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David Tiktinsky - SS623
U.S. Nuclear Regulatory Commission
Division of Waste Management
Washington, D.C. 20555

"NRC Technical Assistance
for Design Reviews"
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Dear David:

Enclosed is the review of "Spent Fuel Test - Climax Mineby Revisited" by T. R. Butkovich(UCID-20673, Lawrence-Berkeley National Laboratory, December 1985. Please call me if you have any questions.

Sincerely,

Roger D. Hart
Program Manager

cc: J. Greeves, Engineering Branch
Office of the Director, NMSS
E. Wiggins, Division of Contracts
DWM Document Control Room

Encl.
rdh/ks

P.O. Box 14806 • Minneapolis, Minnesota 55414 • (612) 623-9599

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ITASCA DOCUMENT REVIEW

File No.: 001-02-14

Document: "Spent Fuel Test - Climax Mineby Revisited" by T. R. Butkovich. UCID-20673, Lawrence-Berkeley National Laboratory. December 1985.

Reviewer: Itasca Consulting Group, Inc.
(J. Daemen, L. Lorig)

Date Approved:

Date Review Completed: 22 May 1986

Significance to NRC Waste Management Program

It has not yet proved possible to duplicate numerically (through modeling) some of the displacements measured during the mineby test performed at the Climax Nevada Test Site Spent Fuel Test Facility. Discrepancies (of the order of 1 to 2 mm, or as much as 600% when compared to numerical results) remain largely unexplained. This paper presents possible explanations based on displacements induced by blasting. The proposition is intriguing, but the evidence presented is inconclusive at best.

A number of implications can be cited with respect to the rock mechanics and, especially, in-situ testing aspects of repository investigation:

- avoiding excessive expectations from comparisons between in-situ testing and numerical modeling. This case (similar to displacements at Stripa, Asse, WIPP) confirms the difficulty of predicting rock displacements within an order of magnitude of mm.

- the likelihood that NRC staff might have to take a position someday as to how closely deformations need to be predicted—i.e., does repository performance require a prediction/numerical matching of displacements to within 1 mm? If so, why? Similar questions may arise with regard to stress, strength, etc.

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- obtaining a full and detailed understanding of complex tests of this type usually appears to require a major analysis effort both before the test is performed (i.e., test design and planning) and subsequent to result acquisition. In light of the extremely high cost and the unique opportunity for an improved understanding of rock mass behavior provided by such tests, the analysis cost would seem fully justified. It appears reasonable nevertheless (at least from this document) that, here, similar to Stripa, the post-test analysis might not have been nearly so thorough as one might wish.

Summary of the Document

The document presents a very brief summary of some of the displacements measured during the mineby test performed as part of the Spent Fuel Test - Climax. These displacements have achieved a certain notoriety because they were in the opposite direction from what had been predicted by numerical models. The document briefly summarizes a few salient results from some of the post-testing numerical modeling efforts aimed at resolving the discrepancies. No satisfactory explanation has yet been given.

The author proposed a new explanation: permanent rock mass deformation as a result of nearby blasting (i.e., explosive excavation of the cavern). Displacements are calculated based on explosive gas expansion. For some displacement measurements, the corrections thus applied improve the measurement model match; for others, the match is significantly poorer after explosive effects are added in—that is, mining-induced displacement calculations correspond more closely to the data.

In sum, no improved explanation of the observations is given but, as the author states, "[T]his analysis raises a red flag with respect to future use of this type of mine-by gauge to measure the effects of mining" (p. 29, last paragraph).

Problems, Limitations, and Deficiencies

Only a bare minimum of information is given about the calculations performed, and all essential input is lacking. For example, critical explosive input parameters are not given, the only reference is to a personal communication, the rock modeling method used is not described, and only the most general description is given of the blast pattern. It is not possible to make any judgement about the validity of the calculations.

We do not agree with the author's caution against using hydraulically-set extensometer anchors (p. 29, last paragraph). Experience at the Atlanta Research Chamber (Rose et al, 1981) and at numerous mines indicate that reasonable results can be obtained even when the gauges are located in close proximity to explosive blasts.

Recommendations

The main recommendation to be drawn might well be to reassert the need for detailed and accurate construction records. Although it is not admitted explicitly, it is perceived that the author did not obtain, with certainty, what type of explosives had been used for particular blasts (e.g., p. 20, top paragraph) and, similarly, the blast descriptions read as specifications, not "as-built" records. (It is to be noted that such data might be needed not only for displacement modeling but also for rock damage studies, vibration studies, etc.)

Considering the high probability that mine-by tests will be an essential part of all repository site characterization plans, NRC might consider developing an integrated analysis of the test. As a first step, this might include assembling and summarizing all information about the Climax mineby test. The document reviewed lists a number of analyses, but it is not clear whether the list is comprehensive. The implication from this document appears to be (again, similar to Stripa) that an extremely expensive experiment has been performed but that only very limited data analysis and interpretation have been performed.

As a minimum, such a comprehensive summary of the Climax mineby test will provide NRC with an improved understanding of what can and cannot be learned from a mineby test and, in this case, of the potential ambiguities and uncertainties raised by the results —rather than resolution of issues.

This approach could be pursued further and in more depth, for example, by having additional numerical modeling done of the Climax mineby test.

Additionally, it may be profitable to review results of other similar experiments done elsewhere, such as those performed at the Atlanta Research Center (Rose et al, 1981). [There, measured movements in a mine-by experiment were also opposite those predicted in pre-design studies. However, careful review of construction records relative to time of instrument installation provided a suitable explanation. Post-test analysis agreed rea-

sonably well (within about 1 mm) with measured displacements. Displacements were measured using extensometers with hydraulically-set anchors.] If enough data is available for several experiments, such a review might suggest under what conditions (i.e., geometry, rock mass geomechanical properties, excavation technique, and instrumentation) meaningful results may be obtained.

Reference

Rose, D. et al. The Atlanta Research Chamber - Applied Research Report and Monographs, Report No. UMTA-GA-0007-81-1, 1981.