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JUN 22 1987 WM Record File 102

WM Project 11
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MEMORANDUM FOR: John J. Linehan, Acting Chief
Operations Branch (Return to WM, 623-SS)
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards

FROM: Ronald L. Ballard, Chief
Technical Review Branch
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards

SUBJECT: THE NNWSI EXPLORATORY SHAFT FACILITY AND THE ISSUE
OF REPRESENTATIVENESS

The DOE's proposed changes to the NNWSI Exploratory Shaft Facility (ESF) (NNWSI Background Paper, March 1987) include increased drifting from the main test level in order to respond to two questions that precipitated the proposed changes. These questions are:

- 1) will it be possible by methods proposed in the Environmental Assessment (EA) "to obtain information that is required to adequately characterize the site," and
- 2) "will the measurements made in the proposed ESF be representative of conditions and processes throughout the repository" (NNWSI Background Paper, March 1987)?

Published reports on the geology of Yucca Mountain indicate that the effects of faulting (including imbricate faulting, larger amounts of offset, higher degrees of rotation, and higher density of fractures) increase near the southern part of the repository (Scott and Bonk, 1984; Scott and Castellanos, 1984; also see Attachment 1). The presence of a more highly faulted terrain in the southern part of the proposed repository may change bounding conditions for the assessment of tectonic stability and the movement of groundwater and, therefore, limit conclusions about retrievability and groundwater travel time that are based on data derived in other parts of the repository block.

Based on evidence of a more highly faulted terrain in the south, we question whether a program of drifting in the northern part of the repository supplemented by a limited exploratory drilling program in the south (EA, pg. 4-3) can provide a representative assessment of the entire repository block. The test plan outlined in the EA does not appear adequate to provide a thorough understanding of significant tectonic features due to the difficulty in noting and understanding such features in drillcore (as pointed out in studies at the Climax-Spent Fuel Test Facility, Wilder and Yow, 1984). We are concerned that unless the DOE can show that the proposed area of drifting is representative of the southern part of the repository block or demonstrate that the surface based

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testing program will obtain data sufficient to define the southern part of the repository, then information might not be available to adequately characterize the site.

Discussions have been held with the DOE regarding a potential meeting on tectonics. During our May 28, 1987, meeting with J. Knight (DOE), he indicated that they were prepared to discuss aspects of tectonism and seismicity at the site. We recommend that a tectonics meeting be arranged at an early date with the DOE and that the concerns outlined above become one of the agenda items to be discussed. The attachment to this memorandum should be forwarded to the DOE prior to the aforementioned meeting to assure a complete discussion of the matter.

We are preparing other agenda items related to tectonism at NNWSI that will be forwarded to you at an early date. Keith McConnell (7-4697) or Charlotte Abrams (7-4390) are available if any questions arise regarding this memorandum.

15/

Ronald L. Ballard, Chief
Technical Review Branch
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Attachment:
As stated

ATTACHMENT 1: Items derived from published reports that suggest major differences exist in the style and density of faulting and fracturing between the northern and southern parts of the proposed repository.

[Specific concerns outlined below rely on extrapolation of data northward from cross-section C-C' which is presented with the geologic map of Yucca Mountain by Scott and Bonk (1984). While the line of this cross-section is south of the perimeter drift of the repository (approximately 400 m), it represents the closest control point available for extrapolation.]

Spacing of faults: Scott and Bonk (1984) have shown that the area west of Abandoned Wash, approximately 400 m south of the southern boundary of the repository, is characterized by numerous small faults (imbricates). Geologic cross-section C-C' published with Scott and Bonk's map indicates that the density of faults near the southern part of the repository block is substantially greater than that in the imbricate zone east of the Exploratory Shaft location. Other published reports (Spengler and Chornack, 1984; Scott and Castellanos, 1984) also suggest that the number and density of fractures increase to the south as well as indicating that all faults (i.e., west of Abandoned Wash) may not be recognized due to talus on the slopes of Yucca Mountain. The proposal to drift eastward to study imbricate faulting (ESF) will address some questions about imbricate fault zones, but will not test the density of faults and fractures that is expressed in cross-section C-C' and which may be present in the southern part of the repository. The east trending drift will, therefore, not necessarily provide a representative picture of the density of faults and fractures to be expected in the southern part of the repository block.

Increased offset along faults: The draft Site Characterization Plan indicates that movement along the Ghost Dance fault increases from near zero at Drill Hole Wash to 38 m at the southern boundary of the repository (draft Site Characterization Report). In addition, the width of the breccia zone associated with the Solitario Canyon fault more than doubles from a point west of the Exploratory Shaft location to the southern part of the repository. The potential exists for similar southerly increases in offsets and widths of breccia zones along the smaller, unnamed faults in the southern part of the repository. Higher offsets along faults could possibly result in increased fracture density and higher dips of bedding within the Topopah Springs Member complicating repository design.

Age of faulting: Recent studies (Whitney and others, 1986; Reheis, 1986) have indicated that the southern parts of the Windy Wash and Bare Mountain fault zones have had displacement in the Holocene while, at least with respect to the Bare Mountain fault, the northern part has not moved in the Holocene. While data are sparse and comparative interpretations about movement along the southern and northern parts of the Windy Wash and Bare Mountain faults are

speculative, these factors may suggest that most recent faulting may be concentrated in the southern part of Yucca Mountain, an interpretation consistent with recent interpretations presented by the USGS on detachment faulting at Yucca (NNWSI Field Trip, February, 1987). If the southern part of Yucca Mountain has had more recent fault activity than the northern part, then tectonic fractures in the southern part of the repository block may be distinctly different in aperture and stability than those encountered in drifts to the north.

Increased rotation and dip on beds: Scott and Castellanos (1984, pg. 77-78) indicate that the dip on beds west of Abandoned Wash varies from 15° eastward to vertical. These dips encountered within the imbricate zone south of the southern part of the repository block are substantially different than those observed in the imbricate zone east of the exploratory shaft where dips appear to remain sub-horizonta1 (cross-section B-B', Scott and Bonk, 1984). Questions arise, therefore, over whether this imbricate zone west of the Abandoned Wash fault continues northward and if steep dips will be encountered in the southern part of the repository.

Low-angle faults: Scott and Bonk (1984) and Scott and Castellanos (1984) identify several faults with anomalously low dips (i.e., approximately 50° versus near vertical) south of and below the southern part of the repository. They speculate that these lower angle faults observed in USW G-3 are an extension of the Abandoned Wash fault rotating into the horizontal (listric faults?). Associated with these faults are two "thick" gouge zones. Although this fault rotation occurs well beneath and south of the repository horizon, the Abandoned Wash fault does extend to the north and may connect with the Ghost Dance fault and, therefore, may exist below the repository. Concerns related to fault rotation include: 1) the interconnectivity of imbricate faults with the Abandoned Wash fault and, therefore, the "thick" gouge zones which may be present beneath the repository horizon, 2) the effect these features may have on travel time to the saturated zone, 3) the change in fracture patterns to be expected with rotation of fault planes and the characterization of pathways for radionuclide transport.

Thinning of Topopah Springs Member: Reports from borehole logs indicate that the Topopah Springs thins from approximately 363 m (USW G-1) in the northern part of the repository block to 301 m (USW H-3) near the southern part of the repository block. While the repository design provides for thinning of the Topopah, the repository horizon may be in texturally different parts of the Topopah Springs Member. Limiting the investigation in the southern part of the repository to drillhole data and extrapolation from the north may not adequately address the degree of welding, the amount of alteration associated with devitrification and the percentage of lithophysae in the southern part of the repository.

Perched Water: Thordarson and others (1984) and Whitfield and others (1985) report small water seeps from a fractures in the Topopah Spring Member in USW H-3 (just south of the repository boundary) and USW H-4 (in the

southeastern part of the repository block). These water seeps may represent the presence of perched water in association with faults in the southern part of the repository block, a concern difficult to address from surface based tests and extrapolation from the north.

[The specific concerns outlined above do not address the Quality Assurance issue that most of the currently available corehole data which describes sub-surface features in the southern part of the repository block may not be suitable for use in licensing.]

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JUN 22 1987

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