To: J. J. Peshel, WMEG, U.S. Nuclear Regulatory Commission
From: J. Daemen JD
Re: Statutory Environmental Assessment for Richton Dome Site, Perry County, Mississippi--Fourth Draft--June 6, 1984.
Date: 9-29-84

This review is based on an incomplete reading of the subject document, with only minor checking of the supporting references.

All the major comments made here apply to the Vacherie dome EA as well (and complement the major comments on that EA made in my review of 8-17-84). Many of the minor comments, with appropriate changes in page numbers and occasional details, apply to the Vacherie EA also. The Richton and Vacherie EA's clearly have much in common.

Major Comments

1. Penetrations (boreholes)

A large number of penetrations (boreholes) of an near the dome have been drilled in the past and are planned for field studies. This has to raise concerns about the risk that holes might affect repository operations (water inrushes) or waste isolation (dissolution). Problems that need to be addressed:
-have all holes been identified?
-what are the risks of water infiltration, salt dissolution, and possible eventual water inrushes resulting from holes?
-how will these holes be plugged, what are the plug design criteria, and how will assurance of satisfactory performance be established?

2. Retrievability

Retrieval concerns are addressed only in an extremely superficial approach. The repeated implication that retrieval is trivial, i.e. mining in reverse, strongly suggests that major retrieval problems are not even conceptually recognized or acknowledged.

3. Site-specific information

At present site-specific geotechnical information is minimal. An assessment of repository performance at this site, especially with regard to geomechanical and design aspects, must rely almost exclusively on generic salt dome behavior. Similarly, surface structure (foundation) behavior can be described in broad generic terms only.

4. In situ testing at Exploratory Shaft

Descriptions read as a broad statement of intent to do some testing, not as the summary of a more detailed test plan. Tests appear to be limited to an absolute minimum.

5. Site suitability

As noted on p. 6-7 of the EA, fourth paragraph, many aspects of site suitability can not be addressed to any significant depth due to present information limits. As a consequence, many findings appear premature.

6. Use of references

A spot check of a few references suggests a strong tendency in the EA to bias the referenced information by using the most favorable information only. This suggests the desirability of performing a more systematic comparison of the information provided in the EA with that in the references and, especially, in independent sources.

Detailed Comments--Chapter Three

3.1. 3.1 location, general appearance and terrain, and present uses.
Is Richton 4 kilometers or 1.5 miles from the boundary? 2.5 miles (=4 km) is given on p. 3-110.

3.2. 3.2.1 Regional Geology
The repeatedly used Censozoic presumably refers to Cenozoic

3.3. Figure 3.4
It would be helpful to indicate the location of the Richton dome.

3.4. Figure 3.6
Virtually impossible to read

3.5. 3.2.3.2.3. Caprock and Salt Stratigraphy
p. 3-26 last paragraph--p. 3-26 top paragraph
It would be highly desirable to establish the relation, if any, between Richton and the Five Island domes. It would be desirable to give some estimate of the probability that inclusions might be present at Richton, and of their frequency (distribution) in the Five Island domes.

3.6. 3.2.5.2. Seismicity
p. 3-34; next to last paragraph
Has the seismicity assessment included the effect of production from nearby oil and gas reservoirs, possibly at greater depth, and with secondary or tertiary recovery methods?

3.7. 3.2.5.4. Uplift and Subsidence
The contradiction between the two uplift estimates needs to be resolved. In particular, it needs to be ascertained whether it is possible that a temporary very high uplift rate might occur during long periods of low average uplift rates.

3.8. 3.2.5.5. Folding
p. 3-38, fourth line from bottom.
Figure 3.2-11 probably should be Figure 3.14

3.9. 3.2.5.6. Salt Dome Development and Geometry
p. 3-40, second paragraph

It would be desirable to indicate explicitly what the relevancy is of the East Texas Salt Basin for Richton: should one expect similar rates, or are there reasons to suggest that the Richton dome rates might be faster or slower.

3.10. 3.2.5.6. Salt Dome Development and Geometry
Fig. 3-17, p. 3-41.

There are significant differences between the dome contour at the -2000 ft. and -4000 ft. level given in this figure and in figure 13-37 of OWWI 120. It is possible that (Earth Technology, 1984), to which I do not have access, resolves the discrepancy. Does this difference reflect some actual uncertainty about the dome shape?

3.11. 3.2.5.7. Dissolution

An important problem, which needs careful review, in particular of (Bentley, 1983).

3.12. 3.2.5.7. Dissolution

This section only reviews dissolution in the past. An assessment will be needed what future dissolution might occur, in particular the effects of the repository (e.g. uplift, subsidence) on caprock and on dissolution, the effects of penetrations (boreholes, shafts, and the effects of groundwater flow pattern changes (e.g. thermal effects).

3.13. 3.2.5.7. Dissolution
Figure 3-18 and p. 3-42, last paragraph.

What is depth of shallow borings, deep wells, and sampling depth?

3.14. 3.2.5.7. Dissolution
Table 3-2, p. 3-44, note (c)

Why are data from wells MCCG-1, MCCG-2, MCCH-3 excluded? (Check Bentley, 1983).

3.15. 3.2.5.7. Dissolution
p. 3-45, second and last paragraph

The estimated maximum dissolution rate appears to be the maximum <u>average</u> dissolution rate. Could rates temporarily be much higher?

3.16. 3.2.6.1. Geomechanical Properties.

The introductory paragraph on p. 3-46 clearly is too simplistic, and, in fact, Table 3-3 lists properties not included here.

3.17. Table 3.3-pages 3.47/48

Data basis is extremely limited.

3.18 3.2.6.1.2. Geochemical Properties of Caprock and Salt
p. 3-49, last paragraph

The average stress gradient proposed by Hoek and Brown, 1980, p. 99, is 0.027 MPa/m (1.2 psi/ft), significantly higher than the 0.023 MPa/m (1 psi/ft) given in the EA. Lindner and Halpern (1977), give three equations, two of which, including the one they themselves propose, give substantially higher rates (1.47 psi/ft).

Hoek and Brown include one data point from a Louisiana salt dome, for which the rate is indeed 1 psi/ft. Lindner and Halpern include one measurement from a Louisiana salt dome, but give no details.

Given the lower density of salt, it is not unreasonable to assume 1 psi/ft is representative. This statement can not be supported by the references given here, however. If other measurements have been made, it would be preferable to cite them directly.

3.19. Table 3-4, p. 3-50, note (c)

Does "typically" imply always or not always--if not, why not give the actual number of tests?

3.20. Table 3-5, p. 3-51

Second and third set of numbers would be more meaningful if the Mises-Schleicher criterion and the creep law used were listed also.

3.21. Figure 3-19, p. 3-52

What types of tests have been performed to obtain the stress circles that intersect the vertical axis?

3.22. Figure 3-19, p. 3-52

Note the extremely drastic strength reduction with temperature.

3.23. 3.2.6.2. Thermal Properties

This section refers several times to BMI/ONWI-522. It is of considerable interest to read in BMI/ONWI-522, on p. 15, the severe difficulties encountered in preparing samples from Richton dome core. These difficulties suggest:
-Richton dome might have very weak caprock and some very weak salt beds
-Samples and hence thermal properties might be highly biased towards strongest formations
-Sample selection and preparation for mechanical properties testing needs to be reviewed in order to assess whether mechanical properties obtained are representative.
-Data on thermal decrepitation is highly suspect, given that only the strongest samples could be tested.

3.24. 3.2.8.1. Hydrocarbons
p. 3-63, third paragraph

The fact that Shell No. 1 Masonite identified over 30 meters of tar sands suggests very strongly that sooner or later someone might be interested in trying advanced recovery techniques. (Karges, 1975) needs to be checked in order to determine why no production was established, even after it had been deemed justifiable to perform extensive testing. Certainly, if Shell deemed it justifiable, at pre-1975 prices, to perform extensive testing, this does suggest that the potential for future hydro-carbon reserves might not be as low as suggested here.

3.25. 3.3.1.3. Flooding

Because a number of mines and mine shafts have been lost due to flooding on the surface, it would be highly desirable for NRC to review independently the flood data, and to make certain that the engineering group is fully aware of the most severe conditions that might be encountered at shaft sites. This will allow an assessment of the adequacy of shaft flooding preventive measures.

3.26. 3.3.2.1.1. Geohydrologic Units

It would be highly desirable to establish explicitly the relation between Figure 3-28, Upper Aquifer, and Table 3.3. (pages 3-47/48), Estimated Geomechanical Characteristics of the Overburden, :Richton Dome. There appear to be significant differences in the lithologic character descriptions of the overburden between the two, as well as some differences in porosity.

3.27. 3.3.2.1.1. Geohydrologic Units

Last sentence of this section, p. 3-88: check justification for the Midway being an effective confining barrier in ONWI-456, pp. 21, 24.

3.28. Figure 3-30, p. 3-90

It would be helpful to indicate the location of the Richton dome on this map.

p. 3-183

Is third reference from bottom, Law Engineering Testing Company, 1980, an ONWI-report?

Detailed Comments--Chapter Four

4.1. 4.1.1. Field Studies--Table 4.2, p. 4.6

It appears that a large number of holes might be drilled into or near the dome. Potential water infiltration, salt dissolution and borehole sealing problems associated with these holes need to be addressed.

4.2. 4.1.1.1.4. Monitoring and Sampling of Wells p. 4-14 and Figure 4-5, p. 4-16.

What is the depth of the deep wells, and what is the depth of the dome/caprock at these well locations?

4.3. 4.1.1.8. Flank Stratigraphic Boreholes p. 4-17 and Figure 4-7, p. 4-19.

Is it the intent to have these holes penetrate the caprock and/or dome salt? How close are they planned to be?

4.4. 4.1.1.15. Sulfur Exploration Wells pp. 4-23, 24

Is there reasonable assurance that all sulfur exploration wells are known? The discrepancies between this section (32 wells into caprock, depths to 570 m) and Table 3-68 (30 wells into caprock, depths to 792 m) obviously are not reassuring in this regard. It must be considered totally unacceptable that one or more boreholes may be reentered, and then only if the surface conditions are found to be in poor condition!

Will plugging in accordance with state regulations provide reasonable assurance that the sealing will remain satisfactory during deformations, temperature and flow-path changes resulting from repository construction and waste emplacement?

4.5. 4.1.1.2.3. Surface Facilities Foundation Boreholes

Presumably several typographical errors: Cone (not core) penetrometer tests, measurements of soil (not salt) properties?

4.6. 4.1.1.2.5. Near-Shaft Hydrologic Test Wells

In section 4.1.1.1.9. (not 4.1.1.9. as cited here) on Dome Area Stratigraphic Boreholes no firm commitment is made to any hydrological testing.

Considering that the stated objective of the work outlined in this section is to obtain detailed knowledge of the aquifer characteristics, the description of the proposed work is extremely vague and noncommital.

4.7. 4.1.2. Exploratory Shaft

It is important to note that the objectives of the exploratory shaft facility (ESF) are limited to gaining access to the potential repository horizon and to perform in situ tests--this does not include characterization of the ground along the shaft.

4.8. 4.1.2.2. Construction

The exploratory shaft will be constructed by large hole drilling (LHD), hence very limited exploration of the ground between the surface and the dome will be possible.

4.9. Table 4-3, p. 4-33

1 acre to hectare, multiply by 0.405 (not 2.47)

4.10. 4.1.2.2.2. Shaft Drilling

If mud will be needed to provide wall support while augering, why would it not be needed for clamshell excavation?

4.11. 4.1.2.2.4. Initial Underground Excavation.
p. 4-51

What salt conditions might make the use of a boom type continuous miner impractical?

4.12. 4.1.2.2.5. Expanded Underground Excavation

There is a (minor) implied contradiction here with the preceding section, which states that the initial test drifts will be excavated with a miner, while here it is suggested that hand-held drills (blasting) will be used.

It is peculiar to propose the use of a load-haul-dump vehicle in conjunction with a continuous miner.

4.13. 4.1.2.3.1. Site Suitability Testing

Impossible to judge. Vague.

4.14. 4.1.2.3.2. At-Depth Testing

Vague.
Nothing on retrievability.
Nothing on salt characterization.
Presumably a very preliminary statement of intent.

4.15. 4.1.2.4. Final Disposition

Second bullet on p. 4-59 is very unclear.

First bullet on p. 4-59 is so vague as to be meaningless.

4.16. 4.1.2.4.1. Subsurface Backfill and Shaft Stripping

Is there any evidence that an 80 percent density can be achieved with pneumatic stowing?

4.17. 4.1.2.4.2. Shaft Backfill

Will all casing (except top 9 ft.) remain in place?

How will a 3 m plug prevent seepage into the shaft?

Will the entire shaft be backfilled with mud?

Will the concrete plug below the intermediate casing float on the brine?

If this section is relevant to NRC, it needs to be questioned very critically. Even if it is not directly relevant, because it deals with abandonment of a shaft at a site not to become a repository, it has to raise serious concerns about any final shaft sealing plans.

4.18. 4.2.1.1.1. Land Use

p. 4-93, 4th paragraph: permanent preemption of 7 hectares (17 acres) or 1.2 hectares (3 acres)?

4.19. 4.2.1.4.2. Ground Water

p. 4-108, second paragraph

It is surprising and disturbing to see a statement in the EA that the effects of boreholes and exploratory shaft on ground water quality and ground water flow regime are unknown. This clearly implies that disturbances might be introduced that might have a long term unknown effect as well.

4.20. 4.2.1.5.2. Geology

Any experimental or other evidence that an 80 percent reduction in void space can be accomplished?

4.21. 4.2.1.5.2. Geology

Any possibility that fracturing, in combination with the ground water disturbances discussed in 4.2.1.4.2., might reactivate or accelerate dissolution?

4.22. 4.3.1. Alternative Exploratory Shaft Construction

This section is as amateurishly written as 4.1.2.2.2. on Shaft Drilling.

Relative merits of the two shaft sinking methods in terms of site characterization are not discussed.

Equipment requirements for this method obviously would be totally different, as would the site layout.

The drilling mud for the freezing holes will have to be disposed of.

Why do the mud pumps and compressors have to be diesel-powered, if electrical power can be provided for conveyor belts.

The emphasis on blasting noise and nitrogen oxides approaches the comical, given the many real dangers associated with conventional shaft sinking.

Why does the drill-and-blast method increase the difficulty of isolating aquifers, and if it does, what implications does this have for the production repository shafts? On what is this statement based, given that in 4.2.1.4.2. it is stated that the effects of shaft boring on ground water are unknown?

Detailed Comments--Chapter Five

5.1. 5.1.1.2. Repository Shafts and Ventilation System
p. 5-14, second paragraph

It is commendable that shaft and liner design and construction will take into account permanent closure requirements as well as operational sealing requirements.

5.2. 5.1.2. <u>Repository Subsurface Facilities</u>

It is to be noted that the main passageways will be substantially larger and have a fundamentally different cross section orientation (twice as wide as high) than do the test drifts in the expanded underground excavation (Section 4.1.2.2.5.).

5.3. 5.1.3.1.4. <u>Shafts and Facilities Development</u>

It is to be noted that a decision apparently already has been made that the main shafts will be sunk by drilling and blasting, after freezing. This is somewhat surprising in light of apparently equally firm commitment to bore the exploratory shaft. These decisions have a number of implications:

-considerably improved site information about the dome overburden will become available during the sinking of the main shafts

-it is possible that more damage will be induced to the main shaft walls than to the exploratory shaft wall, and that the damage will be of a different type, introducing some uncertainty in any extrapolations from the exploratory to the final shafts (e.g. stability, sealing).

-it is probable that the seal locations and the seal installation will be much better controllable in the final shafts than in the exploratory shaft

-permanent sealing of the freezer holes will require particular attention, especially if these holes penetrate the caprock and the salt-caprock interface.

5.4. 5.1.3.1.5. <u>Underground Development</u>

It is to be noted that present plans call for backfilling the storage rooms approximately one year after waste emplacement, and branch and main passage ways will be backfilled soon thereafter.

This has implications for retrievability, emplacement hole and room performance monitoring, temperature distribution.

5.5. 5.1.3.2.3. Retrievability

Retrievability will be maintained. No indication is given as to how, or how it might affect design, construction, and operation.

A commitment is made to demonstrate retrievability, but present plans suggest that this might well be sometime during repository operations.

5.6. 5.1.3.3. Decommissioning and Decontamination.

Broad statement of intent.

All repository horizon sealing with excavated salt.

Very vague statement on shaft backfilling and sealing.

5.7. 5.1.3.3.2. Subsurface Activities

Very vague.

Appears to imply that only one seal will be installed, at the caprock--the construction/operation phase includes seals "where required" to forestall aquifer interconnections (Section 5.1.3.1.4., p. 5-27).

5.8. 5.2.1. Geologic Conditions

What will be the subsidence and uplift at the dome-caprock interface, within the caprock, along the shafts (and boreholes), especially at shaft seal locations.

What strain will be induced in the caprock? Is there a risk of fracturing the caprock, thereby activating dissolution?

Are the WIPP and Paradox basin studies at all relevant for the Richton dome? (Thermal load, properties, salt geometry, etc.).

5.9. 5.2.1. Geologic Conditions

The planned backfilling procedure remains very unclear, even conceptually. According to section 4.1.2.4.1. it will be pneumatic stowing, according to 5.1.3.1.5. mechanically compacting and pneumatically stowing, according to this section mechanically backfilling and pneumatically compacting. And regardless of which procedure is used, an 80 percent void reduction will be achieved.

5.10. 5.2.1. Geologic Conditions

p. 5-41, second paragraph

It would be desirable to gain access to the evaluations that have been made of the potential impacts for salt dissolution, in particular with regard to caprock uplift and subsidence, and associated strains, with regard to penetrations (especially shafts, but also boreholes, especially in light of the potential for a very large number of holes) and seals, including the effects of subsidence and uplift, and the possible resulting differential movements between ground and seals.

I find no discussion in Section 5.2.2. that might allow an assessment of the seals, only a very brief and vague statement that water seals will be employed, and that ground-water protection measures will be incorporated as appropriate.

5.11. 5.2.2.1. Surface Water

The uplift and subsidence induced by waste disposal could affect surface water, flow, drainage, flooding, ground water table level, and these effects appear not to have been considered.

5.12. 5.2.2.2. Ground Water

"Vacherie" probably should read "Richton"

5.13. 5.2.2.2.3. <u>Decommissioning and Closure</u>

The conclusion reached in the summary that the hydrological regime will not be impacted in a major way might be premature in light of the statement in Section 4.2.1.4.2. that the extent and severity of the potential effects is not known at this time.

5.14. 5.2.3. <u>Land Use</u>

Probably should consider the impact subsidence and uplift might have on surface water distribution, water table, and hence land use.

5.15. 5.2.4. <u>Terrestrial and Aquatic Ecosystems</u>

Same comment as 5.14.

5.16. 5.2.6. <u>Aesthetic Conditions</u>

Same comment as 5.14.

Detailed Comments--Chapter Six

<u>Comment Number</u>

6.1. Section 6.2. SUITABILITY OF THE RICHTON DOME SITE FOR DEVELOPMENT AS A REPOSITORY.
Page 6.7, paragraph 5, line 1
Editing oversight

"Vacherie" probably should read "Richton"

Confirms that EA's are largely generic rather than site-specific

Suggest that "Vacherie" be replaced by "Richton"

6.2. Section 6.3.1.1. Geohydrology, Guideline 10 CFR Part 160.4-2-1.
Page 6-88, last category
Data interpretation.

The last sentence on this page and the first one on the next page state that laboratory measurements of hydraulic properties using salt-core samples are suspect because the nature of the salt can result in a relaxation of the crystalline structure once the confining pressures are relieved, and that thus unrepresentatively high permeability estimates may be measured.

The comment suggests that in-situ permeabilities may be lower than laboratory permeabilities. This conclusion does not hold for salt immediately adjacent to excavations, e.g. rooms, shafts, boreholes, as this salt will also be stress relieved, at least in one direction.

The statement might imply that a higher-permeability flow-path will develop parallel and adjacent to all openings.

The comment does not fundamentally affect the finding that the in situ permeability of salt is low.

The uncertainty could be removed by performing permeability tests on cores that have been recovered with pressurized core barrels.

6.3. Table 6-13. Favorable and Potentially Adverse Geohydrology Conditions For Guideline 960.4-2-1.
Page 6-91, (a) Qualifying Condition, first bullet.
Analysis uncertainty.

It appears that the finding is based on calculations in which it is assumed that the salt dome is uniform and has very low permeability everywhere. The calculations do not include anomalies (e.g. brine pockets, sand inclusions), nor their effect on travel times. At least some anomalies are very likely to be present, at least in the outer 100 to 200 meters of the dome. There is uncertainty in the ground-water travel time cited in the finding because it is based on a dome structure model that might overestimate the travel time.

It is recommended that travel time calculations be performed based on the assumption that typical salt dome anomalies are present in the Richton dome.

6.4. Table 6-13. Favorable and Potentially Adverse Geohydrology Conditions for Guideline 960.4-2-1
Page 6-93, (b), (c)

Inappropriate finding.

As the Richton Dome does not lie in the unsaturated zone, it is difficult to see how a finding can be made that a favorable condition for unsaturated zone disposal is found.

It is recommended to change the finding to "Not Applicable," in conformance with the last paragraph under (c) on p. 6-101.

6.5. 6.3.1.1. Geohydrology, Guideline 10 CFR Part 960.4-2-1.
Page 6-97, Third paragraph.

Simplified data analysis.

The dissolution rates used for the calculation are based on averages calculated over a period of 5 million years (page 3-45). The calculation assumes that the average is the same over the much shorter period of 100,000 years. If the true dissolution rate fluctuates around the average, it could be considerably higher for a shorter period.

It is recommended that DOE provide an estimate of the maximum likely dissolution rate over a 100,000 year period.

6.6. Table 6-15. Summary of Rock Characteristics.
Page 6-120, Thermal Decrepitation.

Inadequate data basis.

The observations on thermal decrepitation performed by Lagedrost et al., 1983, have been performed on unstressed rock salt samples. Given the drastic strength reduction observed at 100°C and 200°C (Fig. 3-19, p. 3-52), it might be expected that thermal decrepitation might be much more severe for loaded samples, and hence for the in situ rock salt.

It is recommended that thermal decrepitation tests be performed on rock salt (preferably from the Richton dome) loaded to stress levels corresponding to in situ conditions, and maintained for extended periods of time.

6.7. Section 6.3.1.3. Rock characteristics, Guideline 10 CFR 960.4-2-3.
Pages 6-125/6, 6.3.1.3.4. Analysis of Potentially Adverse Conditions

Incomplete discussion. Unjustified finding.

The conclusion in the first paragraph that no foreseeable rock conditions would require engineering measures beyond available technology is highly questionable in light of the fact that at least two salt mines and one shaft have been lost in this area due to floods. It is true that there is no evidence that this condition will be found, but neither is there evidence that it will not be found. Given the lack of site specific information, no finding can be made at this time.

This section should include a justification as to why major problems encountered at some salt mines are not likely to be encountered here.

This section should include a discussion of gas and brine pockets, of clay seams and clastic inclusions, i.e. of all the anomalies that might be encountered (last paragraph of Section 3.2.3.2.3.) and probably of faults and shear zones as well. In particular, any discussion of brine migration should at least address the issue of what might happen to large (or small) brine filled cavities in proximity of waste canisters.

Thermal degradation of clay might have to be considered.

The discussion of the effects of heat probably should include an analysis of the effect of dome uplift and subsidence, and of the resulting strain, on the caprock isolation performance.

6.8. Section 6.3.1.6. Dissolution, Guideline 10 CFR 960.4-2-6.
Pages 6-142-148

Incomplete evaluation.

This section does not include any evaluation or analysis of the effects a repository might have on dissolution rates, e.g. because of such influences as uplift, subsidence, temperature changes, convective flows, penetrations. The conclusions also rely heavily on the assumption that average dissolution rates calculated over a very long period of time can be applied as maximum rates for a much shorter period of time.

The conclusion (6.3.1.6.6.) and the dissolution rates projected there must be considered premature until a more comprehensive evaluation and analysis is performed.

It is recommended that DOE evaluate the influence of repository operations, especially waste disposal, on potential dissolution rates, and that DOE provide a better justified maximum dissolution rate over a 10,000 year period.

6.9. Section 6.3.1.7. Tectonics.
Pages 6-15, <u>Assumptions and Data Uncertainty</u>

Contradictory evidence.

The discrepancies between geodetic uplift estimates and the geologic data might be real, i.e. short term rates might fluctuate widely.

If it were demonstrated that short term uplift rates could be much higher than long term averages, this could negate the finding, which might therefore be premature.

DOE is to be commended for its intent to re-evaluate this subject.

6.10. Section 6.3.1.8. Human Interference and Natural Resources.
Page 6-101, next to last paragraph.

Contradictory data.

The comment that "sufficient records exist to know the depth and lithology penetrated by each hole" must be considered premature in light of the discrepancies identified in my comment 4.4. on Section 4.1.1.1.15.

These discrepancies cast uncertainty about the reliability of the knowledge of the holes.

It is recommended that the discrepancies in the hole descriptions be resolved, and the adequacy of the records demonstrated.

6.11. Section 6.3.1.8. Human Interference and Natural Resources.
Page 6-102, last paragraph.

Statement contradicting data. Inadequate evaluation.

The statement that "only minor hydrocarbon shows" have been detected directly contradicts the statement on p. 3-63 that "Shell No. a Masonite identified over 30 meters of sand containing heavy asphaltic oil." Moreover, the favorable condition concerns "resources that have or are projected to have in the foreseeable future a value great enough to be considered commercially extractable"--the analysis presented here does not make projections about how soon or under what circumstances these oil sands might become commercially extractable.

This contradiction does not change the finding that the favorable condition is not found, but reinforces it.

It is recommended that DOE re-analyze its position on hydrocarbon resources.

6.12. Table 6-21, page 6-103

(a) Qualifying Condition

Questionable conclusion drawn from contradictory data.

The first bullet could be questioned, given the contradictions and therefore uncertainty in number and depth of sulfur exploration wells, and given the very deep oil exploration wells.

It is recommended that DOE removes the contradictory statements regarding the number and depth of the sulfur wells, and provides convincing evidence that the record is complete.

6.13. Table 6-21, page 6-103

(b) Favorable Condition

Incomplete Finding

There is sufficient evidence of hydrocarbon deposits to have them considered.

It is recommended that DOE include a second bullet under the finding, to list hydrocarbon formations, or that DOE provide a projected evaluation that these formations will not be economically recoverable within the foreseeable future.

6.14. Table 6-21, page 6-103

(c) Potentially Adverse Conditions

Incomplete Finding

Identical comment as under 6.13.

6.15. Table 6-21, page 6-104

(c) Potentially Adverse Conditions, (3) Drilling

Questionable Finding

The claim that the "Potentially adverse condition is not found" appears premature in light of:

-contradictory statements about the number and depth of the sulfur exploration wells.

-unknown condition of sulfur exploration wells, especially plugging and casing

-undocumented condition of petroleum exploration wells

It is recommended that DOE resolve uncertainty about number and condition of wells before a firm finding is made.

6.16. Table 6-21, page 6-165, (d) Disqualifying Condition
Overstated conclusion

The last bullet states that no exploration wells penetrate the proposed repository level. Implied is within the salt dome. Six known petroleum exploration wells and, according to Table 3-10 at least one sulfur exploration well do penetrate the proposed repository level within a short distance from the dome. Although it is probably true that none of this would constitute a disqualifying condition, more information about these holes is needed to confirm this finding.

It is recommended that DOE clearly present the position of the holes with respect to the salt dome at the proposed repository level, as well as at some distances above and below it. It is recommended that DOE establishes reliably the present condition of the sulfur exploration wells.

6.17. Section 6.3.1.8. Human Interference and Natural Resources.
6.3.1.8.4. Analysis of Potentially Adverse Conditions.
Questionable evaluation.

The argument on p. 6-107 trying to justify the conclusion that no hydrocarbons are likely to be present appear to be largely irrelevant given the fact that the presence of 30 m of oil bearing sands already has been established.

It is recommended that ONWI-109 be reviewed critically, e.g. in light of the statements by Karges, 1975, that "Future drilling should establish significant reserves on shallow salt domes" (last sentence of abstract) and "Excellent heavy oil shows were seen in Lower Cretaceous sands on the flanks of D'Lo, Richton, and Midway Domes" (p. 181, first paragraph).

6.18. Section 6.3.1.8. Human Interference and Natural Resources.
6.3.1.8.4. Analysis of Potentially Adverse Conditions.
Page 6-168, (3), Evidence of drilling.
Superficial evaluation.

Considering the large number of holes, the contradictory information within the EA about the number and depth of the holes, and the admitted uncertainty about the conditions of the holes, it is recommended that this finding be re-evaluated.

6.19. Section 6.3.2. Postclosure System Guideline 960.4-1
Page 6-173, 6.3.2.1. Qualifying Condition
Implication of inadequate sealing commitment.

It is recommended to change "seal," third line from bottom, to the plural "seals."

6.20. Section 6.3.2.3. Engineered Barrier System
Page 6-180

Typographical error?

. . . release water . . . probably should be . . . release rates . . .

6.21. Section 6.3.2.4. Geologic Setting
Page 6-182, Geochemistry

Questionable or incomplete assertion.

The statement that the Richton Dome salt has low moisture content probably is based on an average consideration of microscopic inclusions. Locally, e.g. near brine filled cavities, it might not hold true.

It is recommended that DOE evaluate the influence of large brine filled cavities on geochemical repository performance.

6.22. Section 6.3.2.4. Geologic Setting
Page 6-182, Rock Characteristics.

Inadequate finding.

Contrary to the last sentence, almost all salt domes can be expected to have some adverse conditions, in particular various anomalies.

6.23. Section 6.3.3. Preclosure Technical Guidelines
Page 6-188, 6.3.3.1.4. Analysis of Potentially Adverse Conditions.

Incomplete Analysis.

It does not appear that the possible effects of uplift or subsidence induced by waste disposal have been taken into consideration in flood predictions.

It is recommended that DOE analyze the impact of subsidence and uplift on potential flooding.

6.24. 6.3.3.2. Rock Characteristics, Guideline 10 CFR 960.6-2-9.

Biased evaluations.

This entire section is permeated by extreme optimism, based on highly selective use of references. It is recognized that the site specific data presently available is too limited to allow firm findings, but it appears that only favorable generic information is used in these evaluations. Many examples can be given, e.g.:

°p. 6-141, Assumptions and Data Uncertainty

-Salt-mining experience does indeed indicate typically uniform composition, but also leaves very little uncertainty about anomalous zones adjacent to the dome flanks and in the dome interior.

-Given the very substantial strength losses with increasing temperature, as shown in Chapter Three (Figure 3-19), and given the high design temperatures on the disposal hole walls (250°C according to page 6-196, 292°C according to pages 6-250, 252, 253), re-excavation of storage rooms and canister holes will have to proceed very differently from initial repository excavation.

°p. 6-193, Table 6-25, (4)

-The statement that "creep could lead to difficulty in retrieval" probably is an understatement.

-The other phenomena that are not expected to cause any problems include high temperature and its effect on brine and gas pockets. On what basis has a finding been reached that this will not cause any problems?

-The other phenomena that are not expected to cause any problems include high temperature and its effect on ventilation and operational requirements. This initially certainly would cause severe retrieval problems.

°page 6-193, Table 6-26, (5)

-How can a finding be reached that the potentially adverse condition is not found, when page 6-195 states clearly, and when it is to be expected generically (i.e. from other domes), that gas and brine pockets are likely to be encountered.

°page 6-195, 6.3.3.2.4., (2)

-Dewatering and ground freezing are indeed proven technology, but on occasion have failed, specifically so in Gulf Coast salt mines.

°page 6-196, 6.3.3.2.4., (4)

-The thermal decrepitation base (Lagendrost and Capps, 1983) is extremely limited, based on a biased sample set, tested on unloaded samples for very short periods.

-According to pages 6-250, 252, 253, the emplacement hole wall will reach 292°C, well exceeding the 250°C design temperature given here.

-The wide range of potential problems to be overcome for retrieval are not really addressed.

°page 6-197, 6.3.3.2.4., (5)

The conclusion that a potentially adverse condition is not found is extremely difficult to justify in light of past salt mining experience in this area, during which probably all problems listed here have been encountered repeatedly. Kupfer, 1980: "Shearing in salt is universal." "Pressure pockets occur in all but one of the salt mines of Louisiana, the exception being mined at relatively shallow depth."

°pages 6-199, 200

It is true that in most mines water inflow has been controlled. It is equally true that a few mines in the region have had to be abandoned due to uncrollable water inflows.

It is recommended that DOE re-evaluate this section in light of the contradiction of many findings with past experience.

6.25. Section 6.3.3.2. Rock Characteristics.
Page 6-200, 6.3.3.2.6. Conclusion

Excessively optimistic conclusion.

The conclusion seems extremely optimistic, especially understated with regard to retrieval (last sentence of first paragraph), for which one problem only among many potential ones is singled out for attention.

It is recommended that DOE reconsider this conclusion, draw conclusions acknowledging that at present a large uncertainty remains. It is possible that conditions will be ideal, but they might be less than ideal.

6.26. Section 6.3.3.3. Hydrology, Guidelines 10 CFR 960.5-2-10.
Pages 6-201/202. Assumptions and Data Uncertainty

Vague construction options given.

It is recommended that DOE identify the other possible shaft construction techniques and other water-control techniques that could be considered.

6.27. Section 6.3.3.3.
Page 6-202, Analysis

Incomplete analysis.

It is true that successful shaft lining and sealing has been possible, but it is equally true that some mines and shafts have been lost because they could not be sealed. Hence it also is not just obvious that the second bullet in (a) of Table 6-27, page 6-203, is satisfied.

It is recommended that DOE complete this analysis by recognizing that serious sealing problems have been encountered in the past, and either modify its finding or develop arguments as to why it is sustainable.

6.28. Section 6.3.3.3. Hydrology
Page 6-204, Table 6-27, (c)

Finding only partially justified.

See comment 6.27.

6.29. Section 6.3.3.3. Hydrology
Page 6-204, (2)
Finding based on incomplete analysis.
It is recommended that DOE evaluate the influence of subsidence and of uplift on potential flooding.

6.30. Section 6.3.3.3. Hydrology
Page 6-205, 6.3.3.3.4. Analysis of Potentially Adverse Condition.
Incomplete analysis.
The analysis does not recognize that available technology and standard mining practices have not always been successful. The analysis states that freezing will be required, while according to 6.3.3.3.2. other ground water control techniques could be considered.
It is recommended that DOE provides an analysis which recognizes past problems in shaft sinking and sealing.

6.31. Section 6.3.3.4. Tectonics
Page 6-210, 6.3.3.4.4., (2)
Missing reference.
McClure, 1981, should be included in references.

6.32. Section 6.3.4. <u>Preclosure System Guideline 960.5-1(a)(s)</u>
Section 8.3.4.3. <u>Analysis</u>, page 6-220, Hydrology
Incomplete analysis.
It is premature to conclude that the adverse condition is not found. It is impossible, at this early stage of the site-specific information, to predict or even estimate whether water-control will be possible with existing technology, or whether complex engineering measures might be required.
It is recommended that DOE acknowledges the uncertainty in predicting shaft sinking and sealing requirements.

6.33. Section 6.3.4.3.3. <u>Shafts</u>
Page 6-224
Contradictory Analysis
The first sentence of the second paragraph states that the subsurface features with the most significant effect on shaft construction are expected to be generally favorable. Yet these shafts will be sunk through soft water-bearing ground, clearly the most difficult conditions for shaft sinking, with a procedure, freezing, exclusively used for very difficult ground conditions.

Under these conditions a large number of shafts have encountered very severe problems, and some have been abandoned.

It is recommended that DOE recognizes that shaft sinking will be in difficult conditions.

6.34. Section 6.4.2. long-term Postclosure Performance
Page 6-2561, Data Base and Uncertainties

Data with important implications.

The reported in situ temperature of 50°C at the approximate planned repository depth has significant implications. The basic salt strength parameters reported in Chapter 3 (Table 3-5, p. 3-51; Figure 3-19, p. 3-52) have been obtained at 24°C. A substantial strength reduction is seen at 100°C. This leaves considerable uncertainty at 50°C.

It is recommended that DOE perform salt strength and creep tests at expected repository ambient in situ temperatures, and that narrowing down the expected temperature at the repository level be given high priority.

6.35. Section 6.4.2. long-Term Postclosure Performance
Page 6-252, 6.4.2.1.2. Brine Migration in Salt

Possibly incomplete analysis.

The brine migration analysis only deals with microscopic inclusions. Will macroscopic brine pockets migrate, and if so, under what conditions?

It is recommended that DOE address the question as to whether or not macroscopic brine filled cavities will migrate.

6.36. Section 6.4.2. Long-Term Postclosure Performance
Page 6-253, Figure 6.4-3

Important result.

It is to be noted that within 5 years after CHLW package emplacement the room wall temperature might reach 100°C.

It is recommended that DOE discuss the retrieval implications of these temperature distributions.

6.37. Section 6.4.2. Long-Term Postclosure Performance
Page 6-258, Brine Migration Analyses and Results.

Incomplete analysis.

The analysis does not consider the possible occurence of brine pockets. The analysis does not make an assessment of canister displacements that might result from brine migration.

It is recommended that DOE consider the influence of eventual brine pockets on brine migration, and that DOE assesses the influence of brine migration on changes in position of waste packages.

6.38. Table 6.4-14, page 274

Marginal Waste Package Safety Factor

It is to be noted that the waste package can be breached after 300 years if an unlimited brine volume were to reach the package.

It is recommended that DOE evaluates the risk that a connection becomes established between a disposal hole and nearby brine cavities, and that a package breach time be determined for such a connection with the largest possible cavity.

6.39. Section 6.4.2.2. Performance of Shaft Seals

Incomplete analysis.

Shaft sealing failures have been the cause of flooding of several salt mines. The two preliminary analyses quoted here never conclude that such failures can occur. The probable reason is that these analyses do not include worst case assumptions. In particular, it is unlikely that they include a worst case yet realistic assessment of salt dissolution.

It is recommended that DOE broaden the analysis of shaft seal performance, preferably including an assessment of past shaft seal failures in salt mines and a justification as to why such failures are unlikely for a repository.

6.40. Figure 6.4-16, page 6-304

Questionable schematic layout.

The concrete bulkheads are too short to be effective in reducing waterflow significantly. The steel liner is left in place at the salt interface, suggesting a real probability of corrosion risks.

It is recommended that DOE re-evaluate the adequacy of very short concrete bulkheads and the acceptability of leaving steel liners in contact with the salt formation.

6.41. Section 6.4.2.3.4. <u>Physical Extent of Potential Changes</u>

Incomplete analysis.

The section recognizes the present lack of site-specific information, and makes a strong generic case for the probability that the mechanically disturbed zone will remain very small in salt itself. The evaluation does not address the influence of various anomalies (inclusions, e.g. gas, brine, sand; clay seams) on the potential extent of the disturbed zone.

It is recommended that DOE evaluate the influence of anomalies likely or possibly to be encountered in salt domes on the extent of the disturbed zone.

6.42. Section 6.4.2.3.4. Physical Extent of Potential Changes
Page 6-292, Thermal Mechanical Effects on Properties of the Rock.

Identification of important uncertainty.

It is recommended that DOE vigorously pursue the analysis of the influence of waste disposal on caprock isolation performance and salt dissolution.

6.43. Section 6.4.2.6.1.3. Borehole intrusion scenarios
Page 6-230

Incomplete analysis.

The scenario of a borehole passing through the repository and connecting an overlying aquifer and a hydrostatic unit below the repository horizon is dismissed because there is no underlying aquifer. This argument is not sufficient for dismissal, given that it is easily visualized how an angled hole could penetrate the repository and exit the dome somewhat (or much) deeper. This is particularly obvious at Richton, where at least one oil exploration well was deviated significantly, and where the dome flanks are nearly vertical over great depths.

It is recommended that DOE reconsider scenario (1) on the basis of a deviated hole, or provide an acceptable justification as to why such a scenario should not be considered.

6.44. Section 6.4.2.6.1.3. Borehole intrusion scenarios.
Page 6-231, Water flow through shaft-seal system

Unjustified conclusion.

The conclusion is unacceptable because the discussion in Section 6.5.2.2. is incomplete as discussed in comment 6.39.

6.45. Section 6.4.2.6.1.3. Borehole intrusion scenarios
Multiple Borehole Penetrations, page 6-234, last paragraph

Unclear and questionable analysis.

The analysis summarized here appears to be extremely conservative in several regards, and hence it is unlikely that any changes along the lines suggested here would significantly alter the main conclusions.

Nevertheless, for the sake of logical consistency, some aspects deserve clarification and/or modification. Additional information (or a reference to a more complete analysis) is desirable with regard to the following aspects:
-is it assumed that waste disposal holes are vertical?
-is it assumed that holes drilled into the repository are vertical?
-it is unclear why the only concern is a "direct" hit (e.g. what would be the consequences of drilling a hole within a few inches from a package, where the salt would be extremely weak, given the probable temperatures; what would be the consequences of drilling a hole into the salt at the repository level anywhere--the salt being extremely weak at this stage, hence likely to flow into the hole very rapidly unless special stabilization procedures are used; etc.).

It is recommended that DOE clearly state the geometrical assumptions underlying the probabilistic analysis of the multiple borehole penetrations, and that DOE evaluate the consequences of drilling anywhere in the salt dome.

6.46. Section 6.4.2.6.1.4. U-Tube connection scenario
Pages 6-326, 327

Incomplete analysis.

Not taking into account buoyancy effects would seem to remove the most likely and most significant driving force. Establishing the U-tube connection only 1,000 years following permanent closure would seem to delay excessively the most likely cause of such a scenario, which is a combination of shaft seal failure and/or dome edge breaching. The probability of this scenario being developed would seem much higher during operations than after permanent closure.

It is recommended that DOE evaluate the consequences of a U-Tube connection scenario during operations, i.e. as part of the preclosure performance assessment, in addition to its use in the long-term post-closure performance assessment.

DRAFT

To: J. J. Peshel, WMEG, U.S. Nuclear Regulatory Commission
From: J. Daemen
Re: Statutory Environmental Assessment for Cyprus Creek Dome Site, Perry County, Mississippi--Fourth Draft--June 6, 1984.
Date: 10-4-84

This review is based on a partial reading of the subject document with very limited checking of references.

The major comments made on the Richton EA (my review of 9-29-84) apply to this Cypress Creek EA also, as well as to the Vacherie EA, as all three have much in common.

1. <u>Penetrations</u>

The large number of holes already drilled into and near the dome, as well as additional holes planned, suggests a great deal of confidence on the part of DOE that detrimental consequences from such penetrations can be prevented. This concern is never explicitly and comprehensively addressed.

It is recommended that DOE assemble in one section a clear summary of all holes, including their location, depth, and present condition (e.g. plugging, casing, grouting), relative position with respect to the repository, etc. . . , identify potential problems associated with these holes, and preventive measures planned.

Detailed Comments--Chapter Three

Comment Number	Comment

3.1. Page 3-4, Repository Site
Typographical error

It is recommended that the area of underground operations be corrected to 810 hectares (2,000 acres).

3.2. Page 3-4, Controlled Area
Questionable approach

The last sentence of this section implies that incompatible activities would be allowed directly adjacent to the dome. This does not provide an adequate safety margin, especially not as this might in principle seem to allow drilling through the overhang.

It is recommended that DOE reconsider its definition of the controlled area, extending it well beyond the dome outer boundary.

3.3. Section 3.2.1. Regional Geology
Typographical error, line 6.

Should Figure 3-8 read Figure 3-3?

3.4. Section 3.2.1. Regional Geology
Page 3-8, First paragraph
Missing reference.

It is recommended that DOE include Pindell and Dewey, 1982, in its list of references.

3.5. Section 3.2.3.2.3. Caprock and Salt-Stratigraphy.
Page 3-26.
Important uncertainty.

The contact condition between salt and caprock is unknown, and is critically important for salt dissolution and sealing problems.

It is recommended that site investigations stress the importance of identifying the interface conditions between salt and caprock.

3.6. Section 3.2.5.4. Uplift and Subsidence
Conflicting evidence.

It is recommended that DOE make a major effort to reconcile the differences in uplift rates obtained from the three approaches (terrace studies, p. 3-36; geodetic leveling, pp. 3-36, 37; past diapiric estimates, p. 3-40).

3.7. Figure 3-15, Page 3-41
Operational safety and long-term isolation concern.

It appears that some oil wells might penetrate the repository level within the repository boundary.

It is recommended that DOE include the boundary of the underground facility on Figure 3-15, or that the holes be plotted on Figure 3-2. It is recommended that cross sections through the holes be produced, clearly identifying the relative position of holes and repository boundary.

3.8. Table 3-5, Estimated Geomechanical Properties
Page 3-48
Questionable measurement interpretation.

A Poisson's ratio exceeding 0.5 is a meaningless number, suggesting that an isotropic elastic interpretation is inadequate. (This number comes from Richton results).

It is recommended that DOE not include Poisson's ratios over 0.5, but provide raw measuring data (e.g. lateral strain to axial strain ratios), or an acceptable interpretation.

3.9. Section 3.2.6.1.2. <u>Geomechanical Properties of Caprock and Salt.</u>
Page 3-49, Top paragraph
Questionable use of references.

Neither Hoek and Brown, 1980, nor Lindner and Halpern, 1977, suggest 0.023 megapascal per meter.

It is recommended that DOE remove Hoek and Brown, 1980, and Lindner and Halpern, 1977, from this paragraph, or justify how they can be used here, and that DOE provide direct references to previous stress measurements in the Gulf Coast Basin.

3.10. Section 3.2.6.2. Thermal Properties
Page 3-53
Inadequate data basis

The thermal decrepitation results (Lagedrost and Capps, 1981) have been obtained on unloaded samples, and for very short periods of time.

It is recommended that DOE measure thermal decrepitation on salt samples loaded to a stress level approximately equal to that at expected repository depths, and for extended periods of time.

3.11. 3.2.8.1. Hydrocarbons
Page 3-61
Questionable finding

It is recommended that NRC independently review ONWI-169 and other evidence to evaluate the conclusion that the potential for additional hydrocarbon reserves is low.

3.12. Section 3.3.1.3. Flooding
Pages 3-81/82
Incomplete analysis

It is recommended that DOE include the influence of repository effects (e.g. subsidence, uplift) on flood estimates.