respond with your comments on the scope of the work, level of effort, and schedule for the several subtasks. The final report should be completed by December 1986, so that this study will be helpful in the NRC review of the site characterization plans for the HLW geologic repositories.

This action taken by this letter is considered to be within the scope of the current Interagency Agreement NRC-02-08-075. No changes to cost or delivery of authorized products are authorized. Please notify me immediately if you believe this letter would result in changes to cost or delivery of contracted products. I can be reached on 427-4629 (FTS).

/S/

Banad Jagannath, Project Manager
Engineering Branch
Division of Waste Management
Office of Nuclear Materials Safety
and Safeguards

cc: w/attachment
E. Amey, BOM, Wash., D.C.
w/o attachment
D. Forshe, BOM, Wash., D.C.

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TASK ORDER 001 for FIN B 6934:
Rock Support in Underground Geologic Repositories

A. Background

The Department of Energy is currently evaluating three rock media (basalt, tuff, and salt) for the selection of three sites for site characterization. The selected sites will be investigated to determine their suitability for the construction of a geologic repository for the disposal of high-level nuclear waste. In the current conceptual design, the geologic repository resembles an underground mine in many respects, and it is expected that many of the underground mining machinery/hardware/methods will be used (or adapted for use) during the repository construction and operation. However, because the repository thermal environment after waste emplacement will be different from that of the most underground mines, existing knowledge about the performance of roof support systems under ambient conditions may not be adequate in evaluating their performance under repository operations environment. Therefore any proposed rock reinforcement and rock support systems need to be critically examined to determine the effects of heat on their performance.

Several roof support systems have been in use in the underground mines. The point-achored bolts were perhaps the first type of bolts introduced in the mines/tunnels. These bolts, although popular, always lost tension following installation, requiring the mine operator to provide additional support and retightening of the existing bolts. In the early Seventies, the resin fully-grouted bolts gained wide acceptance by many mine operators because of their effectiveness in resisting shear movements in laminated strata. Combinations of point-anchored bolts and fully-grouted bolts were later developed to take advantage of the best features of both. More recently the Split Set and the Swellex bolts were developed by Ingersoll Rand, and Atlas Copco. Thus a cursory review of mining literature suggests, that there is considerable experience behined every bolting systems currently in use.

In contrast to the long history in mining/tunneling, little or no experiecne exists in the hot repository environment to guide the conceptual design and/or selection of effective rock reinforcement/support systems for the nuclear waste repositories. Effect of thermal load on the performance of rock support systems is little understood. Therefore, there is a need to study the problem of rock/support thermal interaction and understand the limitations of the various systems that may be proposed by the DOE.

The NRC staff has commented on the DOE Draft EA's (e.g., Comment No. 6-103, page 97, Yucca Mountain comments) that selection of existing, off the shelf,

roof bolting systems (fully-grouted or point-anchored, etc.) may not be adequate because the thermal stresses imposed on the rock and bolts may cause the support system to deteriorate more rapidly than what is encountered in standard mining/tunneling operations. Differential thermal expansion rates of the rock, the grout and the steel may cause the bolts to loose the capacity to reinforce the roof strata. Also, the resin grout strength may be reduced by heat and this results in support maintenance problems, roof falls and consequently the need to rebolt the roof. Jointed basalt and salt rock will also have their own unique set of rock/support thermal interaction problems.

B. REGULATORY FRAMEWORK

The NRC rule 10 CFR 60 requires that the openings in the underground facility be designed so that operations can be carried out safely (10 CFR 60 133 (e)). Furthermore, Section 60.111(b) of the rule requires that the ability to retrieve must be included in the repository design. Because of these regulatory requirements, the repository must be designed to remain open for a period of about 90 to 100 years and the selected rock bolting and other support systems must be designed to provide support of the heated rock during the repository operation.

C. OBJECTIVES

The tasks outlined herein require the Bureau of Mines to provide technical assistance to the NRC by conducting a comparative engineering study of the effectiveness of various types of rock bolting and other support systems in providing long-term rock reinforcement or support under the thermal environment of a geologic repository. The results of this study will assist the NRC in its review of the SCP's, various phases of the repository design, and eventually the license application. The geologic strata at the sites are not well-defined at present because no entries have been mined yet. However, data from existing exploratoy boreholes can be used to define these strata with some degree of confidence. The thermal environmental conditions in which these bolts will have to function have been predicted by the DOE (using computer models) and any such work can be used for preliminary evaluations of this study. Based on the results of the study, the Bureau of Mines should identify possible flaws, or problems in various roof bolting and other support systems in providing the required long-term support in the expected thermal environment of the repository.

D. Work Required under Task 1:

Subtask 1: Review and summarize available rock bolting and other support systems. Review past and current research and development in

bolting technology in the United States and abroad. Summarize state of the art for fully grouted bolts, yieldable bolts spring-loaded plates, split-set, swellex, etc. and assess their effectiveness in various strata and underground conditions in which they were used. Highlight any information related to basalt, tuff, and salt rock types.

Review past and current research of the state of the art of other methods of rock reinforcement and rock support which could be used under elevated temperatures. Special attention should be given to the research of the potential use of yieldable steel sets for temporary (removable) or permanent rock support.

Prepare a summary report.

Subtask 2: Review and summarize relevant mine operator experiences with bolting and other support systems under heated conditions similar to the expected repository environment. Special emphasis should be given to the problems of longevity of bolts, bolts/grout compatability in terms of thermo-chemical and thermo-mechanical effects.

Examples of possible reference underground sites that may be used for this study are:

1. Deep underground mines where the temperature is high, such as those in South Africa, North America, Europe or elsewhere around the world.

2. Oil shale projects where underground heating of oil shale rock (retorting) was attempted,

3. Stripa project in Sweden, Asse Mine, Lyons, Kansas, WIPP and other International projects of geologic repositories,

Prepare a summary report

Subtask 3: Identify important thermal and mechanical parameters for Tuff, Basalt, and Salt for the operational period of the repository. These paramters include rock temperature around the bolts, rock coefficient of thermal expansion, grout and bolt coefficients of expansion, rock/grout compressive /shear/tensile strengths,

in-situ stresses etc. These parameters can be obtained by critically reviewing the literature, key DOE design documents, Sandia, BWIP and ONWI reports, NRC NUREG's, etc.

Prepare a summary report.

Subtask 4: Evaluate the effect of temperature and the subsequent changes in host rock/grout/bolt thermal and mechanical properties on the potential performance of bolting support systems reviewed in Subtask 1. In this evaluation only simple, scoping calculations are required to assess system performances. Identify any flaws or Problems, and which system(s) may be more effective in the repository thermal environment. Also identify if additional modeling or testing efforts are warranted and propose the scope of such additional work. Advantages of performing such additional work and the products of such work should be discussed in detail.

Prepare a summary interim report.

Subtask 5: Synthesize the results of subtasks 1 through 4 highlighting flaws, or expected problems (short, or long-term) of various rock reinforcement and support systems under the repository environment. The Bureau shall provide the final report which will include all the preceeding interim reports (revised if necessary), a concluding chapter in which the Bureau investigators provide their overall summary and recommendations, and an adequate executive summary. The final report may be issued as a NUREG, after NRC review and discussions, and appropriate peer review.

It should be noted that a decision to perform further work on this topic will be made after the NRC staff reviews of the final report.