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MEMORANDUM FOR: File No. 101
FROM: Ludwig F. Hartung, Project Manager
High-Level Waste Technical
Development Branch
Division of Waste Management
SUBJECT: REVIEW OF DRILL HOLE LOGS AND CORE, BWIP

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BACKGROUND

On January 13, 1983, the NRC requested from DOE documented information in five specific areas related to the Exploratory Shaft (ES) at BWIP. The list of information considered necessary by NRC included the need for information on conditions in nearby drill holes and for DOE's procedures for monitoring and implementing the Quality Assurance (QA) program for the Exploratory Shaft.

The DOE provided on February 23, design, construction and QA documents for the initial ES construction activities. These documents contained the Principle Borehole Report, Borehole RRL-2 (SD-BWI-TI-113, January 1983). Additional information on plans for long term sealing and the consideration of the factors in design and construction of the shaft were received from DOE on April 1, 1983.

The Principle Borehole, RRL-2, was drilled to provide information required for shaft design, selection of porthole locations and site suitability studies. The NRC staff reviewed the RRL-2 borehole report along with the other documents received from DOE.

During the review of these documents, two main points of concern were identified: 1) circulation of drilling fluids was lost resulting in the apparent loss of 300,000 gallons of drilling mud, and 2) several zones of core loss were noted. The principle concern was the zones of core loss between the depths of 3773 to 3783 feet and 3822 to 3824 feet which are

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in the dense interior of the Umtanum flow. The NRC staff discussed the mud and core losses with DOE in phone conversations on March 16 and 17, and during a site visit to Richland, Washington, April 11 through 15, 1983. As a result of the phone conversations, additional information (including the shift reports for several additional holes including RRL-2) was received by the NRC.

SUMMARY

The DOE explained that it was not possible to accurately estimate the amount of mud loss or where mud losses had occurred after the initial loss of circulation. Also, it was not possible to accurately determine the condition of the rock lost while coring. However, DOE felt that the mud loss had occurred principally in the flowtops. The loss of core in the dense interior of the Umtanum flow was attributed to core discing and mechanical problems. DOE explained that the inside diameter (I.D.) of the J. K. Smit diamond impregnated drill bits used in this zone were undersized, allowing the core to drop back into the hole from the bottom of the inner core barrel as it was pulled from the hole. DOE acknowledged, during the March 17 phone call with the NRC staff, that the lost core zone could have been massive, discing or highly fractured. They acknowledged that the zone could have been fault gouge but felt confident that the geophysical logs would have noted this. Hydrologic tests and geophysical tests were conducted by DOE/RHO across this 10 foot zone (3773 to 3783). The hydrologic tests across the interval from 3782 to 3805 indicated that it had an equivalent hydraulic conductivity value of 10^{-12} - 10^{-11} ft/sec. The review of the available geophysical logs (caliper, sonic, density and neutron) did not provide a definite indication of rock quality over the interval of 3773 to 3783. On the basis of the geophysical logs alone, it is not possible to say that the rock over this interval is of either poor or good quality. It was noted that the geophysical logs were not calibrated to basalt and therefore quantitative determinations cannot be made. However, it may be shown that the geophysical response across the interval of lost core is similar to the geophysical response recorded above and below this interval. The DOE estimated that a loss of 132,000 gallons of drilling mud was lost in the Umtanum. An estimated 25,000 gallons of this drilling mud loss may have occurred in a 1.3 foot zone between the depths of 3822 and 3824. An equivalent hydraulic conductivity value of 10^{-4} - 10^{-3} , ft/sec was calculated for the effective thickness interval of 3818

to 3824. The geophysical logs showed a response to the rock in this zone indicating a lower density and higher porosity.

NRC staff and consultant, Mr. Richard Galster (COE) reviewed core photos, corelogs, geophysical logs and core with DOE. Mr. Robert Munson (USBM) reviewed the core logs in anticipation of discussions on April 12 thru 15, 1983. After reviewing the logs and discussing this information, the NRC staff and consultants are in agreement that they could not accept DOE's explanation that the lost core was dense basalt which was cored with an undersized drill bit, disced in the core barrel, fell to the bottom of the hole and was ground up during the next run. The principal reasons for not accepting DOE's explanation are:

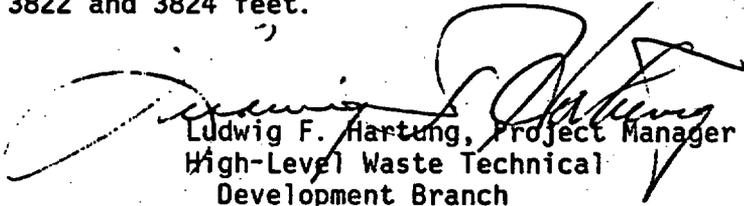
1. After RRL-2 was completed, all the J. K. Smit bits at the site (approximately 30) were checked with an inside diameter (I.D.) standard gauging tool and found to be undersized. The first J.K. Smit bit used in the zone of core loss was inspected by the staff and found to have excessive wear on the inside of the bit rather than on the cutting face. It would be expected that the cutting face of the bit would be damaged ("worn out") if the basalt was ground up in the bottom of the hole. The cutting face had the appearance of uniform bit wear. However, the matrix for impregnated diamonds on the inside of the bit was washed out. This would seem to indicate that the core may have been damaged as it entered the core barrel.
2. Drill records and boxed core show that core had dropped from the core barrel in other runs. This core, as well as core from highly fractured zones, was recovered in RRL-2 using a triple tube core barrel. Runs 313, 314 and 315 of RRL-2 were drilled with a J.K. Smit core bit, but core slipped from the barrel in each run. Most of the core lost in each run was recovered in the next run. The used bit was gauged after drilling 188 feet of rock and found to be within industry standards.
3. Had the core disced upon entering the triple tube core barrel, some, if not all of the core, would have been recovered. Approximately five inches of core was found in the core box for runs 383 and 385 (3773 to 3783 feet) (Note: the geologic log reports a zone of "zero core recovery").

Conclusions

1. The NRC is not able to determine the type of rock that may exist in the lost core zone because there is insufficient data to make an interpretation.
2. DOE/Rockwell does not seem to have a sound, well developed Q.A. program at the field level that is compatible with industry standards. There does not appear to be written direction that establishes guidance for such areas as standard drilling procedures, loss of circulation, high mud losses, cementing zones of lost circulation, matching data such as fracture counts, drill records and reconciling core gains and losses. Also, written procedures were not available to control the gauging of drill bits before use or the mixing of drilling equipment (e.g., core barrels and drill bits) of various manufacturers. The scale that is being used to record the data (e.g., 10 feet to the inch) also makes the effective and timely use of the data difficult. There is no clear guidance available that outlines procedures to integrate the various data obtained from the drill hole with user groups such as design, engineering, hydrology and geophysics. Finally, the intended use of the geotechnical data does not appear to be well outlined in written procedures nor fully appreciated by the field (drillsite) staff.
3. One of the most important sections of rock penetrated by drill hole RRL-2 is the possible repository host rock in the dense interior of the Umtamum flow. The information obtained from this core would be used as the data base for various decisions and plans. Ten feet of the core in this horizon is missing, and therefore the interpretation is open to doubt.
4. The NRC has consistently emphasized that project records should be complete, and that field data, geophysical and geologic logs be available for review. There should not be the appearance that criteria in an application may have been developed from inaccurate, compromised or incomplete data, especially if the discrepancy could be traced to apparent lack of Q.A. plans and procedures.

Recommendations:

1. The DOE should reevaluate their Q.A. program as discussed in this report and in the phone conversation with William Price and Joseph LaRue on April 28, 1983.
2. If DOE is considering the Umtanum as a possible reference repository horizon, it would be prudent for DOE to develop plans to resolve, during site characterization, questions identified in RRL-2 especially in the interval between 3773 and 3783 feet and 3822 and 3824 feet.


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