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MEMORANDUM FOR: Robert E. Browning, Director
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards

FROM: Ronald L. Ballard, Chief
Geosciences & Systems Performance Branch
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards

SUBJECT: SCOPE OF PROPOSED TECHNICAL POSITION ON GEOLOGIC MAPPING OF SHAFTS AND DRIFTS OF A HIGH-LEVEL RADIOACTIVE WASTE REPOSITORY

Enclosed is a scope developed by the Geosciences and Systems Performance Branch (HLGP) of a proposed Technical Position (TP) dealing with the geologic mapping of shafts and drifts of a geologic repository. It was prepared using the Division's work plan on the development of TPs. The scheduled completion date is estimated to be February 5, 1990 and the resource impact to the Division will be approximately 0.3 FTE.

In accordance with the HLWM work plan, those parties receiving copies of this memorandum who are listed below are encouraged to provide recommendations on the need to continue development of this TP. All recommendations should be provided to the Director within ten work days of the date of this memorandum. If you require any additional assistance, please contact the HLGP staff member responsible for development of this TP, Tom Cardone at extension 20528.

/s/

Ronald L. Ballard, Chief
Geosciences & Systems Performance Branch
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Enclosure:
As Stated

cc: C. Thomas J. Linehan S. Treby L. Rouse
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Approved, R. E. Browning

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SCOPE FOR THE TECHNICAL POSITION ON GEOLOGIC MAPPING OF SHAFTS AND DRIFTS OF A HIGH-LEVEL RADIOACTIVE WASTE REPOSITORY

1.0 Regulatory Evaluation

DOE proposes to employ a state-of-the-art but unproven method of mapping the repository shafts and drifts. The staff is of the opinion that a TP may be necessary to set forth NRC guidance that will assure compliance with the regulations, thereby avoiding a potentially troublesome licensing process. The TP would address the following sections of 10CFR60:

(A) §60.72 Construction Records

-60.72 (b)(1) Surveys of the underground facility excavations, shafts, and boreholes referenced to readily identifiable surface features or monuments.

-60.72 (b)(2) A description of the material encountered

-60.72 (b)(3) Geologic maps and geologic cross sections

-60.72 (b)(4) Locations and amount of seepage

-60.72 (b)(7) Anomalous conditions encountered

(B) §60.140 General Requirements

-60.140 (a)(1) Actual subsurface conditions encountered and changes in those conditions during construction and waste emplacement operations are within the limits assumed in the licensing review.

(C) §60.141 Confirmation of geotechnical and design parameters.

-60.141 (a) During repository construction and operation, a continuing program of surveillance, measurement, testing, and geologic mapping shall be conducted to ensure that geotechnical and design parameters are confirmed...

-60.141 (c) As a minimum, measurements shall be made of rock deformations and displacement, changes in rock stress and strain, rate and location of water inflow into subsurface areas, changes in groundwater conditions, and rock pore water pressures including those along fractures and joints...

-60.141 (d) These measurements and observations shall be compared with the original design bases and assumptions.

In keeping with the regulations governing the licensing conditions for the geologic repository, NRC guidance will be directed toward the following objectives:

1. All surveys of the shafts and drifts will apply first order surveying techniques and standards of precision, and will tie into surface benchmarks and baselines established by means of federal land surveys.

2. Geologic maps of the underground are essential to a reliable and complete characterization of the Yucca Mountain Project (YMP). They are requisite to interpreting the geologic and tectonic history of the site, and they provide the means of comparing the geologic assumptions made about the site from surface-derived data and information with the actual condition existing at the repository horizon. To describe the materials and site characteristics encountered in the host rock penetrated by the excavations, the lithology, mineralogy, stratigra-phic contacts, and faults and fractures and their orientations will be recorded and plotted on geologic maps and cross sections. Seepage areas will also be plotted on these maps.

3. Unanticipated and anomalous geologic and structural conditions encountered in the excavations will be recorded, plotted on maps, and analyzed to determine their significance.

4. In the opinion of the staff, one of the most important reasons for mapping the geologic features in the shafts and drafts is to identify all faults encountered and subsequently isolate them from the waste disposal areas. This TP will provide guidance so that the location and subsequent isolation of these zones will be assured.

2.0 Proposed Guidance

DOE should describe and document the geologic mapping method it plans to use in the shafts and drifts. It should demonstrate that the equipment, methodology, and resulting products are QA Level 1 and that the survey is of first order accuracy. The end result must be that the geologic maps produced are representative of conditions in the excavations.

DOE should demonstrate the advantages of the Close-up Photogrammetric Underground Geologic Mapping (CPUGM) method over conventional mapping methods by means of prototype testing and from the experience of others documented in case histories. It should demonstrate that these advantages will be maintained in mapping the shafts and drifts.

Part 60.72 (b)(7) requires that the survey party geologists must identify and record unanticipated and anomalous geologic and hydrologic conditions

in the shafts and drifts. To do so the geologists must have a thorough knowledge of the geology, hydrology, tectonics, stratigraphy, lithology, mineralogy, and volcanic history of the Yucca Mountain site. In addition DOE should provide the geologists with clear and unambiguous conceptual geologic and tectonic models which describe the geologic conditions to be expected as excavation progresses. These models will be developed from surface geologic maps together with projections into the shafts and drifts of information from all cross sections and underground data developed from boreholes, geophysical surveys, ground penetrating radar, and any other exploratory techniques employed in the site characterization program. The models should cover the entire length of the shafts and drifts and should extend to all areas to be penetrated by the boreholes to be drilled from the excavations.

The geologists in the survey party should perform, at a minimum, a detailed line drawing on each side of the excavation at a predetermined and constant height above the floor. In the case of the shafts the detailed line drawing will be along two vertical lines with azimuths 180 degrees apart. This will provide some assurance that no major or significant geologic feature is bypassed in the mapping procedure and will provide a calibration check of the photogrammetric plotter.

Since the surface of the excavation to be mapped will be a three dimensional curved surface, DOE should describe how the planar geologic features such as the faults, fractures, and bedding planes and contacts will be plotted on a two dimensional map. It should discuss the distortion that will result, if it will be significant.

DOE has indicated in CDSCP section 6.2.8.6 and on page of Appendix M of the SCP-CDR that it plans to isolate fault zones from the buried waste canisters in the repository. NRC should require that zones of highly fractured tuff with high flux potential also be isolated from the buried waste areas to prevent groundwater contact with the waste canisters and possible corrosion. The locations of the faults and the potential high flux zones should be noted and precisely located on the maps as zones to be void of canisters and where barrier protection should be constructed on both sides to isolate them.

DOE should describe the procedure for communicating the existence of any faults and high flux zones to notify the party responsible for properly locating these zones. The notification procedure should describe in detail the paper trail to be followed from the time that the zone is identified and recorded to the time the contractor acts to isolate the zone during the period of repository construction.

DOE should attempt to apply other means of observing and recording the geologic features in the underground excavations, for example, ground-penetrating radar. DOE should test the application of ground-penetrating radar underground mapping in three dimensions of the fractures and faults

in the vicinity of the underground excavations. The objective would be to plot the undulations and interruptions of the fracture planes, which cannot be done by any other method. Another underground application of ground-penetrating radar is that it can be used to delineate fractured and unfractured areas as an aid in locating test areas for discrete fracture experiments, blast damage or breakage assessment, and effective rock-bolt anchoring.

All data collected, data analyses, photographs, and all products from the photogrammetric plotter should be documented and stored on magnetic tapes or disks for permanent storage according to QA Level 1 standards.

Backup systems and equipment must be available in the event of failure.

3.0 Justification

The justification for NRC staff providing this guidance is to avoid misunderstandings and delays in the kind of information that is required from DOE. Potential groundwater pathways in the unsaturated zone are important in characterizing the Yucca Mountain site. Since the faults and fractures in the tuff may be a major pathway for groundwater migration, they must be mapped in great detail. Mapping the characteristically fractured tuff at the site is a very labor intensive and time consuming activity. The unproven CDUGM method of underground geologic mapping might accomplish this with considerably less effort and in considerably less time than the conventional mapping method.

The plan of construction requires that the shafts will be lined as the excavation advances with a minimum of 30 feet of rock exposed at any one time. Also, the drifts will be continuously covered with chain-link fabric approximately 6 feet behind the heading. To avoid these obstructions, all geologic mapping must be accomplished before the lining or chain-link fabric is installed. The major impact on shaft and drift construction is the amount of time the contractor must stand by while geologic mapping is accomplished. Because of the need for detailed mapping and the brief time allotted for mapping as the excavation progresses, the close-up photogrammetric method of mapping offers many advantages over conventional mapping methods and may be preferred for the YMP.

4.0 General Information

This TP does not now fit into the overall regulatory development and license review process because we do not at this time have a plan from DOE which describes the underground mapping method to be employed in the shafts and drifts. (A DOE study plan which addresses underground geologic mapping is to be submitted with the SCP.) Consequently, we cannot yet determine if a TP is necessary.

MAPPING

The USGS/Bureau of Reclamation has performed prototype testing of the close-up photogrammetic mapping method in the G-Tunnel at NTS and have developed to QA Level 3 status the equipment, software, and methodology for surveying the drifts. These must be raised to QA Level 1 before the method can be applied in the drifts. However, they have not yet performed prototype testing under simulated shaft sinking conditions, and, therefore, have not yet fully developed the equipment, software, and methodology for that purpose. The USGS/Bureau of Reclamation staff are awaiting approval by DOE to begin prototype testing in a pit on the east flank of Yucca Mountain. DOE has indicated that the actual beginning date for the prototype testing will not be before January 1989. DOE may be awaiting the results of this testing before finally accepting this method for the YMP.

We wish to provide guidance to DOE to help achieve a timely, reliable, and precise mapping method which would expedite the NRC's review process. The guidance we presently have to offer may be presented in a form other than a TP (i.e. standard Review Plan or letter). However, a TP may be required if the guidance offered in some other form is not accepted by DOE.

The following schedule for completion of the TP may have to be revised if information is not forthcoming from DOE in a timely manner. Furthermore, because little substantive information has been provided to NRC and because of reasons stated above, an annotated outline is not advisable at this time.

Upon completion of the prototype testing, the USGS/Bur.of Recl. staff doing the testing will make a presentation to NRC at WFN advocating the CDUGM methodology. Also, a meeting between NRC and DOE is anticipated because staff has been informed by DOE staff that the study plan describing the CDUGM will have few details.

TP SCHEDULE
FOR
GEOLOGIC MAPPING OF SHAFTS/DRIFTS

Milestone	Elapsed Time(wk)	Accum Time(wk)	Date
Start Date	0	0	09/28/88
Scope Completion Date	8	8	01/01/89
Internal Draft	12	20	04/01/89
Internal NRC Comments	4	24	05/01/89
Public Comment Draft	8	32	07/01/89
Federal Register Notice	3	35	07/22/89
Public Comment Period Closed	8	43	09/22/89
Comment Resolution Meeting	8	51	11/22/89
ACNW Meeting	2	53	12/05/89
Final TP Issued	8	61	02/05/90