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Distribution:
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To: R Johnson

Comments—EA
U.S. Department of Energy
Attn: Comments-EA
1000 Independence Avenue, S.W.
Washington, D.C. 20585

Dear Sir:

The Department of the Interior has reviewed the environmental assessments for the Richton Dome, Perry County, and Cypress Creek Dome, Perry County, Mississippi. Our detailed comments are in the enclosed attachment. We appreciate the opportunity to review these documents.

Sincerely,

Bruce Blanchard, Director
Environmental Project Review

Enclosure

1076

General

The opportunity to comment on the draft Environmental Assessments (EAs), the nine candidate sites for the first repository for civilian high-level radioactive waste is appreciated. These large, complex reports represent a meaningful contribution in terms of effort and time. The effort of preparation was obviously large, and available time was short, which might very likely have contributed to some significant shortcomings of internal consistency in the reports. There apparently was little time or manpower devoted to the cross checking of values or descriptions within individual reports. Since the time available for review and comment was also short, research of the background reference documents was not possible. Thus our reviews are necessarily based on the knowledge and experience of individual reviewers, bureau experience and expertise, and the content of the draft Environmental Assessments. Also, our experience at each of the candidate sites is vastly uneven, and the review comments reflect this unavoidable variation.

Three related basic issues that became apparent during our review of the EAs are (1) the modeling of hydrologic systems, (2) the identification of failure modes and the most likely pathways of radionuclide release, and (3) conclusions reached in the EAs are not supported by the data base. In regard to modeling assumptions, reliability of data, and limitations of results of the modeling of hydrologic systems should be better described. Such descriptions might help explain apparently inconsistent ground-water travel times given in different sections of the salt-site EAs as is noted in the specific comments.

The failure modes addressed in the EAs are simplistic. We are particularly concerned that all available geotechnical information available for the various host rocks apparently has not been used to assess the mechanical and thermal responses of the geologic and hydrologic systems to the repository. This is particularly true with regard to the sites where the host rock lies below the water table. The possibility that a response of these systems to a repository might be the opening of vertical pathways for fluid circulation is dismissed either summarily or by means of a partial and theoretical analysis. Probable flow paths from the repository frequently are determined on the basis of inconclusive data on head gradients, on restrictive assumptions on the nature of water-bearing zones, and on flow directions through salt units determined by the unsupportable assumption of Darcian flow through a uniformly saturated and homogeneous porous medium. In general, the conclusions of the EAs as a body appear to go well beyond what the data base justifies. Confidence in the objectivity of the reports will be enhanced by conservation, and demonstrated by closer adherence to what the data base can support. Conclusions are supported with little data in many instances. For example, values for effective porosity and dispersion are necessary to calculate radionuclide transport. Field measurements of those parameters are rare, yet calculations are made as if sufficient data were in hand.

We recommend the EAs should contain a comprehensive discussion of the schedule for various activities related to characterization and nomination of a site. The reviewer must understand what activities will be undertaken concurrently; those activities that will be phased; how review of completed studies will be undertaken; a description of the intermediate decision points in the characterization phase; and how sites being characterized will be evaluated during this process. We believe this important information is needed in the final EA to ensure that sites with presently unknown flaws could be eliminated from further study during the characterization phase. The discussions in Section 4, Expected Effects of Site Characterization Activities, should incorporate this information.

To address chapter 7 adequately requires not only solid, broad-scope technical experience but also an awareness of the needs, goals, and guidelines applied to The Civilian Radioactive Waste Management Program. Chapter 7 is being reviewed here as a unique element since the same text for this chapter appears in each EA. The results are presented separately and not in site-specific terms.

We have two concerns about the ranking system used: (1) the comparison uses different kinds of data, different qualities of data, and different distributions of data, assembled and evaluated by different teams for different kinds of sites; and (2) the ranking scheme which treats all issues of equal value does not seem to be fully defensible, because all concerns are not truly equal in isolating high level radioactive waste.

With regard to the first concern, it is unclear why sites, for which many geotechnical studies have been completed, have been compared to sites for which comparable studies do not exist. Generally, further investigation of a phenomenon, topic, region, etc., reveals increasing complexity over what had previously been described; also, even major new findings often accompany further studies. Therefore, in all likelihood, were the Richton, Deaf Smith, and Davis Canyon Sites as extensively studied as the Hanford and Yucca Mountain Sites, they might not appear as "favorable" in the analyses as the sparse data suggest. Accordingly, some ranking "penalty" probably should be assigned to these sites (Richton, Deaf Smith, and Davis Canyon) in both post and preclosure rankings prior to attempting a meaningful comparison with the Hanford and Yucca Mountain Sites. In addition, a) we wonder if the facts are accurate and complete as stated, b) whether the facts are correctly used and inferences based on them are correctly drawn, c) whether these facts and inferences are correct and fairly summarized and transferred from one chapter to another and into Chapter 7 in particular. We have noted many deficiencies during our review. Some of these deficiencies, such as unsupportable assumptions on ground-water flow provide key input for the rankings in Chapter 7. Accordingly, many of the rankings in Chapter 7 become questionable and may even be in error. Therefore we recommend Chapter 7 should discuss the effect of differences in the data bases among the sites in the comparable analysis. Such a discussion certainly is needed.

Furthermore, the EA's taken as a body are very uneven in treatment of available data. This is understandable to a degree, because each of the site EA's was prepared by a different team of experts describing sites that very considerably in physical characteristics. This unevenness introduces difficulties for the authors of Chapter 7 when using an "equal weight" decision process. There is a need to establish some common framework or operational procedure to obtain some comparability of facts for the sites. This may be approached by assignment of an "important factor" or a weighting to each of the elements of a site (such as elements of ground-water hydrology, tectonics, geochemistry).

Our second concern is that the comparative analysis in Chapter 7 does not adequately weight the favorable and potentially adverse conditions by their importance. Preclosure and postclosure factors are weighted virtually the same (49:51). Mistakes during construction and operation can, at least in principle, be corrected, but postclosure failures are unlikely to be remedied. Within each group of guidelines, the favorable and potentially adverse conditions are weighted equally. There is such a long list of different conditions that a condition of singular importance for one site receives no particular attention. The comparative analysis resolves into a vote-counting numbers game, as if each vote had the same importance, which is definitely not the case.

We recognize that a system of weighting is not easily created and the weights assigned to different conditions will be questioned. It is unclear whether any effort was made to evaluate an approach, as follows. For each of the sites determine an "importance factor" for each of the elements or characteristics of the site that must be used in the comparative analysis. These provide an initial basis for weighting the favorable and potentially adverse conditions individually for each site. As these weighting factors are necessarily judgmental, we recommend that various combinations of weighting factors be applied to determine if a consistent sequence of site rankings can be obtained. The use of Monte Carlo methods should be considered in this evaluation. If such a weighted evaluation process has not been attempted, we recommend that it be tried to determine whether or not the rankings remain stable when individual criteria are weighted. Another approach which would have merit in confirming the rankings would be to impanel a Delphi group. Both of these processes would tend to create a more defensible objective analysis of the sites, ultimately recognizing that subjective judgment is required to reach any ranking, no matter what method is employed. Therefore, we question the grades assigned in the Tables in Chapter 7 of each EA. We believe the addition of a U grade for unresolved would have better identified grey areas and urge this be considered in the preparation of final EAs. The following detailed comments on Chapter 7 point out examples where incorrect comparisons of site characteristics might have been made.

For example it is unclear how the "P" and "NP" scheme of table 7-1 furnish a basis for comparison. The data source for the table should be identified. We question the summaries entered into table 7-1 and others like it. For example, the trustworthiness values for some of the geohydrologic parameters for any of the sites based on preliminary results of studies to date should be presented. It is also unclear whether the benefits of the saturated versus the unsaturated zones have been compared.

Examples of concerns include Page 7-10, paragraph 1—On geohydrology, specifically on travel time to accessible environment, comparison for different sites: Very different data abundance, type of data (model, drill stem test, well data, etc.); different sites may have used different models and perhaps different factors for the margin of "conservative" safety allowance (this factor is cited as 10 for Hanford and Yucca Mountain for specific parameters, but may not be for others. We question whether a single PROSPECTOR type model can be used for all sites. For Richton Dome, travel time is apparently based on a stable and stationary salt dome. Possible diapir movement is covered under "favorable condition no. 2" of the comparison chart. For Richton Dome this criterion rates a P, favorable, but nothing is said about diapir movement.

Favorable condition no. 3 (page 7-12) is rated NP for five sites, but the treatment is much too brief. Here, with the admitted uncertainties, lie possible problems; the nature of the uncertainties and the likelihood of their resolution by preshaft studies and later shaft-based studies should be projected.

If only one of the four subconditions for favorable condition no. 4 is rated positive, the entire condition no. 4 is rated positive. It is unclear whether the four subconditions are of equal weight. We believe the rankings may not be the same for different types of host rock and hydraulic conditions. We recommend the expected flux be a factor in assessing the sites not withstanding the footnote on page 7-15. The assessments should address these issue.

By summarizing and ranking subcategories, such as geohydrology, possible interaction among the major factors (such as hydrology vs. geochemistry) is not considered. This problem must be addressed in the final assessment.

Geochemistry—Favorable condition no. 1—Concerning redox conditions of the sites—again we are faced with disparate bases of data and different uncertainties. The presence of methane and pyrite, etc., may not be pervasive, for instance.

Favorable condition no. 2—Discussion for Hanford concerns reducing conditions but for the other sites the condition is for sorptive properties of the matrix material. Sorptive property of host rock at Hanford is low. We do not understand how these distinct properties can be equated. Once rated, the basis becomes obscured and the reader/user is apt to accept the ratings as on a basis of commonality.

Favorable condition no. 3—Again, the same problem of how to (1) evaluate the individual factors, (2) rate their role for each site, and (3) compare among the sites, remain significant.

Favorable condition no. 4—Limiting release to less than 0.001 percent per year—is rated P for all sites. The bases are different—for all but Hanford it is the absence of water at the waste package; for Hanford it is the presence of reducing condition; high pH, and reduced corrosion of metal overpack (page 7-20). These are different factors, with different reliability. We also recommend the assessments investigate the availability of geochemically compatible and feasible backfills for different kinds of media.

Rock Characteristics (postclosure)—This factor should be prefaced by a statement of the expected magnitude of the thermal pulse for proper evaluation. This important consideration has been omitted. Possible changes in the geologic framework and hydrologic system as a result of the heat load from the emplaced waste should be given intensive attention in future studies. Attendant uncertainties should be explicitly explained in the final assessments. In particular, possible changes in ground water circulation and flowpaths, fracture development, aperature changes of existing fractures, hydrothermal alteration of rock, and vertical and horizontal movement of the rock and land surface should be addressed.

Not just the geohydrology but other properties, specifically postclosure rock characteristics, vary directly as the result of differences between saturated and unsaturated zones. Yet other than in the section on Geohydrology, the differences for these two types of sites are not clearly spelled out (an exception is the recognition of sealing by ductility, page 7-25).

Potentially adverse condition no. 1—It is unclear how the possible stability problem at Hanford is not expected to affect the containment capability. The document states this on page 7-25 without citing the basis for the conclusion.

In the ranking summary section, the possible importance of "potentially adverse condition no. 2" is not given thorough treatment. The possible brine migration effect is allowed in the discussion under that heading, but without apparent justification other than the statement that "these phenomena are not expected to have significant effects at any of the sites," dismissed in the summary discussion. Further, the report states that the salt sites are rated higher because of lack of significant adverse properties. Both statements directly contradict the earlier, more specific discussions. This discrepancy must be investigated and supported.

As stated earlier, the question of developing weighting factors cannot be overemphasized. The almost unmanageable list of different conditions (favorable, potentially adverse, etc.) almost dictates that any single item on the list runs the risk of being forgotten. Thus it appears to become a numbers game with vote counting, as if each vote has the same importance. However, this is manifestly not so. An adverse condition on brine migration in salt should have overwhelming importance if it is present; a corresponding overwhelming factor for basalt might be the postclosure hydrology. The present report completely overlooks these partly judgmental factors. As a result, we believe the rankings might be unrealistic.

Potentially adverse condition no. 1—We question whether the following factor is worth worrying about. If precipitation and runoff rise significantly in the next 100,000 years, could new perched aquifers be created in what is now the unsaturated zone? If so, and if the repository shaft passes through this new aquifer, that could be a cause for concern.

Erosion—Favorable condition no. 3 is readily the important one. As long as the waste is unlikely to be exposed, the primary function of the repository will be fulfilled, thus the other two are insignificant. They merely help to ensure that condition no. 3 is fulfilled in the absence of more direct data. The three conditions are not equal and should not be so listed or compared.

Favorable condition no. 1—Could be rated NP (as is the case for NTS), but if the site is one of depositional aggradation, then it should not pose a problem (may pose one in case of rapid deposition, if a particular horizon is thereby pushed down into the underlying water table; if this should be a topic of concern, it isn't discussed).

Favorable condition no. 2—Wording could, in combination with condition no. 1, be construed to mean that erosion at Hanford during the next 10,000 years could amount to 450 m.

Potentially adverse condition no. 1, page 7-35—This reference to deposition during the last glacial period implies changes in hydrologic conditions resulting from climate effect. Under the latter heading, the only reference (page 7-31) refers to "changes" without any specifics. Taking these two entries together, could imply there's more to the story, for instance infiltration of ground water and resultant changes in permeability, sorptive properties (due to different material in fractures), flux, etc.

Qualifying conditions—The reason for making the qualitative distinction between Hanford and the other sites is not obvious; this point accents the concern about the basis for comparison among the sites.

Dissolution—Potentially adverse conditions and favorable conditions—the presence of breccia pipes, etc., at the three salt sites being conceded, the important task should be to ascertain the age of these activities. Right now the responses given to the two issues above for the three salt sites are not consistent.

Tectonics (postclosure)—Potentially adverse condition no. 1. Diapirism was included in the listing, but no evaluation was given for the salt sites. This might affect the ranking.

Human Interference—No more than passing mention of artificial markers. Are there any site-specific factors affecting the use of artificial markers?

Potentially adverse condition no. 1—What are considered as resources today may not be what people will seek in 5,000 years. Think of oil or coal in the pre-Marco Polo western world, or rutile, or uranium, or bauxite (or, in the foreseeable future, anorthosite). Our present conception of resources is no reliable guide for future explorers. Also, we believe the proximity to a National Park is a significant factor that should be considered under this heading.

Postclosure Systems Guidelines, Pages 7-53 and 7-54—No mention is made of whether the same waste form is assumed for all the sites, or whether waste forms and waste packages are tailored to the sites. We believe one should assume that the decision made in 1984 on the once-through uranium cycle, without reprocessing, will be valid in 20 years. Assessment of the qualifications of sites for use sometime in the 21st century probably should include the option of disposal of reprocessing waste, both hot and cool. Therefore, the assessment is thus quite uncertain and the site comparison may be prejudiced. Page 7-54 states that the waste packages are expected to last "indefinitely." This assumes a dry repository. Possible brine migration or possible electrolytic reaction of waste with water has not been considered. In the EA report for Davis Canyon, the authors mention (pages 6-92 and 6-93) 25 and 8 liters of brine accumulation per emplacement for cooled high-level radioactive waste and for spent fuel rods, respectively, in 100 years, and conceded that "...the presence of brine is expected to cause some corrosion of the waste cannister." Surely, such factors could and should be given thorough consideration and not merely be counted as a vote.

Radiological Hazards, Favorable condition no. 1, population density should address transient populations. For example, this factor might affect the density for Davis Canyon.

Site Ownership and Control—The rankings seem highly artificial to us. Other than top-ranking Hanford, we cannot agree with the priorities. An Act of Congress is required to transfer lands controlled by this Department. We question the success of a process of eminent domain.

Meteorology—This discussion is an example of the comparison (admitted by the authors of the report) of different kinds of data or absence thereof. The sites cannot be ranked on this basis.

Cost—It is not clear whether the cost includes the construction of transportation facilities to the sites and special transportation vehicles. This cost category is not listed under either "construction" or "operation." Transportation costs may vary greatly among the sites.

Format

Topics are difficult to follow because data and interpretations commonly found grouped in a technical report by discipline are scattered throughout several chapters. This is especially notable for geologic and hydrologic matters. Summaries of individual disciplines should be presented thus facilitating a more complete understanding of what is known and what must still be discovered. Alternatively, a detailed index in the final EA could help alleviate the problem. One or the other is necessary for a meaningful exposition of what is known.

As a basis upon which to develop some perspective on the overall quality of presentation, one report, Swisher site, was scanned intentially for internal consistency. This exercise revealed literally hundreds of inconsistencies and contradictions. If this report is representative of the entire group, the Environmental Assessments need a greal deal of hard work before final release. Details of this scanning effort are not provided. But they could be made available upon request should they be considered of value later.

In the interest of utility and effectiveness of the document, the reader should not be required to turn each assessment more than 90^{o} in order to read the material. Some tables are upside down requiring a turn through 180^{o}. It is also possible to find an illustration oriented with words right side up only to find a table on the next page printed upside down. Illustrations and tables in this text should be identically oriented.

Specific Comments

Fluid movements in salt—Darcian flow through salt units is assumed for purposes of ground-water travel time calculations, determination of most likely flow paths to the accessible environment, and performance modeling. Hydraulic gradients in salt units are calculated in the environmental assessments as if hydraulic heads in adjacent hydrologic units were dissipated across the salt units. Flow velocities through the salt units are calculated using permeabilities inferred from regional ground-water flow models or measured on core samples.

Because salt is a plastic medium, the assumption of Darcian flow is unreasonable. Other driving forces such as rock stress and temperature are more likely to produce fluid movement. Hydraulic heads in hydrologic units separated by a salt unit cannot be related through a hydraulic gradient across the salt, as if the salt were a porous medium. Permeability estimates of salt units from the gross regional ground-water flow models are suspect, as are laboratory permeability measurements made on core samples that were subject to in situ conditions not duplicated in subsequent handling and analyses.

We acknowledge that the assumption of Darcian flow through salt is a conservative analysis as far as calculating the magnitude of flow velocities in the salt. However, inherent in this assumption is the concept that ground-water gradients define the direction of the most probable pathway of radionuclide transport through the salt. On the contrary, pathways through the salt are most likely to be determined by differential stress, both in situ and resulting from effects of the repository, temperature, and other possible failure models.

Salt storage piles—A potential environmental impact at each of the salt sites is the presence of extensive salt storage piles. The assessments assert that any deleterious effects at these piles can be mitigated, but this conclusion is not based on in-depth analysis. Important to the conclusion is the assumption that a crust will form at the surface of the salt and provide protection from dissolution and erosion. Operating experience and/or theoretical studies should be cited to demonstrate that such a crust will form and would be effective under the specific climate conditions at the various salt sites.

A liner beneath the salt pile will be relied upon to provide long-term protection for ground water. A review of past and ongoing experiences where such liners have been used, including an evaluation of their effectiveness and the length of their useful life, should be conducted. We are not aware of any practical experience with such liners for the time periods of decades involved here. Any leachate through the liner is assumed to have total dissolved solids (TDS) of 35,000 parts per million (ppm). However, concentrations 10 times this value seem entirely possible.

Caprock—It is assumed that caprock is virtually impermeable and serves as a barrier against salt dissolution at salt domes. In our opinion this is not a valid assumption. Water is known to occur in fractures and solution openings in the consolidated caprock and is present in the unconsolidated anhydrite sands at the top of each salt stock being considered as is indicated by the test drilling conducted as a part of this program. Further indication of fracture and solution porosity in caprock is the zones of lost circulation encountered in drilling caprock. Also the presence of gypsum stringers which are common in the anhydrite caprock indicates that hydration of the anhydrite caprock along fractures is a common feature. Hydration of anhydrite requires water of low ionic strength to permit gypsum to form. Whether the source of the water is water of low ionic strength in units adjacent to or overlying the caprock, somewhat more saline water from formations at depth, or a combination of these sources has not been determined. In any event the available evidence strongly indicates that caprock is characterized by fracture and solution porosity and is capable of transmitting water. It follows that the hydrology of the caprock is an important factor concerning both potential radionuclide migration and salt dissolution at each salt dome and will require careful characterization at each site.

Near dome hydrology—The ground-water hydrology near any of the domes is virtually unknown. Knowledge of the near dome ground-water hydrology is necessary to define the probable pathways of radionuclide movement and to determine dissolution rates at the dome. Pathways described in the EAs indicate lateral movement away from the dome through aquifers at repository depths. Given a vertical head gradient, porous and permeable caprock on the dome, it would appear that nuclides upon arrival at the margins of the salt stock could move vertically as well as horizontally, and this vertical pathway might dominate nuclide transport.

Wetlands Impact

The proposed construction associated with development at the Cypress Creek site and 18 acres of wetlands at the Richton Dome site will have significant adverse impacts on about 200 acres of wetlands. The Department of Energy should further quantify these impacts and develop measures to compensate for the loss. Any costs for acquisition or operation and maintenance associated with compensation should be borne by the Department of Energy for the period the site is in operation.

Richton Site

Page 3-73 - Sidewall cores obtained from unconsolidated or semi-consolidated sediments, such as the units near Richton Dome, are likely to be damaged and thus probably will not provide reliable information on porosity.

Page 3-77, paragraph 5 - A component of upward flow from the confined aquifer units exists north of Richton Dome, as well as to the south.

Page 7-59, first pargraph - Favorable condition no. 2, Remoteness - 10-20 miles cannot be construed as remote.

While following comments apply to both Richton and Cypress Creek, the page numbers are referenced to the Cypress Creek EA.

Pages 3-4 and 3-7, Regional Geology - It is unclear why Kreitler and others, 1981, and Seni and Jackson, 1983 are used as primary references on evolution of regional structure and salt domes. We do not agree that these reports are primary references, however authoritative they may be. The inclusion of the reference, "Lerner, Peter," on development of salt structures in the Gulf Coast basin is recommended.

Page 3-7, paragraphs 2 to 4 - The discussion of subsidence and sedimentation in the Gulf Coast Geosyncline is obscure and is not sufficiently referenced to figure 3-4.

Pages 3-73 and 3-74, section 3.3.2.2., Modeling - Conclusions on flow gradients and flow directions came solely from the model developed by Ertec, 1983a. However, the performance assessment calculations in Chapter 6 are made on the basis of modeling by Intera. Intera's model should be described in this section on Modeling also. Also noted is that the area modeled by Ertec is not described.

Page 3-74, section 3.3.2, Ground-Water Quality- This discussion is written strictly from a suitability-for-use standpoint. A description of the relationship of water quality to hydrology would reinforce conclusions drawn on the character of the ground-water flow system.

Page 4-23, section 4.1.1.1.13 - The use of the hole-to-surface resistivity method to investigate the overdome sediments requires an uncased drillhole. The method is not applicable to the salt dome itself. The execution of a hole-to-surface resistivity survey in the engineering design borehole will require careful scheduling.

Page 4-44, last paragraph - It is stated that the Citronelle and Hattiesburg Formations and the caprock, which are water-bearing, will be stabilized by freezing. The water-bearing properties of the caprock should have been described in Chapter 3. If the caprock contains a brine, explain how it can be reasonable to expect that it can be frozen.

Page 6-84, paragraph 3 - A modeling result that shows direction of ground-water flow within a dome based on aquifer heads in a regional ground-water model is meaningless. The final EA should revise this result.

Page 6-90, section 6.3.1.2.3 - It is stated under item (2) "Evaluation" that the host salt has minimal sorption capacity and that sediments surrounding the salt dome will provide sorption capacity of an undetermined degree. However, in section 6.3.1.2.5, Conclusion for Qualifying Condition, it is stated that any releases of radionuclides from the waste package are expected to be retarded by geochemical conditions within the dome and in surrounding units. This discrepancy should be resolved.

Page 6-131, section 6.3.2.3.1, Waste Package Lifetime - It is stated that external stress will be controlled by lithostatic pressures which are a function of depth. Pressures generated by creep and thermal expansion can be much greater, as is described on p. 6-196 under "Boundary Stress" and in figure 6-14. This issue should be further developed in the final EA.