United States Department of the Interior

BUREAU OF MINES

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Denver Research Center
Ground Control Division

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Mr. David Tiktinsky
WMHT
U. S. Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Spring, Md 20910

Dear Mr. Tiktinsky:

My major reaction to these meetings was to raise the question as to the suitability of the Topopah Springs tuff for the horizontal emplacement of waste canisters. Since this formation is badly broken, at least in some places, the drilling of large diameter (24 inch), 700 feet long holes using a machine not yet in existence is certainly highly problematical. On the other hand, the use of vertical holes is already the state-of-the-art. Therefore, I would suggest that the approach to be used would be one of vertical emplacement initially changing to horizontal holes when a drill is available and the process is demonstrated to be practical. Since the fractures are close together and broken pieces of tuff are small compared to the hole diameter, numerous problems with chunks of rock falling into the hole can be expected. Even casing the hole would not eliminate all of these problems.

I believe the NTS would be a desirable location because of its remoteness and the fact that nuclear testing is already a fact of life there.

My other comments follow.

Dr. Don Vieth, DOE, still is looking for guidelines as to what is needed for the Site Characterization Report (SCR).

Leo Scully, Sandia National Laboratory (SNL) presented the engineering plan and schedule for two reports: 1) the waste emplacement report, and 2) the mine configuration report. He discussed the possibility of using an inclined shaft as well as a vertical shaft for repository access. Both vertical and horizontal canister emplacement are being considered, although the horizontal placement is preferred. The last 100 feet of the 700-foot hole would not contain canisters and act as a heat buffer zone between the other 600 feet of hole loaded with canisters and the drift. The hole would not be backfilled and may be lined with a steel liner, if necessary. This liner would increase the repository cost by 600 to 800 million dollars. The heat load produced by the waste was expected to be in the range 20 to 100 kw per acre but would likely be near 50 kw per acre. The holes would be drilled from a 12 X 20-foot cross section drift, vertical X horizontal dimensions, respectively, with the drill thrusting against the far wall of the drift. Penetration rates with a

machine to be built by Robbins would be 10 to 15 feet per hour. The machine with rotary crushing wheels would have a steerable head and be guided by a lazer beam to maintain hole alignment to within 6 inches per 100 feet and to within 12 inches at the full depth of 700 feet.

Joe Fernandez of SNL presented repository sealing concepts in which tuff was used as an aggregate for concrete. He expected that 5 to 10 percent of the tuff would be grouted. He indicated that there were 4 to 7 fractures/meter of hole length on the average in the Topopah Springs tuff formation. He used two computer programs to solve some of his problems.

Joe Tillerson, SNL, reported on laboratory results to date. In situ tests in the G-tunnel are also in progress. He concluded that the Topopah Springs and G-tunnel tuffs are quite similar in behavior. Mechanical properties have been defined in the laboratory for Yucca Mountain, and the Tram, Bull Frog, Topopah Springs, and Calico Springs tuffs. Tests included the elastic modulus, Poisson's ratio, unconfined tensile strength, and the Coulomb parameters (cohesive strength in shear and the angle of internal friction). Sample sizes to date have been 1 X 2 inch cylinders, diameter X length, respectively.

Roger Zimmerman reported on G-tunnel testing including the rock mechanics and thermal instrumentation in use or about to be used. Large slots to install hydraulic pressure cells were to be cut with a chain saw type undercutter or by means of a wire saw. One large hole in the floor (12 inch diameter?) had a very rough wall with many openings, indicating that even the G-tunnel tuff was not very dense vertically below the drift.

Lynn Tyler talked about the stability of openings relative to joint slip using the Mohr-Coulomb stress-failure criteria for Calico Hills and Topopah Springs members around mine openings for periods of 50 to 100 years using computer solutions. The repository horizon is 225 meters above the water table and with only a 6 inch annual rainfall in the area, should stay relatively dry. Computer programs used included the ADINA and ADINA-T (Bathe-MIT) and the Spectrum 11 and Spectrum 41 (Gnirk-Re/Spec).

Dr. Paul Gnirk, spoke on rock mass classification. The use of pillar design equations with width to height emphasis was questioned by this writer. In 150 years, such equations have been used but no two agree and for good reason. The constraint provided by the geometry and not the geometry directly is responsible for the vastly different results obtained. He would use rock bolts with or without steel expanded metal mesh to support the mine openings in the Calico Hills, Tram, Bull Frog, and Topopah Springs formation. This is standard mining practice.

Dr. W. Hustrulid, Colorado School of Mines (CSM) spoke on shaft design. He considered the problems likely to occur with high angle fractures and concluded that a 12 inch shaft liner would be thick enough. (If the shaft was sunk with drill and blast methods, the 12 inches should be the minimum thickness - CB) He considered several mining machines to drive the mine drifts. The Dosco TB600 miner in use at the Exxon Colony Oil Shale Mine in Western Colorado drives a drift 23 feet wide by 15 feet high to produce 96 tons of rock per hour with a crew of 4 men at a cost of $1.59/ton, plus the cost of

labor. The Paurot E134 machine produces 90 tons/hour in shale, sandstone, and siltstone while producing a drift 20 feet wide and 12 feet high. This machine cost one million dollars. The Robbins Mobile Miner, with disc cutters (misnomer) instead of picks, is a hard rock machine for the harder Topopah Springs formation. This is a drifting machine not the canister hole machine. Its cost is $2.5 million dollars and has a delivery time of 10 months. The machine drives a drift with curved walls, flat roof and floor.

Mr. Nunziato spoke on waste emplacement concepts. He used computer programs for 2 and 3 dimensional analysis. By cooling the drift, the heat around the canister in the floor for vertical emplacement would be less than 100°C. The horizontal emplacement of canisters would require the least refrigeration to keep drifts operational.

Mr. Luke Vortman discussed the design basis for ground motion produced by nuclear bomb testing at NTS. He used accelerometers rather than geophones to measure blast effects in 21 surface and downhole stations. Peak vector accelerations were measured in the vertical and in two horizontal directions. The down hole wave forms were predicted and compared to experimental results. The vertical result was good, the east-west-radial was all right but the north-south results were not good. In the Yucca Mountain, the response was 1.5 to 2.5 times the theoretical results.

NRC discussion with Seth Copland included these items:

1. Idea of using an inclined shaft rather than a vertical shaft should be considered.

2. Approach of using laboratory data to support G-tunnel tests to support in situ exploratory shaft is a good one.

3. Why were so many different data bases used making the results difficult to compare?

4. There were doubts that retrieval would be possible for horizontal emplacement of canisters.

Questions or comments to Sandia at end of meeting were:

1. Continue to look at use of inclined shaft.

2. Approach to developing in situ test program makes sense.

3. Use common data base, state assumptions, explain.

4. Concern about layout without demonstration for horizontal emplacement.

Items for further discussion included:

1. How would 10CFR60 performance requirements be met for performance assessment?

2. Concern was expressed that no backfill would be used.

3. We can live with the hot waste form or can remove the heat. Adiabatic heat assumed poses a problem.

4. A convincing game plan is needed.

5. What predictive models will be used to support a conceptive design? Dr. Vieth indicated that three types of models will be used--geological, hydrological, and mathematical or computer. What are the physical and phenonological models?

6. What are the appropriate criteria for borehole and shaft sealing?

7. What are the appropriate criteria for commingling the waste?

The following comments were by Dr. Don Vieth of DOE. It is important that we commuinicate, that we stay away from value judgements. Health and Safety mentioned. Sampling technique needs to be documented. How do physical properties relate to Health and Safety? DOE needs to know the level of design required by NRC.

In conclusion, I belive that DOE is somewhat at a loss to define what more, if any, is needed to satisfy the NRC SCR requirements.

Sincerely yours,

Clarence O. Babcock
Supervisory Mining Engineer