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Memorandum

To: George E. Niewiadomski, Manager for Respirable Dust and Radiation Hazards, Columbia Plaza, Washington, D.C. gen 7/15/83

Through: Richard Oitto, Research Director, Denver Research Center
Joseph L. Condon, Research Supervisor, Geophysics Division, DRC

From: Robert D. Munson, Geophysicist, Geophysics Division, DRC

Subject: Trip Report - DOE/NRC Tectonic Workshop - Basalt Waste Isolation Project, April 13-15, 1983, Richland, Washington,

At the request of NRC and the Bureau of Mines under Interagency Agreement No. NRC-02-80-075, "Technical Assistance for Assessment of Repository Siting and Design", I attended the subject workshop.

The purpose of this workshop was to discuss and evaluate the current status and results from the geotechnical and engineering investigations being conducted by Rockwell to evaluate the suitability of the BWIP site as a waste repository.

Although my primary task at this workshop was to keep informed and review technological developments and geotechnical data being obtained relative to the geophysical and seismic evaluation of the proposed BWIP site, I also attended sessions related to geology, tectonics, hydrology and engineering.

COMMENTS & OBSERVATIONS:

Hydrology: From the information presented, the hydrology of the site area is probably the least understood. This is indicated by the current data and resultant calculations giving a variance of from 20 years to 1 million years, should contamination occur, to reach the accessible environment.

Seismic: Seismic profiling data of the proposed site area is inadequate. Past programs were minimal in scope and effort and appear to have generated an attitude that seismic profiling cannot be successfully accomplished. Stronger emphasis must be placed on obtaining this type of data, since it can provide subsurface information which to date is based upon geology, seismicity, tectonics and drill hole data.

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The current and proposed seismicity investigations appear adequate in effort. However, there is a need to relate this data to the tectonic stability of the area. Case in point, the primary type of activity is shallow earthquake swarms (less than 6 km), ranging from 1 to 3 in magnitude. Although these swarms tend to align with and migrate along known structural trends, they do not appear to occur on or be associated with any known fault.

There is disagreement on the maximum magnitude earthquake that could be anticipated to occur over the next 1,000 to 10,000 years. The position presently being taken by the NRC is a magnitude 6.5, whereas current and historic data statistically indicates a maximum magnitude of 5.0.

Development of a seismic risk potential based upon current and historic seismicity data is not technically sound. To do this with the degree of reliability that must be achieved, requires a knowledge and understanding of earthquake mechanisms not yet attained and certainly not demonstrated in the BWIP investigative results.

The anticipated ground motion from a magnitude 5.0 earthquake could range from 1.1 in/sec to 8.3 in/sec at a distance of 10 km, depending on the equations used. Assuming a minimum of 1.1 in/sec it is presumable that the underground repository would not sustain any damage. However, the surface facility could very likely be damaged, since frequencies below 40 Hz can cause damage to surface structures below a 2.0 in/sec peak particle velocity. If the distance is reduced to 2 km, the expected 1.1 in/sec increases to 11.6 in/sec, which could severely damage the surface facility, the access shaft and possibly the integrity of the underground repository. Although some vibration data from earthquakes and explosive devices has been measured in underground mine openings, the data base is not sufficient from which guidelines can be established for an underground repository. Furthermore, a definition of what constitutes damage has not been properly considered. Consideration must also be given to the problem of fatigue of the opening when subjected to numerous small magnitude earthquakes.

Stress Measurements: It is extremely difficult to measure stress in a deep borehole. The technique currently being used is the hydrofracturing process. This technique measures the overpressure required to fracture the rock in the direction of maximum horizontal stress. Knowing other rock properties the minimum horizontal stress can be calculated. The maximum vertical stress is generally equal to 1 psi per foot of overburden. Results from measurements taken indicate a maximum horizontal stress of 7-9 K psi with an H_{max} to H_{min} ratio of 2:1 and an H_{max} to Z_{max} of 3:1.

Observation of the core from RRL-2 tends to indicate high excessive horizontal stress due to the degree of discing (10 units/foot to 30 units/foot). Some of the discs are only a few millimeters thick and resemble a stack of poker chips. Observation of this phenomena by other researchers indicates that the ratio of core diameter to disc thickness is related to the compressive strength of the rock and the horizontal stress. If the ratio of core diameter to disc thickness is about 5.6 to 1, then the horizontal stress is about 50% of the compressive strength of the rock. The relationship is not linear, i.e., at a ratio of 11.2 to 1 the horizontal stress is about 85% of the compressive strength of the rock.

A percentage of the high rate of discing in the core from RRL-2 is being rationalized as due to the action of the bit on the rock rather than high excessive horizontal stress. It appears as an impressive theoretical argument to reduce the impact of the probable existence of high horizontal stress.

Engineering: Nearly 10 feet of core was lost from drill hole RRL-2 at 3773 to 3783 feet which is in the critical zone being considered for the respository. This unexplained core loss brings into question the adequacy of the operating procedures and control methods used in drilling the exploratory core holes. Logging of bit loads would greatly aid in the interpretation of penetration rates. Correcting significant increases or losses in circulation as the hole is drilled would aid in interpretation of geological and hydrological evaluation.

Summary: Although the programs and investigative results are addressing the questions, there are areas which lack adequate technical guidance and sound technical operating procedures.

A strong emphasis must be placed on obtaining quality seismic profiling data in an effort to resolve areas of ambiguity and develop more accurate information on the subsurface conditions.

The exploratory drilling program must establish standard operating procedures and control guidelines. Furthermore, these must be strictly adhered to if the maximum amount of data is to be obtained with a high degree of reliability.

Current and future research programs must be designed to be responsive to significant problem areas while expanding and improving the data base.

The BWIP program, by its very nature, involves a multitude of scientific and engineering disciplines. A project of this magnitude and complexity must establish a comprehensive and accurate data base through individual research projects which must conform to the highest standards of performance.

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To accomplish this goal and ultimately provide sites that meet the regulatory requirements, a system must be established to combine these interdisciplinary data into a concise, comprehensive and cohesive format from which critical and directive decisions can be effected.

Robert D. Munson