United States Department of the Interior

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Mr. David Tiktinsky
Engineering Branch
Division of Waste Management
Office of Nuclear Material Safety & Safeguards
Nuclear Regulatory Commission
1920 Norfolk Avenue
Bethesda, Maryland 20814

Dear Dave:

Enclosed are review comments on the document entitled "Nuclear Waste Repository Simulation Experiments, Asse Salt Mine, Federal Republic of Germany: Annual Report 1983" (ONWI-539).

If we can provide further assistance for this document review, please phone me at FTS 776-0741, or Matt DeMarco at FTS 776-0745.

Sincerely,

R. L. Mundell

R. L. Mundell
Supervisory Mining Engineer

cc: Dr. E. B. Amey III, Washington Office
Dr. D. R. Forshey, Washington Office

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WMEG AND WMGT DOCUMENT TECHNICAL REVIEW

FILE:

DOCUMENT: Rothfuchs, T., D. Lübker, A. Coyle, and H. Kalia, "Nuclear Waste Repository Simulation Experiments, Asse Salt Mine, Federal Republic of Germany: Annual Report 1983," BMI/ONWI-539, October 1984.

REVIEWERS: Matthew J. DeMarco
Richard O. Kneisley

DATE REVIEW COMPLETED: May 15, 1985

DATE APPROVED:

BRIEF SUMMARY OF DOCUMENT(S):

The report provides an overview of the high level waste emplacement simulations currently being conducted at the Asse II mine, near Braunschweig, FRG. Cooperating agencies include the Office of Nuclear Waste Isolation (ONWI-USA) and the Institut für Strahlen und Umweltforschung mbH München (IFT/GSF-FRG).

Several areas of the simulation experiments are of particular interest:

- brine migration rates due to gamma radiation and time-dependent thermal gradients,
- mechanical characteristics of salt subject to radiation and thermal loading,
- monitored and predicted behavior of room geometry due to cannister emplacement locations and thermal output,
- waste package material performance.

Each phase of the investigation involving these areas is described in the annual report; however, only preliminary results are presently available. Future work will concentrate on refining waste handling and retrieval techniques and completing the thermomechanical investigations currently in progress.

SIGNIFICANCE TO NRC WASTE MANAGEMENT PROGRAM:

The Asse II mine nuclear waste emplacement simulation will provide valuable generic information for all aspects of underground nuclear waste storage at the proposed U.S. salt repositories.

PROBLEMS, DEFICIENCIES OR LIMITATIONS OF REPORT:

Although the project is far from completion, the annual report describes portions of the test plan which may not be adequate to fully realize the objectives of the simulation program. The appended review comments describe deficiencies in the test plan, many which will surely be resolved in the final report.

ACTION TAKEN:

None.

ACTION RECOMMENDED:

ONWI personnel (Coyle and Kalia) must ensure technical accuracy of related documents prior to publication.

ADDITIONAL COMMENTS

Rock Mechanics Program

Stress Measurements: Stresses are not monitored around the test room to verify the assumed lithostatic stress state used in the numerical modeling evaluation. Atypical or changing stress distributions in the vicinity of the test room may result from previous or nearby mining; however, evaluation of the stress distributions is impossible based on the limited information presented.

Deformation Measurements: The room deformation monitoring effort is clearly insufficient. Rib extensometers were placed only adjacent to the cannisters and only three reference anchors were employed; the depths of the anchors were not justified. Only one floor extensometer was installed and no strata displacement instrumentation was used in the roof. Horizontal floor strain was monitored with an inadequately described type of extensometer. Room closure measurement locations were not spaced throughout the room; no reason for this was provided. The deformation monitoring program is clearly inadequate and will provide minimal information for modeling investigations. In addition, the progression of roof and rib failures, and associated failure mechanisms, will not be monitored, leaving only opinion-based explanations.

Physical Properties: Although physical property testing is continuing, the preliminary results are suspect. The core tested was admittedly poor; however, no details are provided describing core condition or procurement. Surely large quantities of core were obtainable from the test room vicinity. Sampling and test statistics were not provided. No creep tests were conducted. Once again, the importance of this test program warrants a greater effort towards characterizing the conditions existing within the test room environment.

Rock Mass Anomalies: Presented borehole logs suggest considerable nonuniformity of the salt at the test site. Core obtained for laboratory testing was characterized as being weak and "milky." Considering the information presented, the presence of structural anomalies should be evaluated regarding the brine migration and modeling studies.

Floor Heave: Discrepancy in the floor heave data requires clarification. It is stated that 40 mm of floor heave has occurred; however, the movement record for the floor extensometer shows 35 mm over the same time period. Does this imply that the deepest anchor is actually moving (assuming the leveling is accurate)? If so, this data needs further investigation for its impact on disturbed zone depths.

Cannister Interaction: The test cannisters were positioned to avoid interaction. Although thermal gradients and brine migration zones were probably unaffected by the cannister spacing, the mechanical effects of the heaters on the salt are widespread throughout the room. This is most easily observed in the presented floor heave profiles. The modeling investigation should account for this interaction and not concentrate solely on single cannister evaluations.

Pressure Cells: Although installation of the flat cells is discussed, no mention is made concerning the installation of the SGS stressmeters. It is also stated that the flat cells are commonly grouted in the hole with a cement having properties similar to salt. Although polyurethane, used in the proposed sandwich system, has similar properties to salt (assuming the input data to the computer models are representative of the Asse mine conditions), the mortar surrounding the cell has an elastic modulus six times greater than salt with half the Poisson's ratio. This will affect the cell response.

During calibration, the flat cells were barely loaded to expected lithostatic pressures, while the SGS calibration levels were nearly 1,000 psi deficient. Hysteresis effects, especially common with fluid cells, were not discussed. The cross-sensitivities of the cells were also not determined. Once installed, the cells gave much lower readings than predicted. Although this may be due to the predictive model, cell response, or installation problems, it is impossible to determine why the readings were lower than predicted. The effect of temperature on fluid cells should also be investigated.

Pillar Design: Considering the limited rock mechanics program, very little information will be acquired that can be applied to design the pillars between waste storage rooms. Of particular importance would be the determination of the extent of the shear, plastic, and elastic zones within the ribs; these parameters, combined with pillar and opening geometries, will influence load transfer onto abutments and pillar yielding. Adequate pillar designs are necessary to ensure required backfill compaction, retrieval options, and minimal disturbed zones.

Presented Data: Many of the graphs presenting pressure and deformation curves are incomplete, show unexplained anomalous behavior, untypical scatter and variability, and missing data, making it very difficult to evaluate the findings.

Brine Migration Program

Brine Migration Models: The brine migration tests are supposedly being conducted to provide input data for computer simulations. However, no discussion is provided describing the nature of the modeling or results already obtained. Thermal-mechanical models used to predict room stresses and deformations are discussed, but brine migration predictive models have not been included. "Calculated" brine migration is referred to but never elaborated upon.

Temperature Profiles: No discussion is presented concerning the near-cannister temperature profiles and how they will compare to actual waste emplacements. Estimates of actual waste storage temperature gradients are not referenced for comparison purposes. The effects of the guard heaters on the thermal profile and brine migration are also not explained. Uncertainties surrounding the engineered cannister design should be described to address some of these concerns.

Retrieval Program

Retrieval: It is stated in the text that cannister retrieval is anticipated to be the opposite of installation. It is very likely that after two years this will not be true, and no contingency plans are presented. It is mentioned that a type of truss using jacking screws will be used to break the test assembly free from the borehole. The screws will rest on the floor near the cannister hole and may experience considerable load. Considering the proximity to many holes and a weakened floor rock, the probability of a bearing failure should be evaluated.

Modeling Program

Modeling Result: Two finite-element codes, DAPROK and MAUS, are presented for comparison of predicted and observed room closure/floor heave. Both codes, it is assumed, used the same material properties. However, no information is provided covering where these values were derived; if the values are not from site 2, they may not be representative, and if they are, they may be biased due to possible problems with core retrieval and/or poor core condition.

An additional problem in comparing DAPROK and MAUS finite-element model predictions is the use of two entirely different meshes which results in significantly different horizontal deformation estimates. The text offers a sound explanation for the large horizontal elongations predicted by DAPROK. Other differences between the models also exist: (1) the DAPROK mesh is narrower and may include unwanted edge effects, and (2) boundary conditions (pins, rollers) or imposed loads are not shown for both codes; it must be assumed they were the same.

The statement that both the MAUS and DAPROK finite-element models predict nearly the same deformation increase following the start up of heating is not justified by the presented data plots. The post-heating deformations for both models are not in "good" agreement, but vertical room closure and floor heave are in fair agreement with the MAUS model predictions.