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United States Department of the Interior

WM DOCKET CONTROL CENTER

BUREAU OF MINES
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Mr. Robert E. Browning
Director
Division of High Level Waste Management
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Browning:

We have completed the study requested by your office on the feasibility of sinking a shaft to the Cohassett flow at the Hanford site. In reviewing the geological, hydrological, and rock mechanics aspects of the site, it is the Bureau's opinion that technology exists to safely sink a 3,300 ft shaft through the basaltic lava flows of the Pasco Basin. Because of the possible adverse water and ground conditions at the site, this opinion must be qualified in two areas: (1) water inflows may not be preventable, thereby requiring removal by pumping from the shaft bottom; and (2) there may be some limitations on shaft diameter. In general, the technology exists to sink a shaft in almost any location and physical condition. However, under the potential adverse water condition at the Hanford site, the decision to sink a shaft will depend on economic rather than technical feasibility.

In order of priority, the four major concerns in sinking a shaft at Hanford are: water inflows, weak unstable ground, high horizontal rock stress, and a potential for rock bursts. The Hanford site contains a major unconfined aquifer at 650 feet of depth, and numerous confined aquifers existing in interbeds and flow tops. Below the Hanford and Ringold sediments which contain the unconfined aquifer, there are 5 interbeds and about 22 to 26 flow tops. The permeable Vantage interbed is about 300 feet above the Cohassett flow which ranges in depth from 2,992 feet to 3,255 feet below the surface. There are also reports of some artesian flow conditions and the possibility of dissolved methane gas in the water.

Under such water conditions, two methods of shaft sinking appear feasible: large-hole drilling and conventional drill and blast with freezing and pregrouting. Large-hole drilling using a mud-filled hole is probably the preferred method in terms of economics and safety. A steel casing can be inserted in the completed shaft followed by grouting between the casing and the wall rock. Artesian heads or high water flow rates may decrease the effectiveness of the grout filling. This and temporary blockage of the rock joints with drilling mud may prevent total vertical blockage of water flow. State-of-the-art large-hole drilling technology may limit the size of the shaft, and the sinking method suitable for the exploratory shafts may not be suitable for larger diameter production shafts.

Conventional drill and blast shaft sinking is the most common method used for large diameter shafts. Freezing of the upper unconfined aquifer would probably

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be required. Pregrouting and selective freezing using liquid nitrogen or cold brine could be used at the lower confined aquifers. Expansion and subsequent contraction of the rock joints during the freeze/thaw process could increase the flow of water vertically through the surrounding rock. This may cause inter-aquifer flow connections and increased flow at the shaft bottom. Some deep gold mines of South Africa have water inflows of 40,000 gpm; and this water is pumped to the surface with no resulting problems in ground stability or safety.

Zones of weak rock, fractured and brecciated pillow basalts, are the second major concern in shaft sinking at Hanford. With water pressure potentials of 1,400 psi, these zones could wash out causing ground instability. This can be alleviated by early detection of the zones and remedial grouting, or isolation prior to shaft interception. High horizontal stress as evidenced by core discing has been discussed as a concern. Also, a high horizontal to vertical stress ratio (range of 2.3-2.7) has been cited as being indicative of rock bursting. High stress is only important as it relates to the rock strength. When stress exceeds rock strength, the rock will fail. Most rock failures are nonviolent and are not classed as rock bursts. The brittleness of the rock, its ability to store strain energy, the ratio of peak strength to residual strength during failure, and the rate of mining are all factors that must be considered in evaluating a rock's potential to burst. To assess this potential, it is necessary to measure the post-failure stress-strain characteristics of the rock.

In the deep mines of the Coeur d'Alene Mining District of North Idaho and the gold fields of South Africa, it is common for the stresses around the periphery of shafts or tunnels to exceed the strength of the rock. Failures for the most part are nonviolent and installed supports safely and effectively control the failed rock. In the Coeur d'Alene Mining District, deep shafts are routinely located in areas where the horizontal to vertical stress ratio approaches two with ground control problems routinely handled and bursting is generally not a problem. If bursting should become a problem, the rock can be drilled and fractured ahead of mining to relieve excessive stress buildup, although prefracturing at Hanford may present difficulties with water control as destress fracturing may increase the permeability of the rock mass. This may not be desirable at Hanford because of the possibility that such prefracturing may cause a preferential pathway for radionuclide migration. Also, the rate of mining can be reduced to decrease the rate of energy release.

In summary, shaft sinking in the basalt flows at Hanford is technically feasible. The largest problem confronting this shaft sinking operation is water control. The interception of numerous aquifers will require the most advanced methods in shaft sinking and water control technology. Other problems such as ground control and rock bursting can be overcome much more easily.

Therefore, we believe the overall decision regarding shaft construction feasibility must be shifted from the realm of technical feasibility to that of economic feasibility.

Sincerely,

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Assistant Director--Mining Research

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