

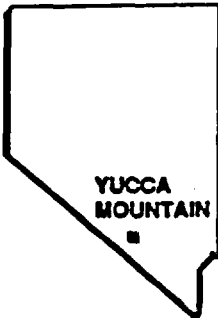
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U.S. DEPARTMENT OF ENERGY

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YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

RESPONSES TO ENVIRONMENTAL PROTECTION AGENCY COMMENTS ON THE SITE CHARACTERIZATION PLAN

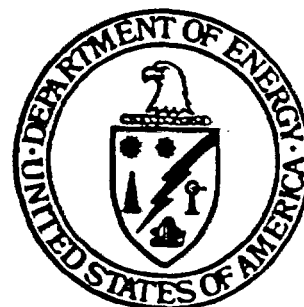
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DECEMBER 1990

UNITED STATES DEPARTMENT OF ENERGY



U.S DEPARTMENT OF ENERGY'S COMMENT RESPONSES FOR THE COMMENTS RECEIVED FROM
THE U.S. ENVIRONMENTAL PROTECTION AGENCY

The U.S. Environmental Protection Agency submitted comments on the Site Characterization Plan in a letter dated May 30, 1989. The U.S. Department of Energy first renumbered the pages contained in the letter received from the EPA and identified individual comments within the letter. The comments were then enumerated from the package that was submitted; the total number of comments was twelve. A copy of the enumerated comment package is provided under separate enclosure for cross reference. Each comment number is marked in the margin of the page and the page number is marked in the upper right hand corner of the page. Where multiple comments occur on one page, each is bracketed by horizontal lines.

For each comment, the DOE response package provides a description of the comment, followed by the response to the comment. Each comment was either furnished an individual response, or cross-referenced to a response addressing comments pertaining to the same overall theme.

U.S. DEPARTMENT OF ENERGY RESPONSES TO COMMENTS
RECEIVED FROM THE U.S. ENVIRONMENTAL PROTECTION AGENCY
ON THE SITE CHARACTERIZATION PLAN

COMMENT 1:

In response to Secretary Herrington's letter of December 28, 1988, and in accordance with Section 309 of the Clean Air Act, the U.S. Environmental Protection Agency (EPA) has reviewed the U.S. Department of Energy's (DOE) Site Characterization Plan for the Yucca Mountain Site. This site is to be characterized for future possible use as a high-level nuclear waste repository. EPA generally agrees with the proposed characterization plan, and we believe it will provide the necessary data to analyze compliance with EPA's standards for the disposal of high-level radioactive waste.

DOE has described a comprehensive and systematic approach towards determining compliance with the EPA standards that were promulgated in 1985. DOE's approach will consider a wide range of potential release mechanisms with appropriate analytical simplifications and screening procedures to avoid considering insignificant release mechanisms. Similarly, one concern we have with the approach involves human activities. We want to make it clear that the containment requirements of the disposal standards will apply to the total projected releases from all significant processes and events, and that the complementary cumulative distribution function (CCDF) used to determine compliance must incorporate both natural and human-initiated processes and events. Compliance may not be considered separately for these two categories.

Response:

The complementary cumulative distribution function (CCDF), which is the recommended approach to summarizing repository behavior for comparison to U.S. Environmental Protection Agency containment requirements, is a relatively simple concept that is very difficult to implement. U.S. Department of Energy (DOE) understands the philosophy behind the concept of CCDF to include all risks, both from natural phenomena and from human-induced, in a single probability distribution. However, as stated in the comment, very different types of uncertainties will apply to natural and human-initiated events. Compared with the natural phenomena, human activities are more difficult to project into the future. For example, an application of Markov's inequality to the U.S. Nuclear Regulatory Commission's (NRC's) 10 CFR 60.112 can easily demonstrate how one can violate U.S. Environmental Protection Agency's (EPA) containment requirement by assuming a human intrusion scenario that will bring to the surface only a few waste packages for whatever reason and by whatever means. All scenarios, of course, have associated probabilities, but it is impossible to assign a meaningful probability to an activity that is yet to be conceived. When no quantitative or even qualitative estimates of the probability are available, the whole concept of the CCDF becomes invalid. It may make sense to apply the concept of the CCDF only to those activities, natural and human-initiated, whose past history is amenable to statistical treatment so that their associated probabilities can be estimated.

Given the way the EPA standard is currently written, human intrusion must be included in constructing the CCDF. However, as experience with the Waste Isolation Pilot Plant (WIPP) site has shown, human intrusion will most likely dominate all other effects in the CCDF. DOE is evaluating the experience gained to date from WIPP, with the intention of developing a final strategy for the treatment of human intrusion in the assessment of repository system performance. Also, EPA is in the process of revising its containment standards, and when EPA publishes its rule for comment, DOE would comment on the issue of human intrusion.

As extensive as it is, the Site Characterization Plan still is a high level document with a specific emphasis on site characterization. No specific activity is described in the SCP for the development of a CCDF methodology. It is, however, being addressed as a part of performance assessment methodology development, which is an activity under WBS 1.2.1.4.1. The methodology undoubtedly would incorporate human-initiated activities. The extent of these activities, however, would have to be bounded as discussed above. Further details are yet to be developed. DOE looks forward to working with EPA, NRC, and other interested parties in developing a reasonable approach to summarizing the behavior of the repository in a manner that would allow comparison with the curie release limits.

COMMENT 2:

The plan indicates that backfill is not required in the repository for hydrologic reasons. However, backfill and seals are deterrents to human intrusion for those time periods when institutional controls can no longer be relied on.

Response:

It is true that backfill is not required to reduce the flow of liquid water in the host rock, according to current concepts of flow in the unsaturated zone. However, other considerations, including discouraging random human vandalism and curiosity seekers, indicate that backfilling of some type will be used to seal shafts, drifts and boreholes as is stated in Section 8.3.3. Hydrologic effects as well as mechanical stability are among the factors that will be considered in selecting the methods of sealing.

COMMENT 3:

EPA strongly supports DOE's commitment to carry out performance projections for 100,000 years, even though such projections are not required. In addition, we recommend that DOE determine the origin of the calcite-silica veins found in the Yucca Mountain area, since these deposits relate to the geological history and tectonic stability of the site.

Response:

U.S. Department of Energy (DOE) appreciates the endorsement to carry out performance projections for 100,000 years. Note, however, that the uncertainties associated with such long-term projections may be so large that the numerical results should only be interpreted qualitatively. The purpose of the 100,000-year performance projection is by no means to demonstrate compliance to the regulatory requirements for such a long period. DOE plans only to provide confidence that no failure modes are imminently pending in the years following the containment period of 10,000 years and to demonstrate the robustness of the system performance in a semi-quantitative manner.

Performance evaluation for 100,000 years is not required by U.S. Nuclear Regulatory Commission (NRC). Neither was it required by U.S. Environmental Protection Agency in the remanded 40 CFR 191. It is a requirement of 10 CFR 960 for the selection of a repository site.

A determination of the origin of the calcite/silica veins formed in the Yucca Mountain area is indeed a planned high-priority activity outlined in the Site Characterization Plan (SCP) (Activity 8.3.1.5.2.1.5, Studies of Calcite and Opaline Silica Vein Deposits), which is part of Study Plan 8.3.1.5.2.1 (Characterization of the Quaternary Regional Hydrology). The approaches being used in this activity have been developed through the concurrence of numerous program participants, including the NRC, during two workshops conducted in 1986. The established methodology was subsequently endorsed, with minor modifications, by a multidisciplinary peer panel of nationally recognized experts in 1987. The methodology includes analyses of the vein-filling materials, the fractured wallrock, and potential sources of the vein-filling minerals such as groundwater, soil water and deep seated hydrothermal fluids. These materials will be analyzed in terms of their geochemical and isotopic compositions, total mineralogy, geochronology, and paleontology; these analyses will provide the data base that bears upon the origin of the calcite/silica veins. Preliminary results of studies were reviewed with NRC staff and State of Nevada representatives at a technical exchange held on February 6-7, 1990, in Las Vegas, Nevada.

REFERENCES

DOE, (U.S. Department of the Energy), 1989. Study Plan 8.3.1.5.2.1, Characterization of the Quaternary Regional Hydrology, Yucca Mountain Project Office, Las Vegas NV.

COMMENT 4:

Emphasis should be placed on determining the origin of the calcite-silica veins found in the Yucca Mountain Area because this relates to the question of tectonic stability. A U.S. Geological Survey refers to the calcite-silica veins as "hydrogenic" which infers that they could be the result of either descending surface waters or ascending hydrothermal waters from tectonic events. One theory is that the deposits might be hydrothermal and related to Quaternary volcanism. The concern is that hydrothermal activity at or near the site could corrode the waste package and accelerate release of radionuclides to the accessible environment. The resolution of this concern is significant in determining site suitability. To determine the origin of the calcite-silica veins, more focus should be given to the study of other types of minerals in the area, which could yield clues as to the origin of the calcite-silica veins. Also, the study of magma production in the area is important because it relates to tectonic stability.

Response:

The U.S. Department of Energy's plans for determining the origin of the calcite/silica veins are, in part, discussed in the response to the previous comment (U.S. Environmental Protection Agency #3). Studies of other types of minerals in the area are included in Study Plan 8.3.1.5.2.1 (Characterization of Quaternary Regional Hydrology). They consist of mapping, sampling, and analyses of deposits at modern springs (cool, warm, and hot) and paleosprings, as well as apparently hydrothermal deposits along faults or other mineralized zones and undisputed pedogenic accumulations of carbonate minerals. Other studies will provide information that will be useful to the calcite/silica investigations. Study 8.3.1.9.2.1 (Natural Resource Assessment of, Nye County, Nevada) will accumulate and analyze geologic, geochemical, and geophysical information in order to assess the potential for the development of mineral resources at or near the site. The alteration mineralogy of the rocks at Yucca Mountain is addressed in study 8.3.1.3.2.2 (History of Mineralogical and Geochemical Alteration of Yucca Mountain) as part of mineralogic investigations supporting analyses of radionuclide mobility. Study 8.3.1.8.4.1 also addresses alteration mineralogy, but in the specific context of its relation to tectonism.

With respect to possible magma production in the area, studies 8.3.1.8.1.1 (Probability of a Volcanic Eruption Penetrating the Repository), 8.3.1.8.5.1 (Characterization of Volcanic Features), and 8.3.1.8.5.2 (Characterization of Igneous Intrusive Features) will investigate the locations, structural controls, and timing of both extrusive and intrusive igneous activity in the area. Magnetic and geothermal investigations will aid in the assessment of the potential for both igneous and hydrothermal activity. Rates of magma production, as well as geochemical evolution of the magmas, over the last 14 million years are continuing topics of interest in these investigations because of their relation to the probability of future igneous activity and, as the comment notes, the history of tectonic stability in the area.

REFERENCES

DOE, (U.S. Department of the Interior), 1989. Study Plan 8.3.1.5.2.1, Characterization of the Quaternary Regional Hydrology, Yucca Mountain Project Office, Las Vegas NV.

COMMENT 5:

Our hydrology review focused on the matrix and fracture flow characteristics of the saturated and unsaturated zones in relation to the travel time of groundwater from the potential repository horizon to the accessible environment. Although investigations are planned for "characterization of the regional ground-water flow system" in section 8.3.1.2.1.3, the SCP does not indicate any specific plans to determine the boundaries of the subbasins which make up the hydrographic study area. These boundaries are necessary to fully understand the effects of potential hydrological changes in the region. Three subbasins, the Oasis Valley Subbasin, the Alkali Flat-Furnace Creek Ranch Subbasin, and the Ash Meadows Subbasin, make up this area. The boundaries have been inferred "from potentiometric levels, geologic controls of subsurface flow, discharge areas, and inferred flow paths." Suggested methods which could assist in determining the boundaries are: (1) using flow nets to determine the direction of groundwater flow; and (2) performing pump tests, such as the Boulton method, to verify the results of the drawdown recovery method. Other methods which could be used in determining boundaries are: (3) collecting rainfall data along the gradients; and (4) using different methods for measuring evapotranspiration by determining run-off, recharge and precipitation to validate results.

Response:

In addition to Site Characterization Plan section 8.3.1.2.1.3, (Characterization of the Regional Ground-water Flow System), section 8.3.1.2.1.4 (Regional Hydrologic System Synthesis and Modeling) also indicates the use of two-dimensional and two-layer (quasi-three dimensional) models in testing the sensitivity of the regional system to boundary assumptions. The U.S. Department of Energy chose the current boundaries on the basis of areally more extensive modeling but acknowledges that they are subject to re-evaluation. Further details regarding testing the significance of boundary conditions and plans for characterizing them are available in the Study Plans 8.3.1.2.1.3 and 8.3.1.2.1.4.

With respect to the suggested methods for investigation:

1. Digital modeling techniques incorporate those of the suggested flow-net analyses and are much more powerful.
2. The possible need for applying models for heterogeneous conditions (such as the suggested double-porosity, delayed-yield analysis of fractured rocks by Boulton and Streltsove (1977), as reviewed by Moench (1984) is discussed in Activity 8.3.1.2.3.1.3, Analysis of single- and multiple-well hydraulic-stress tests, and Activity 8.3.1.2.3.1.4, Multiple-well interference testing.

Methods for collecting rainfall and for measuring evapotranspiration are discussed in Study Plan 8.3.1.2.3.1 (Characterization of the Site Saturated-zone Ground-water Flow System). These methods will be applied to areas other than those specified in the study plan if it becomes necessary.

DOE (U.S. Department of Energy), 1990. Study Plan 8.3.1.2.1.3, Characterization of the Regional Ground Water Flow System, Yucca Mountain Project Office, Las Vegas, NV.

Boulton & Streltsove, (1977). Unsteady Flow in a Pumped Well in a Two-Layered Water-Bearing Formation, Journal of Hydrology, p. 245-256.

Moench, A.F., (1984). Double-Porosity Models for a Fissured Groundwater Reservoir with Fracture Skin, Water Resources Research, V20, #7.

COMMENT 6:

Although the SCP includes plans to investigate the groundwater flow system in the saturated zone, the methods for the investigations should be more explicit, such as indicating the type and number of pump tests to be run, with justification for the type of pump test selected.

Response:

Activities 8.3.1.2.3.1.4 (Multiple-well Interference Testing) and 8.3.1.2.3.1.5 (Testing of the C-hole Sites with Conservative Tracers) as described in the Site Characterization Plan (SCP) will determine what kind of hydraulic and tracer tests are appropriate for Yucca Mountain. Until these activities are completed, it is not appropriate to specify the type and number of pumping tests.

This "methods development" approach is described in much more detail in Study Plan 8.3.1.2.3.1, (Characterization of the Site Saturated Zone Ground Water Flow System (under development)) than it is in the SCP.

COMMENT 7:

In the unsaturated zone, the flow characteristics should be measured to determine where and when fracture flow characteristics dominate over matrix flow characteristics.

Response:

Several studies and activities address measurements applicable to determining the partitioning between fracture flow and matrix flow, including infiltration and percolation studies 8.3.1.2.2.1 (Characterization of Unsaturated-zone Infiltration) and 8.3.1.2.2.2 (Water Movement Tracer Tests using Chloride and Chlorine-36 Measurements of Percolation at Yucca Mountain), surface-based study for percolation characterization (8.2.1.2.2.3 Characterization of Percolation in the Unsaturated Zone--surface-based Study), and Exploratory Shaft Facility studies of percolation, diffusion, and hydrochemistry (8.2.1.2.2.4 (Characterization of Yucca Mountain percolation in the Unsaturated Zone--exploratory Shaft Facility Study), 8.2.1.2.2.5 (Diffusion Tests in the Exploratory Shaft facility), and 8.2.1.2.2.7 (Hydrochemical Characterization of the Unsaturated Zone). The principal hydrologic characteristics that are important include but are not limited to infiltration flux including spatial and temporal variability; matrix properties of all units including permeability as a function of saturation, porosity, degree of saturation, pore-size distribution, etc.; in situ properties such as water tension and water content; and observations and experimental results in the ESF and the laboratory. Various modeling and synthesis efforts (studies 8.3.1.2.2.8 (Fluid Flow in Unsaturated Fractured Rock and 8.3.1.2.2.9 Site Unsaturated-Zone Modeling Synthesis) will help in integrating and analyzing these applicable data and will result in predictions of the relative importance of fracture flow as a function of percolation flux.

REFERENCES

- DOE, (U.S. Department Of Energy), 1989. Study Plan 8.3.1.2.2.2, Water Movement Tracer Tests Using Chloride and Chlorine-36 Measurements of Percolation at Yucca Mountain, Yucca Mountain Project Office, Las Vegas NV.
- DOE, (U.S. Department Of Energy), 1989. Study Plan 8.3.1.2.2.4, Characterization of Yucca Mountain percolation in the Unsaturated Zone--exploratory Shaft Facility Study, Yucca Mountain Project Office, Las Vegas NV.
- DOE, (U.S. Department Of Energy), 1990. Study Plan 8.3.1.2.2.7, Hydrochemical Characterization of the Unsaturated Zone, Yucca Mountain Project Office, Las Vegas NV.

COMMENT 8:

Several areas of chapter 6 indicate that backfill is not required in the repository for hydrologic reasons. However, while the design for closure currently includes backfilling the underground openings, from section 6.2.7, "the need for backfill must be assessed based on the stability analyses of the underground openings and the analyses of the hydrologic conditions within the repository." Another factor to be considered in the need for backfill is using it as a deterrent for human intrusion, along with the seal system, even if it is found that backfill is not required for stability or hydrologic reasons.

Response:

It is true that backfill is not required to reduce the flow of liquid water in the host rock, according to current concepts of flow in the unsaturated zone. However, other considerations, including discouraging random human vandalism and curiosity seekers, indicate that backfilling of some type will be used to seal shafts, drifts and boreholes as is stated in Section 8.3.3. Hydrologic effects as well as mechanical stability are among the factors that will be considered in selecting the methods of sealing.

COMMENT 9:

Many uncertainties are addressed in the conceptual design, and while this design may exclude certain events which appear to have a low probability of occurrence, the final design should consider all investigation results during the final design process to ensure that no conditions or events have been overlooked. Specifically, on page 7-8, a design condition for the waste package is that it is assumed to be subject to a pressure of one atmosphere. This design condition gives no consideration to the potential for faulting effects on the waste package, which could cause the package to be subject to a pressure greater than one atmosphere. Faulting effects are not identified as being design uncertainties in chapter 7, although the SCP does include faulting in the investigations of section 8.3.1.8.2, which studies effects of tectonic events on the waste package. The integration of the design conditions in chapter 7 and the results of these investigations is unclear.

Response:

The U.S. Department of Energy believes faulting effects on the waste package design are implicitly considered. However, Table 8.3.1.8-2 implicitly infers that failure of the waste package will certainly result from an intersecting fault movement of more than 5 cm, or ground motion that closes the air gap around the waste package--regardless of the waste package construction. The inclusion of hot rolled high-conductivity copper as a candidate waste package container material (Section 7.3.2.2, Table 7-7) underscores a tacit assumption that for the advantage of high corrosion resistance a material of low yield strength may be considered. This, in turn, indicates that breaching of intersected canisters is inevitable during a fault movement of more than 5 cm.

The one atmosphere pressure is based on the containers sitting in an open borehole well above the water table. Therefore, as discussed, there are no significant hydrostatic or lithostatic loads. The container designs will withstand rock falls and sloughing and those pressures associated with anticipated events. The containers are not designed to withstand unanticipated events such as a shear caused by severe faulting. In this case, it is assumed that the container will fail, but this failure rate is expected to be quite low as discussed in Site Characterization Plan Table 8.3.4.2-3.

COMMENT 10:

Compliance with EPA standards. With regard to assessing the system's long-term performance after closure, the Department has described a very comprehensive and systematic approach towards determining compliance with the EPA disposal standards that were published in 1985. This approach will consider a wide range of potential release scenarios, but with appropriate analytical simplifications and with screening procedures to avoid considering scenarios that should not contribute significantly to the overall analyses.

We have one concern with the approach towards determining compliance with the containment requirements (section 191.13). On page 8.3.5.13-23 of the SCP, the Department states that:

In calculating the CCDF, the DOE intends to take into account all those natural processes and events that are sufficiently credible to warrant consideration.
(emphasis added)

The implication of this sentence and the following paragraphs is that processes and events that might be initiated by human activities will be treated in some different, separate way. We recognize that very different types of uncertainties will apply to natural and human-initiated events, and often be appropriate to study them separately while planning site characterization. However, we want to make it clear that the containment requirements will apply to the total projected releases from all significant processes and events, and that the CCDF to be used to determine compliance must incorporate both natural and human-initiated processes and events. Compliance may not be considered separately for these two categories.

Response:

The U.S. Department of Energy (DOE) appreciates the U.S. Environmental Protection Agency's (EPA) favorable evaluation of the SCP approach to postclosure performance assessment. The response to EPA Comment #1 addresses DOE's concern regarding the treatment of human-initiated events for the postclosure performance assessment.

COMMENT 11:

100,000-year performance projections. On pages 8.3.5.18-21 through 18-27, the SCP describes the Department's approach for carrying out performance projections for 100,000 years, as discussed in 10 CFR 960.3-1-5. EPA wants to strongly endorse DOE's continued commitment to do these very long-term projections, even though they are no longer strictly required after passage of the NWPAA. A very useful approach for these analyses was established in 10 CFR 960, and proceeding with them will add confidence to the site characterization process.

Response:

The U.S. Department of Energy (DOE) appreciates the U.S. Environmental Protection Agency (EPA) endorsement of the DOE commitment to performing very long-term projections of performance assessment. The DOE response to EPA Comment #3 discusses the purpose of these projections.

COMMENT 12:

External review of performance assessment methods and results. In many places throughout section 8.3.5, the Department refers to peer reviews of analytical models and data and to the professional and expert judgments that will be needed to do the performance assessments. EPA agrees that such judgments and reviews will be an essential part of the process, and we want to encourage the Department to include a wide spectrum of participants from many organizations in these reviews. In addition, the Department should do all it can to make the computer programs used available and accessible to all who might be interested in carrying out their own evaluations of the protection provided by the site.

Response:

U.S. Department of Energy (DOE) strongly agrees with this comment and appreciates U.S. Environmental protection Agency's endorsement. In addition to many internal and external reviews planned for the site characterization activities and the data from them, the models and data used in performance assessment will be validated. The proposed validation methodology relies to a considerable extent on peer reviews and expert judgment. In addition, DOE is participating and presenting technical information in many domestic and international conferences and workshops such as INTRAVAL, HYDROCOIN and INTRACOIN, GSA meetings, Decision Science Professional Conferences, etc. This participation allows ongoing exposure of information to review by an extended scientific audience. Codes with input and output data sets will be made publicly available in a timely manner to facilitate external parties.

Environmental Protection Agency Comment Distribution

Comment Number	Page	SCP Section	Group Assigned	Comment description
1	1	8.3.5.13	PA	CCDF used to determine compliance must incorporate both natural and human-initiated events
2	1	6	ENG	Backfill is needed to prevent human intrusion
3	1	General	PA G	Performance projections should be carried out for 100,000 yrs and origin of calcite-silica veins should be determined
4	3	8.3.1.5.2.1.5	G HYD	Emphasis should be placed on determining the origin of the calcite-silica veins.
5	3	8.3.1.2.1.3	HYD	Need to determine boundaries of ground-water flow systems sub-basins.
6	3	8.3.1.2	HYD	Need to identify and justify the type of methods used to investigate the saturated zone.
7	4	8.3.1.2	HYD	Need to determine where and when fracture flow dominates over matrix flow
8	4	6.2.3.1.2.4	ENG	Backfill is required to prevent Human intrusion. (Note, appears commentor misunderstood SCP--text states that backfill <u>will</u> be done to prevent intrusion, <u>but</u> is not needed for hydrologic reasons).
9	4	7 8.3.1.8.2	WP ENG	Faulting effects are not considered in waste package design
10	4	8.3.5.13	PA	The CCDF used to determine compliance with the EPA regulations must incorporate both the natural and human-initiated processes and events.
11	5	8.3.5.18	PA	DOE should carry out performance projections for 100,000 years

12

5

8.3.5

PA

Wide spectrum of participants
should be included in professional
and expert review panels.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

DEC 28 1988

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OFFICE OF EXTERNAL AFFAIRS

Handwritten routing slip with names: Debra, [unclear], [unclear], [unclear], [unclear], [unclear], [unclear], [unclear], [unclear], [unclear], [unclear], [unclear]

Mr. Samuel Rousso
Acting Director
Office of Civilian Radioactive Waste Management
Department of Energy
Washington, DC 20585

Dear Mr. Rousso:

In response to Secretary Herrington's letter of December 28, 1988, and in accordance with Section 309 of the Clean Air Act, the U.S. Environmental Protection Agency (EPA) has reviewed the U.S. Department of Energy's (DOE) Site Characterization Plan for the Yucca Mountain Site. This site is to be characterized for future possible use as a high-level nuclear waste repository. EPA generally agrees with the proposed characterization plan, and we believe it will provide the necessary data to analyze compliance with EPA's standards for the disposal of high-level radioactive waste.

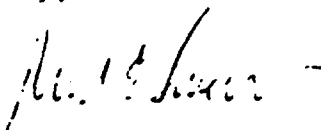
1 DOE has described a comprehensive and systematic approach towards determining compliance with the EPA standards that were promulgated in 1985. DOE's approach will consider a wide range of potential release mechanisms with appropriate analytical simplifications and screening procedures to avoid considering insignificant release mechanisms. Similarly, one concern we have with the approach involves human activities. We want to make it clear that the containment requirements of the disposal standards will apply to the total projected releases from all significant processes and events, and that the complementary cumulative distribution function (CCDF) used to determine compliance must incorporate both natural and human-initiated processes and events. Compliance may not be considered separately for these two categories.

2 The plan indicates that backfill is not required in the repository for hydrologic reasons. However, backfill and seals are deterrents to human intrusion for those time periods when institutional controls can no longer be relied on.

3 EPA strongly supports DOE's commitment to carry out performance projections for 100,000 years, even though such projections are not required. In addition, we recommend that DOE determine the origin of the calcite-silica veins found in the Yucca Mountain area, since these deposits relate to the geological history and tectonic stability of the site. Additional detailed comments are enclosed for your use.

We appreciate the opportunity to comment on the Plan, and, if we may be of further assistance, please contact me or Mr. Richard Guimond (475-9600), the Director of EPA's Office of Radiation Programs. The respective contacts on our staffs are Dr. W. Alexander Williams (382-5909) and Ms. Priscilla Bunton (475-9633).

Sincerely,



Richard E. Sanderson
Director
Office of Federal Activities

Enclosure

"BEST AVAILABLE COPY"

DETAILED COMMENTS OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY
ON THE U.S. DEPARTMENT OF ENERGY'S
YUCCA MOUNTAIN SITE CHARACTERIZATION PLAN (SCP)

GEOLOGY

4 1. Emphasis should be placed on determining the origin of the calcite-silica veins found in the Yucca Mountain Area because this relates to the question of tectonic stability. A U.S. Geological Survey refers to the calcite-silica veins as "hydrogenic" which infers that they could be the result of either descending surface waters or ascending hydrothermal waters from tectonic events. One theory is that the deposits might be hydrothermal and related to Quaternary volcanism. The concern is that hydrothermal activity at or near the site could corrode the waste package and accelerate release of radionuclides to the accessible environment. The resolution of this concern is significant in determining site suitability. To determine the origin of the calcite-silica veins, more focus should be given to the study of other types of minerals in the area, which could yield clues as to the origin of the calcite-silica veins. Also, the study of magma production in the area is important because it relates to tectonic stability.

HYDROLOGY

5 2. Our hydrology review focused on the matrix and fracture flow characteristics of the saturated and unsaturated zones in relation to the travel time of groundwater from the potential repository horizon to the accessible environment. Although investigations are planned for "characterization of the regional ground-water flow system" in section 8.3.1.2.1.3, the SCP does not indicate any specific plans to determine the boundaries of the subbasins which make up the hydrographic study area. These boundaries are necessary to fully understand the effects of potential hydrological changes in the region. Three subbasins, the Oasis Valley Subbasin, the Alkali Flat-Furnace Creek Ranch Subbasin, and the Ash Meadows Subbasin, make up this area. The boundaries have been inferred "from potentiometric levels, geologic controls of subsurface flow, discharge areas, and inferred flow paths." Suggested methods which could assist in determining the boundaries are: (1) using flow nets to determine the direction of groundwater flow; and (2) performing pump tests, such as the Boulton method, to verify the results of the drawdown recovery method. Other methods which could be used in determining boundaries are: (3) collecting rainfall data along the gradients; and (4) using different methods for measuring evapotranspiration by determining run-off, recharge and precipitation to validate results.

6 3. Although the SCP includes plans to investigate the groundwater flow system in the saturated zone, the methods for the investigations should be more explicit, such as indicating the type

and number of pump tests to be run, with justification for the type of pump test selected.

7 4. In the unsaturated zone, the flow characteristics should be measured to determine where and when fracture flow characteristics dominate over matrix flow characteristics.

CONCEPTUAL REPOSITORY DESIGN

8 5. Several areas of chapter 6 indicate that backfill is not required in the repository for hydrologic reasons. However, while the design for closure currently includes backfilling the underground openings, from section 6.2.7, "the need for backfill must be assessed based on the stability analyses of the underground openings and the analyses of the hydrologic conditions within the repository." Another factor to be considered in the need for backfill is using it as a deterrent for human intrusion, along with the seal system, even if it is found that backfill is not required for stability or hydrologic reasons.

CONCEPTUAL WASTE PACKAGE DESIGN

9 6. Many uncertainties are addressed in the conceptual design, and while this design may exclude certain events which appear to have a low probability of occurrence, the final design should consider all investigation results during the final design process to ensure that no conditions or events have been overlooked. Specifically, on page 7-8, a design condition for the waste package is that it is assumed to be subject to a pressure of one atmosphere. This design condition gives no consideration to the potential for faulting effects on the waste package, which could cause the package to be subject to a pressure greater than one atmosphere. Faulting effects are not identified as being design uncertainties in chapter 7, although the SCP does include faulting in the investigations of section 8.3.1.8.2, which studies effects of tectonic events on the waste package. The integration of the design conditions in chapter 7 and the results of these investigations is unclear.

PERFORMANCE ASSESSMENT

10 7. Compliance with EPA standards. With regard to assessing the system's long-term performance after closure, the Department has described a very comprehensive and systematic approach towards determining compliance with the EPA disposal standards that were published in 1985. This approach will consider a wide range of potential release scenarios, but with appropriate analytical simplifications and with screening procedures to avoid considering scenarios that should not contribute significantly to the overall analyses.

We have one concern with the approach towards determining compliance with the containment requirements (section 191.13). On page 8.3.5.13-23 of the SCP, the Department states that:

In calculating the CCDF, the DOE intends to take into account all those natural processes and events that are sufficiently credible to warrant consideration. (emphasis added)

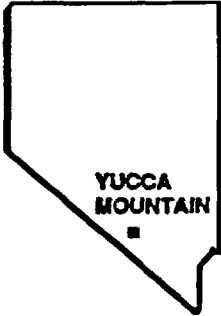
10 The implication of this sentence and the following paragraphs is that processes and events that might be initiated by human activities will be treated in some different, separate way. We recognize that very different types of uncertainties will apply to natural and human-initiated events, and it will often be appropriate to study them separately while planning site characterization. However, we want to make it clear that the containment requirements will apply to the total projected releases from all significant processes and events, and that the CCDF to be used to determine compliance must incorporate both natural and human-initiated processes and events. Compliance may not be considered separately for these two categories.

11 8. 100,000-year performance projections. On pages 8.3.5.18-21 through 18-27, the SCP describes the Department's approach for carrying out performance projections for 100,000 years, as discussed in 10 CFR 960.3-1-5. EPA wants to strongly endorse DOE's continued commitment to do these very long-term projections, even though they are no longer strictly required after passage of the NWPAA. A very useful approach for these analyses was established in 10 CFR 960, and proceeding with them will add confidence to the site characterization process.

12 9. External review of performance assessment methods and results. In many places throughout section 8.3.5, the Department refers to peer reviews of analytical models and data and to the professional and expert judgments that will be needed to do the performance assessments. EPA agrees that such judgments and reviews will be an essential part of the process, and we want to encourage the Department to include a wide spectrum of participants from many organizations in these reviews. In addition, the Department should do all it can to make the computer programs used available and accessible to all who might be interested in carrying out their own evaluations of the protection provided by the site.

U.S. DEPARTMENT OF ENERGY

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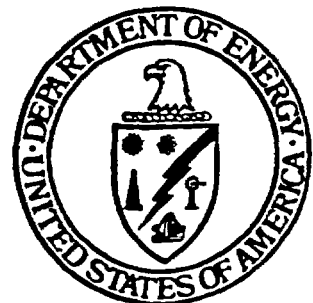


YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

RESPONSES TO ENVIRONMENTAL PROTECTION AGENCY COMMENTS ON THE SITE CHARACTERIZATION PLAN

DECEMBER 1990

UNITED STATES DEPARTMENT OF ENERGY



U.S DEPARTMENT OF ENERGY'S COMMENT RESPONSES FOR THE COMMENTS RECEIVED FROM
THE U.S. ENVIRONMENTAL PROTECTION AGENCY

The U.S. Environmental Protection Agency submitted comments on the Site Characterization Plan in a letter dated May 30, 1989. The U.S. Department of Energy first renumbered the pages contained in the letter received from the EPA and identified individual comments within the letter. The comments were then enumerated from the package that was submitted; the total number of comments was twelve. A copy of the enumerated comment package is provided under separate enclosure for cross reference. Each comment number is marked in the margin of the page and the page number is marked in the upper right hand corner of the page. Where multiple comments occur on one page, each is bracketed by horizontal lines.

For each comment, the DOE response package provides a description of the comment, followed by the response to the comment. Each comment was either furnished an individual response, or cross-referenced to a response addressing comments pertaining to the same overall theme.

U.S. DEPARTMENT OF ENERGY RESPONSES TO COMMENTS
RECEIVED FROM THE U.S. ENVIRONMENTAL PROTECTION AGENCY
ON THE SITE CHARACTERIZATION PLAN

COMMENT 1:

In response to Secretary Herrington's letter of December 28, 1988, and in accordance with Section 309 of the Clean Air Act, the U.S. Environmental Protection Agency (EPA) has reviewed the U.S. Department of Energy's (DOE) Site Characterization Plan for the Yucca Mountain Site. This site is to be characterized for future possible use as a high-level nuclear waste repository. EPA generally agrees with the proposed characterization plan, and we believe it will provide the necessary data to analyze compliance with EPA's standards for the disposal of high-level radioactive waste.

DOE has described a comprehensive and systematic approach towards determining compliance with the EPA standards that were promulgated in 1985. DOE's approach will consider a wide range of potential release mechanisms with appropriate analytical simplifications and screening procedures to avoid considering insignificant release mechanisms. Similarly, one concern we have with the approach involves human activities. We want to make it clear that the containment requirements of the disposal standards will apply to the total projected releases from all significant processes and events, and that the complementary cumulative distribution function (CCDF) used to determine compliance must incorporate both natural and human-initiated processes and events. Compliance may not be considered separately for these two categories.

Response:

The complementary cumulative distribution function (CCDF), which is the recommended approach to summarizing repository behavior for comparison to U.S. Environmental Protection Agency containment requirements, is a relatively simple concept that is very difficult to implement. U.S. Department of Energy (DOE) understands the philosophy behind the concept of CCDF to include all risks, both from natural phenomena and from human-induced, in a single probability distribution. However, as stated in the comment, very different types of uncertainties will apply to natural and human-initiated events. Compared with the natural phenomena, human activities are more difficult to project into the future. For example, an application of Markov's inequality to the U.S. Nuclear Regulatory Commission's (NRC's) 10 CFR 60.112 can easily demonstrate how one can violate U.S. Environmental Protection Agency's (EPA) containment requirement by assuming a human intrusion scenario that will bring to the surface only a few waste packages for whatever reason and by whatever means. All scenarios, of course, have associated probabilities, but it is impossible to assign a meaningful probability to an activity that is yet to be conceived. When no quantitative or even qualitative estimates of the probability are available, the whole concept of the CCDF becomes invalid. It may make sense to apply the concept of the CCDF only to those activities, natural and human-initiated, whose past history is amenable to statistical treatment so that their associated probabilities can be estimated.

Given the way the EPA standard is currently written, human intrusion must be included in constructing the CCDF. However, as experience with the Waste Isolation Pilot Plant (WIPP) site has shown, human intrusion will most likely dominate all other effects in the CCDF. DOE is evaluating the experience gained to date from WIPP, with the intention of developing a final strategy for the treatment of human intrusion in the assessment of repository system performance. Also, EPA is in the process of revising its containment standards, and when EPA publishes its rule for comment, DOE would comment on the issue of human intrusion.

As extensive as it is, the Site Characterization Plan still is a high level document with a specific emphasis on site characterization. No specific activity is described in the SCP for the development of a CCDF methodology. It is, however, being addressed as a part of performance assessment methodology development, which is an activity under WBS 1.2.1.4.1. The methodology undoubtedly would incorporate human-initiated activities. The extent of these activities, however, would have to be bounded as discussed above. Further details are yet to be developed. DOE looks forward to working with EPA, NRC, and other interested parties in developing a reasonable approach to summarizing the behavior of the repository in a manner that would allow comparison with the curie release limits.

COMMENT 2:

The plan indicates that backfill is not required in the repository for hydrologic reasons. However, backfill and seals are deterrents to human intrusion for those time periods when institutional controls can no longer be relied on.

Response:

It is true that backfill is not required to reduce the flow of liquid water in the host rock, according to current concepts of flow in the unsaturated zone. However, other considerations, including discouraging random human vandalism and curiosity seekers, indicate that backfilling of some type will be used to seal shafts, drifts and boreholes as is stated in Section 8.3.3. Hydrologic effects as well as mechanical stability are among the factors that will be considered in selecting the methods of sealing.

COMMENT 3:

EPA strongly supports DOE's commitment to carry out performance projections for 100,000 years, even though such projections are not required. In addition, we recommend that DOE determine the origin of the calcite-silica veins found in the Yucca Mountain area, since these deposits relate to the geological history and tectonic stability of the site.

Response:

U.S. Department of Energy (DOE) appreciates the endorsement to carry out performance projections for 100,000 years. Note, however, that the uncertainties associated with such long-term projections may be so large that the numerical results should only be interpreted qualitatively. The purpose of the 100,000-year performance projection is by no means to demonstrate compliance to the regulatory requirements for such a long period. DOE plans only to provide confidence that no failure modes are imminently pending in the years following the containment period of 10,000 years and to demonstrate the robustness of the system performance in a semi-quantitative manner.

Performance evaluation for 100,000 years is not required by U.S. Nuclear Regulatory Commission (NRC). Neither was it required by U.S. Environmental Protection Agency in the remanded 40 CFR 191. It is a requirement of 10 CFR 960 for the selection of a repository site.

A determination of the origin of the calcite/silica veins formed in the Yucca Mountain area is indeed a planned high-priority activity outlined in the Site Characterization Plan (SCP) (Activity 8.3.1.5.2.1.5, Studies of Calcite and Opaline Silica Vein Deposits), which is part of Study Plan 8.3.1.5.2.1 (Characterization of the Quaternary Regional Hydrology). The approaches being used in this activity have been developed through the concurrence of numerous program participants, including the NRC, during two workshops conducted in 1986. The established methodology was subsequently endorsed, with minor modifications, by a multidisciplinary peer panel of nationally recognized experts in 1987. The methodology includes analyses of the vein-filling materials, the fractured wallrock, and potential sources of the vein-filling minerals such as groundwater, soil water and deep seated hydrothermal fluids. These materials will be analyzed in terms of their geochemical and isotopic compositions, total mineralogy, geochronology, and paleontology; these analyses will provide the data base that bears upon the origin of the calcite/silica veins. Preliminary results of studies were reviewed with NRC staff and State of Nevada representatives at a technical exchange held on February 6-7, 1990, in Las Vegas, Nevada.

REFERENCES

DOE, (U.S. Department of the Energy), 1989. Study Plan 8.3.1.5.2.1, Characterization of the Quaternary Regional Hydrology, Yucca Mountain Project Office, Las Vegas NV.

COMMENT 4:

Emphasis should be placed on determining the origin of the calcite-silica veins found in the Yucca Mountain Area because this relates to the question of tectonic stability. A U.S. Geological Survey refers to the calcite-silica veins as "hydrogenic" which infers that they could be the result of either descending surface waters or ascending hydrothermal waters from tectonic events. One theory is that the deposits might be hydrothermal and related to Quaternary volcanism. The concern is that hydrothermal activity at or near the site could corrode the waste package and accelerate release of radionuclides to the accessible environment. The resolution of this concern is significant in determining site suitability. To determine the origin of the calcite-silica veins, more focus should be given to the study of other types of minerals in the area, which could yield clues as to the origin of the calcite-silica veins. Also, the study of magma production in the area is important because it relates to tectonic stability.

Response:

The U.S. Department of Energy's plans for determining the origin of the calcite/silica veins are, in part, discussed in the response to the previous comment (U.S. Environmental Protection Agency #3). Studies of other types of minerals in the area are included in Study Plan 8.3.1.5.2.1 (Characterization of Quaternary Regional Hydrology). They consist of mapping, sampling, and analyses of deposits at modern springs (cool, warm, and hot) and paleosprings, as well as apparently hydrothermal deposits along faults or other mineralized zones and undisputed pedogenic accumulations of carbonate minerals. Other studies will provide information that will be useful to the calcite/silica investigations. Study 8.3.1.9.2.1 (Natural Resource Assessment of, Nye County, Nevada) will accumulate and analyze geologic, geochemical, and geophysical information in order to assess the potential for the development of mineral resources at or near the site. The alteration mineralogy of the rocks at Yucca Mountain is addressed in study 8.3.1.3.2.2 (History of Mineralogical and Geochemical Alteration of Yucca Mountain) as part of mineralogic investigations supporting analyses of radionuclide mobility. Study 8.3.1.8.4.1 also addresses alteration mineralogy, but in the specific context of its relation to tectonism.

With respect to possible magma production in the area, studies 8.3.1.8.1.1 (Probability of a Volcanic Eruption Penetrating the Repository), 8.3.1.8.5.1 (Characterization of Volcanic Features), and 8.3.1.8.5.2 (Characterization of Igneous Intrusive Features) will investigate the locations, structural controls, and timing of both extrusive and intrusive igneous activity in the area. Magnetic and geothermal investigations will aid in the assessment of the potential for both igneous and hydrothermal activity. Rates of magma production, as well as geochemical evolution of the magmas, over the last 14 million years are continuing topics of interest in these investigations because of their relation to the probability of future igneous activity and, as the comment notes, the history of tectonic stability in the area.

REFERENCES

DOE, (U.S. Department of the Interior), 1989. Study Plan 8.3.1.5.2.1, Characterization of the Quaternary Regional Hydrology, Yucca Mountain Project Office, Las Vegas NV.

COMMENT 5:

Our hydrology review focused on the matrix and fracture flow characteristics of the saturated and unsaturated zones in relation to the travel time of groundwater from the potential repository horizon to the accessible environment. Although investigations are planned for "characterization of the regional ground-water flow system" in section 8.3.1.2.1.3, the SCP does not indicate any specific plans to determine the boundaries of the subbasins which make up the hydrographic study area. These boundaries are necessary to fully understand the effects of potential hydrological changes in the region. Three subbasins, the Oasis Valley Subbasin, the Alkali Flat-Furnace Creek Ranch Subbasin, and the Ash Meadows Subbasin, make up this area. The boundaries have been inferred "from potentiometric levels, geologic controls of subsurface flow, discharge areas, and inferred flow paths." Suggested methods which could assist in determining the boundaries are: (1) using flow nets to determine the direction of groundwater flow; and (2) performing pump tests, such as the Boulton method, to verify the results of the drawdown recovery method. Other methods which could be used in determining boundaries are: (3) collecting rainfall data along the gradients; and (4) using different methods for measuring evapotranspiration by determining run-off, recharge and precipitation to validate results.

Response:

In addition to Site Characterization Plan section 8.3.1.2.1.3, (Characterization of the Regional Ground-water Flow System), section 8.3.1.2.1.4 (Regional Hydrologic System Synthesis and Modeling) also indicates the use of two-dimensional and two-layer (quasi-three dimensional) models in testing the sensitivity of the regional system to boundary assumptions. The U.S. Department of Energy chose the current boundaries on the basis of areally more extensive modeling but acknowledges that they are subject to re-evaluation. Further details regarding testing the significance of boundary conditions and plans for characterizing them are available in the Study Plans 8.3.1.2.1.3 and 8.3.1.2.1.4.

With respect to the suggested methods for investigation:

1. Digital modeling techniques incorporate those of the suggested flow-net analyses and are much more powerful.
2. The possible need for applying models for heterogeneous conditions (such as the suggested double-porosity, delayed-yield analysis of fractured rocks by Boulton and Streltsove (1977), as reviewed by Moench (1984) is discussed in Activity 8.3.1.2.3.1.3, Analysis of single- and multiple-well hydraulic-stress tests, and Activity 8.3.1.2.3.1.4, Multiple-well interference testing.

Methods for collecting rainfall and for measuring evapotranspiration are discussed in Study Plan 8.3.1.2.3.1 (Characterization of the Site Saturated-zone Ground-water Flow System). These methods will be applied to areas other than those specified in the study plan if it becomes necessary.

DOE (U.S. Department of Energy), 1990. Study Plan 8.3.1.2.1.3, Characterization of the Regional Ground Water Flow System, Yucca Mountain Project Office, Las Vegas, NV.

Boulton & Streltsove, (1977). Unsteady Flow in a Pumped Well in a Two-Layered Water-Bearing Formation, Journal of Hydrology, p. 245-256.

Moench, A.F., (1984). Double-Porosity Models for a Fissured Groundwater Reservoir with Fracture Skin, Water Resources Research, V20, #7.

COMMENT 6:

Although the SCP includes plans to investigate the groundwater flow system in the saturated zone, the methods for the investigations should be more explicit, such as indicating the type and number of pump tests to be run, with justification for the type of pump test selected.

Response:

Activities 8.3.1.2.3.1.4 (Multiple-well Interference Testing) and 8.3.1.2.3.1.5 (Testing of the C-hole Sites with Conservative Tracers) as described in the Site Characterization Plan (SCP) will determine what kind of hydraulic and tracer tests are appropriate for Yucca Mountain. Until these activities are completed, it is not appropriate to specify the type and number of pumping tests.

This "methods development" approach is described in much more detail in Study Plan 8.3.1.2.3.1, (Characterization of the Site Saturated Zone Ground Water Flow System (under development)) than it is in the SCP.

COMMENT 7:

In the unsaturated zone, the flow characteristics should be measured to determine where and when fracture flow characteristics dominate over matrix flow characteristics.

Response:

Several studies and activities address measurements applicable to determining the partitioning between fracture flow and matrix flow, including infiltration and percolation studies 8.3.1.2.2.1 (Characterization of Unsaturated-zone Infiltration) and 8.3.1.2.2.2 (Water Movement Tracer Tests using Chloride and Chlorine-36 Measurements of Percolation at Yucca Mountain), surface-based study for percolation characterization (8.2.1.2.2.3 Characterization of Percolation in the Unsaturated Zone--surface-based Study), and Exploratory Shaft Facility studies of percolation, diffusion, and hydrochemistry (8.2.1.2.2.4 (Characterization of Yucca Mountain percolation in the Unsaturated Zone--exploratory Shaft Facility Study), 8.2.1.2.2.5 (Diffusion Tests in the Exploratory Shaft facility), and 8.2.1.2.2.7 (Hydrochemical Characterization of the Unsaturated Zone). The principal hydrologic characteristics that are important include but are not limited to infiltration flux including spatial and temporal variability; matrix properties of all units including permeability as a function of saturation, porosity, degree of saturation, pore-size distribution, etc.; in situ properties such as water tension and water content; and observations and experimental results in the ESF and the laboratory. Various modeling and synthesis efforts (studies 8.3.1.2.2.8 (Fluid Flow in Unsaturated Fractured Rock and 8.3.1.2.2.9 Site Unsaturated-Zone Modeling Synthesis) will help in integrating and analyzing these applicable data and will result in predictions of the relative importance of fracture flow as a function of percolation flux.

REFERENCES

- DOE, (U.S. Department Of Energy), 1989. Study Plan 8.3.1.2.2.2, Water Movement Tracer Tests Using Chloride and Chlorine-36 Measurements of Percolation at Yucca Mountain, Yucca Mountain Project Office, Las Vegas NV.
- DOE, (U.S. Department Of Energy), 1989. Study Plan 8.3.1.2.2.4, Characterization of Yucca Mountain percolation in the Unsaturated Zone--exploratory Shaft Facility Study, Yucca Mountain Project Office, Las Vegas NV.
- DOE, (U.S. Department Of Energy), 1990. Study Plan 8.3.1.2.2.7, Hydrochemical Characterization of the Unsaturated Zone, Yucca Mountain Project Office, Las Vegas NV.

COMMENT 8:

Several areas of chapter 6 indicate that backfill is not required in the repository for hydrologic reasons. However, while the design for closure currently includes backfilling the underground openings, from section 6.2.7, "the need for backfill must be assessed based on the stability analyses of the underground openings and the analyses of the hydrologic conditions within the repository." Another factor to be considered in the need for backfill is using it as a deterrent for human intrusion, along with the seal system, even if it is found that backfill is not required for stability or hydrologic reasons.

Response:

It is true that backfill is not required to reduce the flow of liquid water in the host rock, according to current concepts of flow in the unsaturated zone. However, other considerations, including discouraging random human vandalism and curiosity seekers, indicate that backfilling of some type will be used to seal shafts, drifts and boreholes as is stated in Section 8.3.3. Hydrologic effects as well as mechanical stability are among the factors that will be considered in selecting the methods of sealing.

COMMENT 9:

Many uncertainties are addressed in the conceptual design, and while this design may exclude certain events which appear to have a low probability of occurrence, the final design should consider all investigation results during the final design process to ensure that no conditions or events have been overlooked. Specifically, on page 7-8, a design condition for the waste package is that it is assumed to be subject to a pressure of one atmosphere. This design condition gives no consideration to the potential for faulting effects on the waste package, which could cause the package to be subject to a pressure greater than one atmosphere. Faulting effects are not identified as being design uncertainties in chapter 7, although the SCP does include faulting in the investigations of section 8.3.1.8.2, which studies effects of tectonic events on the waste package. The integration of the design conditions in chapter 7 and the results of these investigations is unclear.

Response:

The U.S. Department of Energy believes faulting effects on the waste package design are implicitly considered. However, Table 8.3.1.8-2 implicitly infers that failure of the waste package will certainly result from an intersecting fault movement of more than 5 cm, or ground motion that closes the air gap around the waste package--regardless of the waste package construction. The inclusion of hot rolled high-conductivity copper as a candidate waste package container material (Section 7.3.2.2, Table 7-7) underscores a tacit assumption that for the advantage of high corrosion resistance a material of low yield strength may be considered. This, in turn, indicates that breaching of intersected canisters is inevitable during a fault movement of more than 5 cm.

The one atmosphere pressure is based on the containers sitting in an open borehole well above the water table. Therefore, as discussed, there are no significant hydrostatic or lithostatic loads. The container designs will withstand rock falls and sloughing and those pressures associated with anticipated events. The containers are not designed to withstand unanticipated events such as a shear caused by severe faulting. In this case, it is assumed that the container will fail, but this failure rate is expected to be quite low as discussed in Site Characterization Plan Table 8.3.4.2-3.

COMMENT 10:

Compliance with EPA standards. With regard to assessing the system's long-term performance after closure, the Department has described a very comprehensive and systematic approach towards determining compliance with the EPA disposal standards that were published in 1985. This approach will consider a wide range of potential release scenarios, but with appropriate analytical simplifications and with screening procedures to avoid considering scenarios that should not contribute significantly to the overall analyses.

We have one concern with the approach towards determining compliance with the containment requirements (section 191.13). On page 8.3.5.13-23 of the SCP, the Department states that:

In calculating the CCDF, the DOE intends to take into account all those natural processes and events that are sufficiently credible to warrant consideration.
(emphasis added)

The implication of this sentence and the following paragraphs is that processes and events that might be initiated by human activities will be treated in some different, separate way. We recognize that very different types of uncertainties will apply to natural and human-initiated events, and often be appropriate to study them separately while planning site characterization. However, we want to make it clear that the containment requirements will apply to the total projected releases from all significant processes and events, and that the CCDF to be used to determine compliance must incorporate both natural and human-initiated processes and events. Compliance may not be considered separately for these two categories.

Response:

The U.S. Department of Energy (DOE) appreciates the U.S. Environmental Protection Agency's (EPA) favorable evaluation of the SCP approach to postclosure performance assessment. The response to EPA Comment #1 addresses DOE's concern regarding the treatment of human-initiated events for the postclosure performance assessment.

COMMENT 11:

100,000-year performance projections. On pages 8.3.5.18-21 through 18-27, the SCP describes the Department's approach for carrying out performance projections for 100,000 years, as discussed in 10 CFR 960.3-1-5. EPA wants to strongly endorse DOE's continued commitment to do these very long-term projections, even though they are no longer strictly required after passage of the NWPAA. A very useful approach for these analyses was established in 10 CFR 960, and proceeding with them will add confidence to the site characterization process.

Response:

The U.S. Department of Energy (DOE) appreciates the U.S. Environmental Protection Agency (EPA) endorsement of the DOE commitment to performing very long-term projections of performance assessment. The DOE response to EPA Comment #3 discusses the purpose of these projections.

COMMENT 12:

External review of performance assessment methods and results. In many places throughout section 8.3.5, the Department refers to peer reviews of analytical models and data and to the professional and expert judgments that will be needed to do the performance assessments. EPA agrees that such judgments and reviews will be an essential part of the process, and we want to encourage the Department to include a wide spectrum of participants from many organizations in these reviews. In addition, the Department should do all it can to make the computer programs used available and accessible to all who might be interested in carrying out their own evaluations of the protection provided by the site.

Response:

U.S. Department of Energy (DOE) strongly agrees with this comment and appreciates U.S. Environmental protection Agency's endorsement. In addition to many internal and external reviews planned for the site characterization activities and the data from them, the models and data used in performance assessment will be validated. The proposed validation methodology relies to a considerable extent on peer reviews and expert judgment. In addition, DOE is participating and presenting technical information in many domestic and international conferences and workshops such as INTRAVAL, HYDROCOIN and INTRACOIN, GSA meetings, Decision Science Professional Conferences, etc. This participation allows ongoing exposure of information to review by an extended scientific audience. Codes with input and output data sets will be made publicly available in a timely manner to facilitate external parties.

Environmental Protection Agency Comment Distribution

Comment Number	Page	SCP Section	Group Assigned	Comment description
1	1	8.3.5.13	PA	CCDF used to determine compliance must incorporate both natural and human-initiated events
2	1	6	ENG	Backfill is needed to prevent human intrusion
3	1	General	PA G	Performance projections should be carried out for 100,000 yrs and origin of calcite-silica veins should be determined
4	3	8.3.1.5.2.1.5	G HYD	Emphasis should be placed on determining the origin of the calcite-silica veins.
5	3	8.3.1.2.1.3	HYD	Need to determine boundaries of ground-water flow systems sub-basins.
6	3	8.3.1.2	HYD	Need to identify and justify the type of methods used to investigate the saturated zone.
7	4	8.3.1.2	HYD	Need to determine where and when fracture flow dominates over matrix flow
8	4	6.2.3.1.2.4	ENG	Backfill is required to prevent Human intrusion. (Note, appears commentor misunderstood SCP—text states that backfill <u>will</u> be done to prevent intrusion, <u>but</u> is not needed for hydrologic reasons).
9	4	7 8.3.1.8.2	WP ENG	Faulting effects are not considered in waste package design
10	4	8.3.5.13	PA	The CCDF used to determine compliance with the EPA regulations must incorporate both the natural and human-initiated processes and events.
11	5	8.3.5.18	PA	DOE should carry out performance projections for 100,000 years

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8.3.5

PA

Wide spectrum of participants
should be included in professional
and expert review panels.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

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OFFICE OF
EXTERNAL AFFAIRS

Vertical stamp: NNI-1989-1824
Handwritten signatures and initials: Deborah, P. Miller, J. G. ...
Date: 4/2/89

Mr. Samuel Rouso
Acting Director
Office of Civilian Radioactive Waste Management
Department of Energy
Washington, DC 20585

Dear Mr. Rouso:

In response to Secretary Herrington's letter of December 28, 1988, and in accordance with Section 309 of the Clean Air Act, the U.S. Environmental Protection Agency (EPA) has reviewed the U.S. Department of Energy's (DOE) Site Characterization Plan for the Yucca Mountain Site. This site is to be characterized for future possible use as a high-level nuclear waste repository. EPA generally agrees with the proposed characterization plan, and we believe it will provide the necessary data to analyze compliance with EPA's standards for the disposal of high-level radioactive waste.

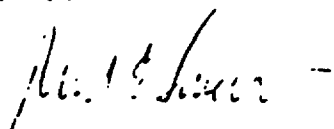
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2 The plan indicates that backfill is not required in the repository for hydrologic reasons. However, backfill and seals are deterrents to human intrusion for those time periods when institutional controls can no longer be relied on.

3 EPA strongly supports DOE's commitment to carry out performance projections for 100,000 years, even though such projections are not required. In addition, we recommend that DOE determine the origin of the calcite-silica veins found in the Yucca Mountain area, since these deposits relate to the geological history and tectonic stability of the site. Additional detailed comments are enclosed for your use.

We appreciate the opportunity to comment on the Plan, and, if we may be of further assistance, please contact me or Mr. Richard Guimond (475-9600), the Director of EPA's Office of Radiation Programs. The respective contacts on our staffs are Dr. W. Alexander Williams (382-5909) and Ms. Priscilla Bunton (475-9633).

Sincerely,



Richard E. Sanderson
Director
Office of Federal Activities

Enclosure

"BEST AVAILABLE COPY"

DETAILED COMMENTS OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY
ON THE U.S. DEPARTMENT OF ENERGY'S
YUCCA MOUNTAIN SITE CHARACTERIZATION PLAN (SCP)

GEOLOGY

4 1. Emphasis should be placed on determining the origin of the calcite-silica veins found in the Yucca Mountain Area because this relates to the question of tectonic stability. A U.S. Geological Survey refers to the calcite-silica veins as "hydrogenic" which infers that they could be the result of either descending surface waters or ascending hydrothermal waters from tectonic events. One theory is that the deposits might be hydrothermal and related to Quaternary volcanism. The concern is that hydrothermal activity at or near the site could corrode the waste package and accelerate release of radionuclides to the accessible environment. The resolution of this concern is significant in determining site suitability. To determine the origin of the calcite-silica veins, more focus should be given to the study of other types of minerals in the area, which could yield clues as to the origin of the calcite-silica veins. Also, the study of magma production in the area is important because it relates to tectonic stability.

HYDROLOGY

5 2. Our hydrology review focused on the matrix and fracture flow characteristics of the saturated and unsaturated zones in relation to the travel time of groundwater from the potential repository horizon to the accessible environment. Although investigations are planned for "characterization of the regional ground-water flow system" in section 8.3.1.2.1.3, the SCP does not indicate any specific plans to determine the boundaries of the subbasins which make up the hydrographic study area. These boundaries are necessary to fully understand the effects of potential hydrological changes in the region. Three subbasins, the Oasis Valley Subbasin, the Alkali Flat-Furnace Creek Ranch Subbasin, and the Ash Meadows Subbasin, make up this area. The boundaries have been inferred "from potentiometric levels, geologic controls of subsurface flow, discharge areas, and inferred flow paths." Suggested methods which could assist in determining the boundaries are: (1) using flow nets to determine the direction of groundwater flow; and (2) performing pump tests, such as the Boulton method, to verify the results of the drawdown recovery method. Other methods which could be used in determining boundaries are: (3) collecting rainfall data along the gradients; and (4) using different methods for measuring evapotranspiration by determining run-off, recharge and precipitation to validate results.

6 3. Although the SCP includes plans to investigate the groundwater flow system in the saturated zone, the methods for the investigations should be more explicit, such as indicating the type

and number of pump tests to be run, with justification for the type of pump test selected.

4. In the unsaturated zone, the flow characteristics should be measured to determine where and when fracture flow characteristics dominate over matrix flow characteristics.

CONCEPTUAL REPOSITORY DESIGN

5. Several areas of chapter 6 indicate that backfill is not required in the repository for hydrologic reasons. However, while the design for closure currently includes backfilling the underground openings, from section 6.2.7, "the need for backfill must be assessed based on the stability analyses of the underground openings and the analyses of the hydrologic conditions within the repository." Another factor to be considered in the need for backfill is using it as a deterrent for human intrusion, along with the seal system, even if it is found that backfill is not required for stability or hydrologic reasons.

CONCEPTUAL WASTE PACKAGE DESIGN

6. Many uncertainties are addressed in the conceptual design, and while this design may exclude certain events which appear to have a low probability of occurrence, the final design should consider all investigation results during the final design process to ensure that no conditions or events have been overlooked. Specifically, on page 7-8, a design condition for the waste package is that it is assumed to be subject to a pressure of one atmosphere. This design condition gives no consideration to the potential for faulting effects on the waste package, which could cause the package to be subject to a pressure greater than one atmosphere. Faulting effects are not identified as being design uncertainties in chapter 7, although the SCP does include faulting in the investigations of section 8.3.1.8.2, which studies effects of tectonic events on the waste package. The integration of the design conditions in chapter 7 and the results of these investigations is unclear.

PERFORMANCE ASSESSMENT

7. Compliance with EPA standards. With regard to assessing the system's long-term performance after closure, the Department has described a very comprehensive and systematic approach towards determining compliance with the EPA disposal standards that were published in 1985. This approach will consider a wide range of potential release scenarios, but with appropriate analytical simplifications and with screening procedures to avoid considering scenarios that should not contribute significantly to the overall analyses.

We have one concern with the approach towards determining compliance with the containment requirements (section 191.13). On page 8.3.5.13-23 of the SCP, the Department states that:

In calculating the CCDF, the DOE intends to take into account all those natural processes and events that are sufficiently credible to warrant consideration. (emphasis added)

10 The implication of this sentence and the following paragraphs is that processes and events that might be initiated by human activities will be treated in some different, separate way. We recognize that very different types of uncertainties will apply to natural and human-initiated events, and it will often be appropriate to study them separately while planning site characterization. However, we want to make it clear that the containment requirements will apply to the total projected releases from all significant processes and events, and that the CCDF to be used to determine compliance must incorporate both natural and human-initiated processes and events. Compliance may not be considered separately for these two categories.

11 8. 100,000-year performance projections. On pages 8.3.5.18-21 through 18-27, the SCP describes the Department's approach for carrying out performance projections for 100,000 years, as discussed in 10 CFR 960.3-1-5. EPA wants to strongly endorse DOE's continued commitment to do these very long-term projections, even though they are no longer strictly required after passage of the NWPAA. A very useful approach for these analyses was established in 10 CFR 960, and proceeding with them will add confidence to the site characterization process.

12 9. External review of performance assessment methods and results. In many places throughout section 8.3.5, the Department refers to peer reviews of analytical models and data and to the professional and expert judgments that will be needed to do the performance assessments. EPA agrees that such judgments and reviews will be an essential part of the process, and we want to encourage the Department to include a wide spectrum of participants from many organizations in these reviews. In addition, the Department should do all it can to make the computer programs used available and accessible to all who might be interested in carrying out their own evaluations of the protection provided by the site.