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RADIOACTIVE WASTE ISOLATION IN SALT:
PEER REVIEW OF THE OFFICE OF NUCLEAR WASTE ISOLATION'S
PLAN TO DECOMMISSION AND RECLAIM EXPLORATORY
SHAFTS AND RELATED FACILITIES

by

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Energy and Environmental Systems Division
Geoscience and Engineering Group

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NOTICE TO READERS

At the request of the Salt Repository Project Office, Argonne National Laboratory critically reviewed a plan for decommissioning and reclaiming an exploratory shaft facility. This plan was prepared by the Office of Nuclear Waste Isolation (ONWI) for inclusion in a preliminary site characterization report for the Permian Basin. (A microfiche copy of the reviewed plan is attached to the inside back cover of this report.)

Since the original publication of the plan, the architect/engineer for the exploratory shaft has conducted a thorough review of federal, state, and local permitting requirements, and has revised the plan accordingly. Also, the environmental assessments currently being prepared to support the nomination of sites for detailed study contain evaluations of the impacts of site characterization and discussions of both decommissioning and reclamation. Evaluation of federal and state regulations applicable to decommissioning, as part of site characterization activities, will continue throughout the site characterization period, and plans for decommissioning will be revised as required as the site characterization plan(s) are updated.

Argonne's review report has been given to ONWI's Site Characterization Plan Project Office as a guide for developing final statements on exploratory shaft decommissioning, as required by the Nuclear Waste Policy Act of 1982. Revised decommissioning and reclamation plans will be available for additional scrutiny by Argonne as part of the review of the site characterization plan for a recommended salt site.

FOREWORD

Documents are being submitted to the Salt Repository Project Office (SRPO) of the U.S. Department of Energy (DOE) by Battelle Memorial Institute's Office of Nuclear Waste Isolation (ONWI) to satisfy milestones of the Salt Repository Project of the Civilian Radioactive Waste Management Program. Some of these documents are being reviewed by multidisciplinary groups of peers to ensure DOE of their adequacy and credibility. Adequacy of documents refers to their ability to meet the standards of the U.S. Nuclear Regulatory Commission, as enunciated in 10 CFR Part 60, and the requirements of the National Environmental Policy Act and the Nuclear Waste Policy Act of 1982. Credibility of documents refers to the validity of the assumptions, methods, and conclusions, as well as to the completeness of coverage.

Since late 1982, Argonne National Laboratory has been under contract to DOE to conduct multidisciplinary peer reviews of program plans and reports covering research and development activities related to siting and constructing a mined repository in salt for high-level radioactive waste. The present report summarizes Argonne's review of ONWI's *Appendix A: Decommission/Reclamation Plan for the Exploratory Shaft and Other Facilities Associated with Site Characterization*, dated April 8, 1983. This appendix was drafted as part of a preliminary site characterization plan for the Palo Duro Basin in Texas.

The review procedure involved obtaining written comments on the plan from two extramural and four Argonne experts in relevant research areas. Reviewer comments were integrated into this report by the review session chairman, with the assistance of Argonne's core peer review staff. All of the peer review panelists concurred in the way in which their comments were represented in this report (see App. A). The peer review panel met at Argonne on August 9, 1983, and a draft of this report was sent to SRPO on September 15, 1983.

PREVIOUSLY PUBLISHED REPORTS IN THE SERIES

"RADIOACTIVE WASTE ISOLATION IN SALT"

- ANL/EES-TM-242** Peer Review of the Office of Nuclear Waste Isolation's Geochemical Program Plan (Feb. 1984)
- ANL/EES-TM-243** Peer Review of the Office of Nuclear Waste Isolation's Socioeconomic Program Plan (Feb. 1984) (revised July 1984)
- ANL/EES-TM-246** Peer Review of the Office of Nuclear Waste Isolation's Plans for Repository Performance Assessment (May 1984)
- ANL/EES-TM-254** Peer Review of the Office of Nuclear Waste Isolation's Reports on Preferred Repository Sites within the Palo Duro Basin, Texas (June 1984)
- ANL/EES-TM-256** Special Advisory Report on the Status of the Office of Nuclear Waste Isolation's Plans for Repository Performance Assessment (Oct. 1983)

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A microfiche copy of the following unpublished report is attached to the inside back cover of this report: Office of Nuclear Waste Isolation, *Appendix A: Decommission/Reclamation Plan for the Exploratory Shaft and Other Facilities Associated with Site Characterization*, Battelle Memorial Institute, Columbus, Ohio (April 8, 1983).

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The credentials of the peer review panel members are summarized in App. B.

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SUMMARY OF RECOMMENDATIONS

The following recommendations for improving the Office of Nuclear Waste Isolation's plan for decommissioning and reclaiming exploratory shafts and other facilities associated with site characterization have been abstracted from the body of this report. The plan should be modified to:

1. Discuss more comprehensively the technical aspects of activities related to decommissioning and reclamation. More detailed information will help convince the staff of the U.S. Nuclear Regulatory Commission and others that the activities as outlined in the plan are properly structured and that the stated goals can be achieved.
2. Address in considerably greater detail how the proposed activities will satisfy specific federal, state, and local laws and regulations.
3. State clearly the precise purpose of the plan, preferably at the beginning and under an appropriate heading.
4. Also under an appropriate heading and immediately after the section on purpose, describe the scope of the plan. The tasks covered by this plan and closely related tasks covered by other appropriate plans should be clearly differentiated.
5. Discuss the possible environmental effects of drilling the exploratory shaft, excavating drifts in salt, and drilling boreholes as part of site characterization. Mitigation activities should be designed to counter specific potential impacts. High priority should be given to minimizing groundwater contamination and restoring the surface to a condition consistent with the proposed land use following completion of characterization activities at sites not chosen for repository construction.
6. Define ambiguous technical terms, either in the text when first introduced or in an appended glossary.

1 INTRODUCTION

Battelle Memorial Institute's Office of Nuclear Waste Isolation (ONWI) wrote *Appendix A: Decommission/Reclamation Plan for the Exploratory Shaft and Other Facilities Associated with Site Characterization* as part of a preliminary draft of a site characterization plan for the Palo Duro Basin in Texas. As an appendix or in another format not yet specified by the U.S. Nuclear Regulatory Commission (NRC), the plan may eventually be part of a U.S. Department of Energy's (DOE's) application to NRC for a license to construct a repository in salt at a site in the Palo Duro Basin. Parallel plans are being included in the environmental assessments being prepared for the seven salt repository sites under consideration. At a later date, revised versions of these plans will likely be appended to site characterization plans prepared for those salt repository sites selected for detailed characterization.

Argonne's peer review involved obtaining written critiques of the plan from two extramural and four Argonne experts in relevant research areas. Panelists did not contact ONWI personnel, and none of the panelists have been involved in any programs sponsored by DOE or directed by ONWI such that their participation in the review could be construed as a conflict of interest. The four Argonne panelists met on August 9, 1983, to review and discuss all of the written comments. The review session chairman then drafted this report.

No specific guidance was provided to Argonne by DOE on how to conduct the review. The following questions were prepared by Argonne to guide the review process.

1. Are the main issues adequately identified?
2. Are the proposed activities for decommissioning and reclaiming the site technically sound and clearly stated?
3. Can the stated goals of the plan be achieved?
4. Are there any additions or deletions that would make the document more useful?

Throughout its review, the Argonne peer review panel referenced its comments on the plan to two documents: (1) 10 CFR Part 60, NRC's final rule entitled *Disposal of High-Level Radioactive Wastes in Geologic Repositories, Technical Criteria*, Fed. Reg., 48(120):28,194-28,229 (June 21, 1983) and (2) NRC's Regulatory Guide 4.17 entitled *Standard Format and Content of Site Characterization Reports for High-Level-Waste Geologic Repositories* (July 1982). These documents are referred to in the text that follows as "10 CFR 60" and "Regulatory Guide," respectively. Reference is also made to provisions of the Nuclear Waste Policy Act of 1982 (NWPAA).

2 REGULATORY REQUIREMENTS

Section 113(b)(A)(iii) of NWPA refers to "decommissioning of such candidate site" and "mitigation of any significant adverse environmental impacts caused by site characterization activities." Section 134 of 10 CFR 60, entitled "Design of seals for shafts and boreholes," describes criteria for designing such seals and selecting materials and placement methods. The Regulatory Guide does not explicitly address decommissioning of exploratory shafts and associated facilities, stating only that "...it is not necessary to issue a separate regulatory guide on the format to be used..." for appendices to the site characterization plans.

Although the ONWI plan for decommissioning and reclamation of exploratory shafts and related facilities addresses the issues raised in the sections of NWPA and 10 CFR 60 cited above, portions of the plan could be revised to address these issues more explicitly. In general, the plan should show that the planned activities satisfy all pertinent federal, state, and local laws and regulations. Indeed, the activities should be designed to comply with the applicable laws and regulations; that is, they should either prevent or mitigate long-term environmental impacts.

The plan is ambiguous as to whether the proposed activities are designed to satisfy specific state and local or more general generic requirements. For example, Fig. 2 (site stratigraphy); the term "Permian" on page A-20; the several references to the Pullman soil series and the associated bibliographic citation on pages A-3, A-31, and A-32; and the mention of the Railroad Commission of Texas and the Texas Department of Water Resources on page A-2 all indicate that the plan was drafted for the site characterization plan for the Palo Duro Basin. On the other hand, much of the plan is generic in nature.

A revised draft should demonstrate that the proposed activities will satisfy the specific legal and regulatory requirements of the state of Texas. For example, a specific activity could be related to obtaining a permit, complying with a particular law, or satisfying a regulatory requirement. In addition, the plans appended to site characterization plans for other potential salt repository sites should demonstrate that planned tasks satisfy the specific legal and regulatory requirements of the applicable host states.

3 TECHNICAL ISSUES RELEVANT TO REGULATORY REQUIREMENTS

Several technical issues that appear relevant to repository construction authorization and licensing were raised by members of the Argonne peer review panel. Because these issues could be of concern to federal, state, and local regulatory agencies, they are discussed in some detail in the following subsections.

3.1 SURFACE DEVELOPMENT

3.1.1 Storage Area

Materials drilled from the exploratory shaft and mined from the drifts will be stockpiled in a storage area. The plan states that "the entire storage area is considered contaminated by salt..." (p. A-6, lines 5-6). Under certain environmental protection regulations, these stockpiles might be considered as solid waste or as sources of elements or compounds that could pose a hazard if concentrated in leachate. The soil in the storage area might have to be compacted to reduce infiltration of leachate from the pile. Alternatively, state regulations might require (1) relatively impermeable clay or impermeable synthetic material underliners for the storage area, (2) groundwater monitoring, or (3) a leachate collection system.

3.1.2 Fluid Impoundments

Fluid impoundment structures are proposed to prevent excessive erosion and to mitigate potential adverse environmental impacts, such as contamination of groundwater, surface water, and soil. The plan should discuss in detail the ability of the three proposed types of fluid impoundments to meet relevant regulatory requirements.

The purpose of the mud pit, one of the types of fluid impoundment, is clearly explained. However, what type of material will be used to construct the embankments surrounding the mud pit? And, what are the relevant physical properties of the impermeable synthetic membrane and soil cement?

The evaporation/retention pond, the second type of fluid impoundment, is another site of potential environmental impact. Will the pond be large enough to contain the water pumped from the shaft? How will the pumping rate from the shaft be estimated? The plan should discuss the data needed to make these engineering calculations as well as the methodology, with supporting references given where needed. The plan should also indicate what constitutes a suitable disposal site in the event that wastewater would have to be transported off site, possibly at great expense.

Sediment collection basins, the third type of fluid impoundment, are designed to catch precipitation runoff from most of the site by gravity drainage into topographically low areas. Although the plan describes the purpose of these structures and appears to address the appropriate regulatory concerns, additional technical details would be

necessary if application were made for an underground mining permit (p. A-2, lines 6-20) under Office of Surface Mining regulations (30 CFR 783 and 784). For example, what values are anticipated for commonly measured water-quality parameters for these basins and which effluent standards will apply? If saline water is expected, what treatment facilities will be necessary? Will appropriate water treatment equipment be at the site for the duration of exploratory shaft activities?

3.2 SUBSURFACE DEVELOPMENT

The plan should contain additional technical details concerning construction of the exploratory shaft and boreholes. For example, support is needed for the contention that freshwater will not migrate down the exploratory shaft or that freshwater in the Dockum Group and overlying Ogallala Formation will not be contaminated during drilling operations by brine from underlying formations. Not only supporting data but calculation methods are needed to show that these goals can be achieved.

Several panelists were skeptical of the statement that it may not be necessary to set casing through the unconsolidated Ogallala Formation to support the sides of the shaft (p. A-9). Actually, it may be prudent to set and cement casing from the ground surface to the base of the Dockum Group, not only for support but to prevent brine contamination of potable water while drilling through the underlying formations.

In general, the discussions of shaft development should be more detailed. The plan should describe the type of cement to be used, should explain Dowell seals (p. A-9, lines 18 and 33), and should discuss the anticipated effective lifetime of shaft sealing elements (e.g., seals, concrete, and cement) in the exploratory shaft environment. Construction materials and procedures must be discussed more thoroughly to give the plan greater credibility.

3.3 SUBSURFACE RECLAMATION

3.3.1 Decommissioning Alternatives

The plan completely neglects the alternative to decommissioning and reclaiming exploratory shafts and related facilities, that is, incorporating the exploratory shaft into the repository design. When a site is chosen for repository development, the extant exploratory shaft could serve as a pilot hole for a shaft. If such incorporation will be described in Sec. 8 (Conceptual Design) of the site characterization plan, the decommission/reclamation plan should refer to that section. At some point, the latter plan should make clear that the exploratory shaft could serve as a pilot hole for a repository shaft and that excavated drifts could be used as repository tunnels. The plan presently applies only to those exploratory shaft sites not chosen for repository development.

3.3.2 Backfilling Exploratory Shaft Drifts

A revised plan should contain additional technical details, supporting data, and literature references with respect to backfilling drifts with crushed salt. Although pneumatic stowing is mentioned on page A-20 (line 26), it is not described. Readers who infer that pneumatic stowing is simply a material delivery process might be concerned about compaction. In the last paragraph on page A-21 and at the top of page A-23, the plan states that the crushed salt backfill will be emplaced under pressure to 75% of its original in situ density. The plan should justify this figure by including supporting data or referring to such data if contained elsewhere in the site characterization plan.

The panelists agreed that pneumatic stowing appears to be an appropriate procedure for backfilling the drifts with crushed salt. However, a density in excess of 75% of the original density might be achieved either by pneumatic stowing alone or by also using mechanical compaction equipment.

The hydraulic conductivity of the emplaced backfill should be addressed, because 75% of the original in situ density may represent a significant increase in porosity and permeability. Such changes might promote salt dissolution if groundwater were to infiltrate the drift. Several questions need to be answered. What is the time-dependent influence of backfill consolidation on subsidence of the overburden and ground surface above the drifts? Will the backfilling procedure and the resultant 75% of original density provide sufficient backfill volume to prevent subsidence of the ground surface above the drifts (Wagner, 1980)?

On page A-10 (lines 3-4), the authors express their concern that "all equipment used underground shall be 'permissible' by MSHA [Mining Safety and Health Administration] for operations in 'gassy mines' where required." If tests of the proposed stowing equipment show that arcing occurs with the crushed salt backfill, monitoring of methane levels will be necessary to ensure safety.

Although a value for the density of crushed salt backfill is not cited in Kelsall et al. (1983), the authors state on pages 24-25 that "...the dominant factor controlling the rate of consolidation [of crushed salt] is the closure rate of the tunnels which in turn is highly dependent on site-specific salt properties." Also on page 25 is a statement to the effect that additional laboratory work will be required on the consolidation behavior of crushed salt to obtain the relationship between porosity, elastic modulus, permeability, and strength. More work is also required on analyzing and modeling room closure rates and modeling in situ consolidation behavior. The relationships between program plan elements for repository sealing and other project work elements, such as laboratory experiments and in situ field testing, are clearly delineated in Kelsall et al. (1983). The decommission/reclamation plan should detail applicable program interfaces, wherever practical.

The plan does not propose to use bulkheads to seal the exploratory shaft drifts. On page 17, Kelsall et al. (1983) define bulkheads as "...relatively impermeable seal components interspersed with sections of backfill in both the [repository] shafts and access tunnels. Their primary function is to limit groundwater flow internally within the seals as well as at the seal-rock interface and in the disturbed zone." Because salt is

soluble, water must not enter the drifts, even if it breaches the seals in the shaft. Given that Sec. 8 of the site characterization plan and Kelsall et al. (1983) indicate that bulkheads will be used to seal repository tunnels, the rationale for not using bulkheads in exploratory shaft drifts should be explained.

Potential long-term adverse impacts resulting from salt dissolution include (1) subsidence of rock strata above the dissolved salt and consequent subsidence of the overlying ground surface and (2) structural failure of shaft seals caused by volume reduction of backfill beneath the seal and the resulting loss of support. Subsidence of the ground surface could affect land use. Failure of a shaft seal might lead to further infiltration of the crushed salt backfill by fresh groundwater, thereby enhancing dissolution or contamination of an overlying aquifer by brine. These concerns should be addressed in the next revision of the plan.

3.3.3 Backfilling and Sealing the Exploratory Shaft

The credibility of the plan would be enhanced if more information were given on such items as the physical properties of the proposed concrete plugs, chemical seal rings, and brine-saturated drill cuttings. Also, consideration might be given to compacting dry cuttings with a tamper to achieve a higher backfill density and a decreased probability of brine contamination of an overlying freshwater aquifer. Finally, more details should be given concerning (1) resistance of the sealing materials to the salt environment, (2) laboratory and in situ testing of sealing materials, and (3) construction of concrete plugs and chemical seal rings. Whether observation wells should be used to monitor long-term performance of backfill and plugs should be discussed.

3.4 SURFACE RECLAMATION

3.4.1 Fluid Impoundments

Those portions of the plan that address fluid impoundments must take cognizance of state environmental regulations. In particular, the embankment material, the physical properties of the soil cement, and the physical properties of the "impermeable" synthetic membrane of the mud pit should be described. Also, plans for removal and disposal of the impermeable synthetic liners underlying the mud pit and storage area should be detailed. To prevent long-term environmental impacts, regulatory agencies will demand specific proposals for the removal and disposal of liners or, if left in place, their decontamination.

3.4.2 Excavated Material

A large volume of excavated material will remain on the surface after the shaft and drifts are backfilled. The plan should include procedures for disposing of these materials in an environmentally acceptable manner.

3.4.3 Revegetation

The proposed surface reclamation tasks can likely be completed successfully, but additional technical explanation is needed. For example, the plan does not state whether the mulch will be crimped or tacked into the soil and whether additional fertilizer or nitrogen will be necessary. Seeding rates for areas surrounding the exploratory shaft, boreholes, and trenches are appropriate for given species if the values are in pounds per acre. However, the conversions to metric units are not equivalent. On pages A-32 and A-33, 3.0 lb PLS/acre equals 3.36 kg/ha, not 0.6 kg/ha, and 4 lb PLS/acre equals 4.48 kg/ha, not 0.7 kg/ha. Even with the use of a rangeland drill, problems may arise during seeding of topsoil stockpiles (p. A-5) and during revegetation (p. A-32). The plan should also describe the types of measurements to be made as part of the monitoring program (p. A-33).

3.5 HYDROLOGIC TESTING WELLS

Proposed plans for disposal of groundwater pumped from wells during pump tests should be described, including the procedures to be used if the pumped groundwater is saline or does not meet relevant water-quality standards. If evaporation ponds will not be located close to the test borings, how will the pumped water be transferred to the ponds?

3.6 TECHNICAL PROCEDURES

Several technical procedures in the plan not directly related to licensing or regulatory requirements should be clarified. For example, the plan should explain the reasons for lime stabilization of roadways, the parking area, and parts of the activity and administration areas (p. A-3, line 29; p. A-10, line 20). How does the lime stabilize these areas?

If existing oil and gas exploration wells are to be reentered for hydrologic and geophysical testing and observation, will the old casing have to be pulled and the holes reamed (p. A-19, lines 14-16)? What will be done with the old casing, if any? How will the freshwater aquifer be sealed to prevent brine contamination during the proposed pump tests?

Stockpiling of topsoil should be explained in greater detail. For example, the reasons for separate topsoil stockpiles should be given (pp. A-3, A-5, and A-10). What is the influence of the lower subsoil on plant growth? The 4-ton/acre mulching rate for the topsoil stockpile appears to be high (p. A-5, lines 5-6). Most reclamation efforts in arid areas use about half that rate. Why is this rate higher than the mulching rate cited for revegetation (3 tons/acre) (p. A-32, lines 20-21)? Will the mulch be tacked or crimped into the soil? The need to add nitrogen to compensate for nitrogen assimilation when using mulch is not mentioned. In addition, some of the seed varieties to be used for reseeding the topsoil stockpile become established very slowly. Also, the seeding rates in metric units do not correspond with the appropriate rates given in English units (see Sec. 3.4.3).

Finally, performance evaluation of the shaft seals is not mentioned in the plan. Is ONWI considering testing the seals before their use? If such a testing program is referred to in another document, the plan should reference the document. If there is a testing program, the plan should summarize its laboratory and field-testing aspects. In addition, testing of seals before installation and testing of seals in the shaft should be related to relevant sections of Kelsall et al. (1983).

4 PLAN ORGANIZATION

4.1 PURPOSE, SCOPE, AND APPROACH

The plan should state the purpose, scope, and approach of the program more clearly. Although the introduction to the plan contains elements of a purpose, the purpose should be stated more explicitly. On page A-1, the plan states that "the plan insures the restoration of the exploratory shaft facility and adjacent areas affected by characterization activities to a condition compatible with area land uses." This statement is incomplete in that the plan also contains elements of a conceptual scheme for development of on-site and off-site surface and subsurface facilities for use in site characterization. Such material accounts for 19 of the 38 pages, that is, for half of the plan.

The scope of work also needs clearer delineation. For example, detailed geologic mapping and in situ rock mechanics testing are apparently outside the scope of this plan. And, a short discussion of scope would preclude questions about data collection as the exploratory shaft is being drilled or drifts mined out. References are needed to relevant ONWI plans or publications, such as the exploratory shaft conceptual design reports (Office of Nuclear Waste Isolation, 1983a, b, c) and Kelsall et al. (1983).

In general, the approaches to be used are described throughout the text. A statement in the introduction to this effect might serve as a guide to the reader.

4.2 POTENTIAL IMPACTS

The plan should address potential environmental impacts more thoroughly and then show how the proposed activities mitigate those impacts, with a view to satisfying federal, state, and local laws and regulations.

4.3 TERMINOLOGY AND DEFINITIONS

The terminology of the plan should be consistent with that of NWPA and 10 CFR 960. In addition, the plan should define ambiguous terms, such as "safe decommission," "restoration," and "condition compatible with area land uses." Such definitions should occur in the text when the terms are first introduced or in an appended glossary.

4.4 TEXT AND FIGURES

Better coordination of the text and figures would improve the effectiveness of the report. For example, the note in Fig. 1 implies that various shaft construction methods are still under consideration. However, the text discusses only the large-hole drilling method. In describing casing installation, the discussions of wells (pp. A-13 and A-16) should reference Figs. 4 and 6. Parenthetically, Figs. 4 and 6 should not have the same title.

In general, the figure titles should be more descriptive. Also, Fig. 2 shows stiffened steel casing and corrugated casing. Is the corrugated casing also made from steel? The symbols " CH_4 " and " H_2S " should be defined in the general notes to Fig. 2. Figure 10 is generally useful. However, the text should discuss in more detail the timing required by different topsoil stockpile and revegetation seeding mixtures. Some of the proposed seed varieties require more time to become established than others. The text on pages A-3 and A-5 would be more understandable if the reader were referred to Fig. 10.

4.5 REORGANIZATION

The section on surface development beginning on page A-2 could be improved by reorganization. "Activity Area" and "Storage Area" are not surface development tasks. Discussions of these two areas and the administration area could form a new section that describes on-site surface facilities. Such a section should summarize the location and purpose of the activity, storage, and administration areas prior to discussing surface development. In other words, the reorganized "On-Site Facilities" section would start with a description of surface facilities and move on to a discussion of surface development tasks.

To be consistent with the suggested reorganization, the title of the section "Fluid Impoundments" should be changed to "Impoundment of Fluids." This section discusses how fluids are to be contained and does not describe the impoundment structures themselves.

The reader might be more effectively guided by indentation of several subheadings. In the section on "Subsurface Development," indent subsections "Deep Hydrologic Characterization Holes" and "Stratigraphic Holes" under "Deep Boreholes." Indent "Shallow Hydrologic Characterization Holes" and "Shallow Exploration Borings" under "Shallow Boreholes."

5 MANAGEMENT

5.1 TIMETABLE

Management aspects of the plan would be improved by discussing how individual tasks are related and how they will be coordinated into a coherent program. A well-conceived program with an appropriate management structure will enhance the overall credibility of the plan.

A figure showing a timetable for facility development should be included, as should a figure showing how the plan and its milestones are related to Salt Repository Project milestones. Reclamation aspects of the timetable could remain in Fig. 10, or they could be included in an expanded timetable for both facility development and reclamation.

5.2 CAN THE STATED GOALS OF THE PLAN BE ACHIEVED?

The individual tasks described in the plan can likely be completed successfully. However, the relationships between the tasks, construction materials, construction procedures, and construction impacts on the environment are inadequately explored. Success will also depend on the actual construction specifications, the procedures to be followed by the contractor, and the effectiveness of construction inspection and quality assurance procedures. The plan must tie all of these factors together, either by discussing them in a section on technical management or by incorporating comments throughout the text that describe how the individual tasks flow together and are managed as part of an overall technical program.

The surface reclamation aspects of the plan appear to be well conceived. However, additional research by ONWI should result in a more effective reclamation plan. For example, additional research on seed varieties will result in a more effective seed mixture.

The plan contains insufficient technical detail for the probability of its eventual success to be assessed. If comments concerning technical management of the plan are added and if comprehensive discussions of the plan's technical aspects are incorporated, the revised plan will likely be perceived as achievable.

6 PAGE-BY-PAGE COMMENTARY

<u>Page</u>	<u>Lines</u>	<u>Comment</u>
A-2	30	"It" does not have a definite antecedent. The subject in the preceding sentence is plural.
A-3	18-27	It is not clear whether there is one or more stockpiles of soil. Are "existing topsoil" and "surficial soil" the same?
A-4		In the note in Fig. 1, delete "and shaft construction method" if appropriate.
A-5	3	Which stockpile is referred to? The previous paragraph mentions the possibility of a second stockpile. For how long must the stockpiles be stabilized?
A-5	9-11	The stated seeding rates for the topsoil stockpile appear to be low. Also, what are the fertilizer rates?
A-5	18-22	These sentences need to be more specific. Details as to which types of soils would be suitable for different end uses would enhance credibility.
A-6	1	Which regulatory standards are being referred to?
A-6	14-25	This paragraph should be more specific. For example, what material will be used for the levees? Are the important physical properties of the "impermeable synthetic membrane" and "soil cement"?
A-6	23-25	If this plan was written for the Palo Duro Basin, why is there uncertainty about the regulatory requirements? Are the regulatory requirements for Texas in transition? What is required by 30 CFR 784?
A-6	33-36	Same as previous comment.
A-7	11	Will the engineering design borehole serve as the pilot hole for the shaft?
A-7	15-16	Add the approximate depth to the top of competent rock and the anticipated length of core to be drilled.
A-7	29	Boreholes through unconsolidated materials will generally collapse without the use of drilling mud. The phrase "...increases their tendency for sloughing" is not precise.
A-9	3	Shouldn't "may" be changed to "will"?

<u>Page</u>	<u>Lines</u>	<u>Comment</u>
A-9	7-8	What is a conductor casing? What are its relevant physical properties?
A-9	10	What type of cement will be used? Will the cement be relatively impermeable?
A-10	3-4	This sentence is ambiguous at best. Identify where the use of "permissible" equipment is necessary.
A-12	8-9	Will the off-site topsoil stockpiles be stabilized by seeding or chemical treatment?
A-13	24-33	Is there a separate storage area for cores?
A-15		Same comment as above.
A-18	1-10	What drilling technique will be used? The hammer must be weighed and quality-assurance certified for SPT (standard penetration test) calculations.
A-18	16-19	What borehole diameter will be used, and what sampling (coring) intervals are proposed?
A-18	20-22	What drilling techniques (rotary wash, or auger) will be used?
A-18	23-26	What borehole diameter and drilling technique will be selected?
A-20	6	Insert "Basin" after "Permian."
A-20	9-10	Add citations to specific regulations.
A-21	4	Is the hydraulic conductivity of drill cuttings saturated with salt water drilling mud low enough to form a relatively impermeable seal? Is this a bentonite mud or grout? Add supporting data.
A-21	11	Same comment as above.
A-22		How many feet of the shaft are to be pneumatically backfilled?
A-23	9-10	What is the volume of excavated material that will remain on the surface after backfilling is completed?
A-23	15-17	How will this dissolution method be controlled? What will prevent excess dissolution?
A-23	28	Are there data to support the statement that this material serves as an aquitard?

<u>Page</u>	<u>Lines</u>	<u>Comment</u>
A-25	1-12	Add data on seals and plugs.
A-25	30-32	What are the physical properties of this seal/cap?
A-30	18-24	What are the factors controlling removing the liner or leaving it in place?
A-33	3	What types of measurements are proposed?
A-33	10	Boreholes don't have operators.
A-33	14-16	What type of cement -- a bentonite grout?
A-34	2	Insert "an" before "offsite."
A-38		Add complete citations for the appropriate regulations (e.g., 30 CFR Part 784 on page A-2).

REFERENCES

Code of Federal Regulations, 1979, Title 30, Part 783 [30 CFR 783], *Underground Mining Permit Applications — Minimum Requirements for Information on Environmental Resources*.

Code of Federal Regulations, 1979, Title 30, Part 784 [30 CFR 784], *Underground Mining Permit Applications — Minimum Requirements for Reclamation and Operation Plan*.

Kelsall, P.C., et al., *Repository Sealing Program Plan: Repository in Salt*, Battelle Memorial Institute, Office of Nuclear Waste Isolation, Columbus, Ohio, ONWI-414 (Jan. 1983).

Office of Nuclear Waste Isolation, *Exploratory Shaft Conceptual Design Report: Paradox Basin*, Battelle Memorial Institute, Columbus, Ohio, ONWI-390 (1983a).

Office of Nuclear Waste Isolation, *Exploratory Shaft Conceptual Design Report: Gulf Interior Region Salt Domes*, Battelle Memorial Institute, Columbus, Ohio, ONWI-391 (1983b).

Office of Nuclear Waste Isolation, *Exploratory Shaft Conceptual Design Report: Permian Basin*, Battelle Memorial Institute, Columbus, Ohio, ONWI-392 (1983c).

Wagner, R.A., *Preliminary Investigation of the Thermal and Structural Influence of Crushed-Salt Backfill on Repository Disposal Rooms*, Battelle Memorial Institute, Office of Nuclear Waste Isolation, Columbus, Ohio, ONWI-138 (Aug. 1980).

APPENDIX A
CONCURRENCE SHEET

APPENDIX A
CONCURRENCE SHEET

I concur that the Argonne National Laboratory report on ONWI's Decommission/Reclamation Plan for the Exploratory Shaft and Other Facilities Associated with Site Characterization fairly represents my comments, where incorporated, to the peer review panel.

Joseph S. Busch

Jeffrey P. Schubert

David F. Fenster

David G. Simpson

Wyman Harrison

Stanley Zellmer

APPENDIX B
CREDENTIALS OF PEER REVIEW PANEL MEMBERS

Joseph S. Busch

Northwestern University: B.S., Chemical Engineering (1949)

Johns Hopkins University: M.S., Chemical Engineering (1953)

Carnegie Mellon University: Ph.D., Chemical Engineering (1960)

Dr. Busch is a Principal Engineer with Raymond Kaiser Engineers, Oakland Calif. He has 32 years of experience working on nuclear and chemical engineering projects for both government and industry. He has supervisory and design experience with solid, liquid, and gas processing systems for nuclear and nonnuclear facilities. His nuclear experience includes work on both fast reactors and light-water reactors.

Dr. Busch participated in the National Waste Terminal Storage Program by working on a conceptual design for a mined repository in salt for highly radioactive waste. He was assistant project manager in charge of underground technology and also served as head of the thermal analysis group. As such he directed the work of mining rock mechanics, heat transfer, and ventilation engineers and consultants, and coordinated the design of subsurface systems with that of surface facilities.

Dr. Busch also served as manager of a preconceptual design of an incinerator facility to be constructed at Idaho National Engineering Laboratory. He has also participated in the Basalt Waste Isolation Project and the Nevada Nuclear Waste Storage Investigation.

Dr. Busch is a registered chemical engineer in Pennsylvania, Michigan, Mississippi, and New York. He has published numerous papers on heat transfer, nuclear systems, and pollution abatement.

David F. Fenster

City College of the City University of New York: B.A., History (1967)

University of Illinois: M.A., History (1968)

Queens College of the City University of New York: M.S., Geology (1975)

Certified Professional Geologist, No. 4668, American Institute of

Professional Geologists

Certified Professional Geologist, No. 85, State of Indiana

Mr. Fenster joined the staff of the Geoscience and Engineering Group of the Energy and Environmental Systems Division of Argonne National Laboratory in 1982. He is currently Technical Project Manager and member of the multidisciplinary core peer review panel of the technical data base for the salt host-rock portion of the National Waste Terminal Storage program. He also served as a technical reviewer for parts of Argonne's Lake Superior regional report related to siting high-level radioactive waste repositories in crystalline rocks.

Prior to coming to Argonne, Mr. Fenster was a Project Geologist with Dames & Moore, Park Ridge, Ill. He had been with Dames & Moore since joining the staff of the Cranford, N.J., office in 1974. During his tenure with Dames & Moore, Mr. Fenster acquired extensive experience in seismotectonics, structural geology, radioactive and hazardous waste disposal, regional geology, engineering geology, hydrogeology, and general geologic field mapping. For example, Mr. Fenster was Principal Investigator for Stratigraphy for the Generic Environmental Impact Statement concerning disposal of radioactive waste in bedded salt, granitic rocks, and argillaceous formations for Oak Ridge National Laboratory. He also worked on a revised draft (unpublished) of a national-screening-level, site-selection investigation for high-level radioactive waste isolation in crystalline rocks.

Mr. Fenster also worked on geologic investigations related to nuclear power plant siting and licensing. He is familiar with U.S. Nuclear Regulatory Commission review and licensing procedures, having worked on early site reviews, preliminary safety analysis reports, final safety analysis reports, and detailed fault investigations.

Mr. Fenster has published on high-level radioactive waste repository siting, midcontinent tectonics, and structural geology in the Northeast, and has worked on over 30 consulting reports. He is a member of five professional societies, including the Association of Engineering Geologists.

Wyman Harrison

University of Chicago: S.B., Geology (1953), after three years of undergraduate work at Stanford University

University of Chicago: S.M., Geology (1954)

University of Chicago: Ph.D., Geology (1956)

Registered Geologist, No. 2476, State of California

Certified Professional Geologist, No. 134, American Institute of Professional Geologists, and No. 487, State of Virginia

Dr. Harrison is Associate Director for Geoscience and Engineering for Argonne National Laboratory's Energy and Environmental Systems Division. He directs a 25-person group that performs analytical and experimental studies related to management of energy and mineral resources and to development and deployment of related technologies. Major activities of the group include (1) acquisition of geophysical and geotechnical data bases, (2) analysis of the data of geoscience to support the design and deployment of energy technologies, and (3) development of physical and mathematical models of geophysical/ geotechnical systems.

Dr. Harrison's group recently completed comprehensive surveys of the geoscience data on crystalline rock complexes in the northeastern and Lake Superior regions of the United States to help assess their potential as possible sites for repositories for high-level radioactive waste. Dr. Harrison has conducted numerous other geological and geotechnical studies at Argonne, ranging from estimating petroleum resources of the Soviet Union to determining near-shore circulation in Lake Michigan.

From 1971 to 1975, Dr. Harrison was Professor of Geography (Associate Department Chairman) at the University of Toronto, where he specialized in geophysical studies related to the siting of supertanker ports and slope stability in sedimentary terrains. Prior to that, he was Associate Director for Physical, Chemical, and Geological Oceanography at the Virginia Institute of Marine Science and a Professor of Marine Science at the University of Virginia. Dr. Harrison was Director of Environmental/Science Services Administration's (now National Oceanic and Atmospheric Administration's) Land and Sea Interaction Laboratory from 1964 to 1968. Before that he was on the faculty of Dartmouth College's Department of Geology and a geologist with the Indiana Geological Survey.

An author of over 100 papers, reports, reviews, and books, Dr. Harrison was made Senior Scientist at Argonne in 1976.

Jeffrey P. Schubert

University of Illinois, Urbana: B.S., Geology (1972)

Pennsylvania State University: M.S., Geology (1978)

Mr. Schubert is a Hydrogeologist in the Environmental Research Division at Argonne National Laboratory, where he has worked since 1975. He has investigated the hydrogeology, geochemistry, water quality, and reclamation of numerous disposal sites for coal wastes and surface coal mines across the country. His research has involved hydrogeological properties of glacial materials, sedimentary rocks, and coal mine spoils; specialized field monitoring schemes and equipment; groundwater sampling and analysis; hydraulic properties of fractured rock; surface-water/groundwater interchange; geochemistry and attenuation mechanisms of contaminant transport in geologic media; and computer modeling of groundwater systems and pollutant migration.

Mr. Schubert has worked on a project to study the withdrawal of water from flooded underground coal mines for use in heat pump systems in buildings. He also investigated the storage and movement of water in flooded underground mine voids in the Pennsylvania anthracite basins and potential well yields, as well as roof stability and potential subsidence problems associated with dewatering of mine voids.

Before coming to Argonne, Mr. Schubert was a Research Assistant for the Department of Geosciences, Pennsylvania State University. His field and laboratory research related to the geology and hydrology of groundwater flow systems in and near underground coal mines. He integrated the gathered data into a groundwater flow simulation model and predicted responses of the flow system to various schemes for dewatering wells.

Mr. Schubert has published more than 20 articles, papers, and reports on hydrology, geochemistry, water quality, reclamation, and subsidence research related to mining. He is a member of the American Geophysical Union, the National Water Well Association, and the International Mine Water Association.

David G. Simpson

Wilkes College: B.S., Chemistry (1964)

Wilkes College: M.S., Chemistry (1968)

Mr. Simpson has been Chief of the Division of Federal Demonstration Projects, U.S. Office of Surface Mining, Eastern Technical Center, Wilkes-Barre Field Office since 1981. He has worked on projects to demonstrate state-of-the-art methods for mitigating adverse environmental effects of mining, including mine subsidence, mine fires, mine refuse dumps, acid mine drainage, and surface mining; to develop new and improved methods of avoiding, mitigating, and repairing environmental damage resulting from mining activities; and to provide engineering, technical, and supervisory support for projects using such technology. His two principal areas of research are control of mine subsidence and control of hazardous shafts, both of which require sound reclamation practices.

Since 1968 but prior to coming to the Wilkes-Barre Field Office, Mr. Simpson worked as Supervisory Physical Scientist and Research Chemist for the U.S. Bureau of Mines at the Pittsburgh Research Center in Morgantown, W.Va. Much of his experience there centered on abatement of environmental problems in mines. Other work involved mined land reclamation and uses of fly ash. Mr. Simpson also worked as a Research Associate at Wilkes College on a water-quality program to investigate acid mine drainage.

Mr. Simpson has published papers on acid mine drainage, stack gases, and mined land reclamation. He is a member of the American Chemical Society and the American Council for Reclamation Research.

Stanley D. Zellmer

Iowa State University: B.S., Agronomy (1960)

Certified Professional Agronomist, CPAG No. 1995, American
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Mr. Zellmer is an Environmental Systems Engineer in the Energy and Environmental Systems Division of Argonne National Laboratory. He has been Deputy Director for Physical Research of the Land Reclamation Program since 1978. As such he is responsible for coordinating and managing research projects and assisting in the administration of the Land Reclamation Program. Mr. Zellmer joined the Argonne staff in 1973 and has worked on air quality assessment, reclamation projects, and agronomic field studies.

From 1969 to 1973 Mr. Zellmer was a programmer in the Environmental Radiation Division, Laboratory of Nuclear Medicine and Radiation Biology, University of California, Los Angeles. In this position, he produced and maintained computer programs that summarized environmental, biological, and chemical data, and performed various statistical tests on the data. From 1960 to 1969 he was a Principal Technician in the Environmental Factors Section at the same institution, working on a long-term study of fission-product cycles in an agricultural system. This project included a sampling program and associated laboratory investigations. He also worked on various greenhouse and growth-chamber studies on plant uptake and moisture stress and on investigations of desert ecosystems.

Mr. Zellmer is a member of the planning committee of the Midwest Reclamation Tour and Review, Coal Extraction and Utilization Research Center. He was a member of the Staunton Task Force, Illinois Abandoned Mined Lands Reclamation Council, and of a review committee of the System Coal Task Force Team. He has presented short courses on "Environmental Effects of Coal Extraction and Use," "Coal Mining and Reclamation," and "Agronomic Aspects of Reclamation."

Mr. Zellmer is the author of more than 25 publications and is a member of five professional organizations.