ARGONNE NATIONAL LABORATORY
9700 South Cass Avenue
Argonne, Illinois 60439

ANL/EES-TM--242

DESA 000075

ANL/EES-TM-242

RADIOACTIVE WASTE ISOLATION IN SALT:
PEER REVIEW OF THE OFFICE OF NUCLEAR
WASTE ISOLATION'S GEOCHEMICAL PROGRAM PLAN

prepared by

W. Harrison, M. Seitz,* D. Fenster, A. Lerman,**
D. Brookins,† and M. Tisue

Energy and Environmental Systems Division
Geoscience and Engineering Group

February 1984

work sponsored by

U.S. DEPARTMENT OF ENERGY
Salt Repository Project Office
Office of Civilian Radioactive Waste Management

*Chemical Technology Division, ANL

**Northwestern University

†University of New Mexico

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

7/77

00000000 1

**Department of Energy
National Waste Terminal
Storage Program Office
505 King Avenue
Columbus, Ohio 43201**

January 26, 1984

NOTICE TO READERS

At the request of the Salt Repository Project Office, Argonne National Laboratory carried out a review of a statement of geochemical data needs and study objectives prepared by the Office of Nuclear Waste Isolation. Argonne was asked to consider not only the technical merit of the proposed geochemical program but also whether NRC 10 CFR Part 60 and Regulatory Guide 4.17 requirements had been met. While this document was not a formal plan for future geochemical studies, it was felt to be an appropriate vehicle for circumscribing the needed geochemical input to future site studies. Also, it was our hope that the review panel might identify additional data requirements and approaches to help ensure that site selection and characterization will proceed in an orderly and effective manner.

Since Argonne conducted its review, this office has decided that a geochemistry program plan per se should not be written. Rather, geochemical data needs and the plans for acquiring those data will be discussed in detail in Chapter 10 (Issues and Plans) of the Site Characterization Plans (SCPs) that will be written for all sites taken to the stage of detailed characterization. The review report prepared by the Argonne panel has been given to the SCP preparation group and should contribute significantly to this planning effort.

Thomas A. Baillieul

Thomas A. Baillieul
Acting Chief
Site Evaluation Branch
Salt Repository Project Office

SRPO:TAB:ksw

FOREWORD

Documents are being submitted to the Salt Repository Project Office of the U.S. Department of Energy (DOE) by Battelle Memorial Institute's Office of Nuclear Waste Isolation (ONWI) to satisfy major milestones of the salt host-rock portion 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 U.S. Nuclear Regulatory Commission's separate subsystem-level standards enunciated in the 10 CFR Part 60 rule and National Environmental Policy Act requirements. 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 high-level nuclear waste repository in salt. The present report summarizes Argonne's review of ONWI's Geochemical Program Plan dated July 1982.

Argonne was requested by DOE to review the plan on January 21, 1983 (see App. A). The review procedure involved obtaining written comments on the plan from two of Argonne's core peer review staff, and from one Argonne and two extramural experts having broad experience in the fields of isotope and aqueous geochemistry, groundwater geochemistry and transport, and trace-element migration. The peer review panel met at Argonne on April 29, 1983. Reviewer comments were integrated into the present report by the review session chairman, with the assistance of Argonne's core peer review staff. Each of the peer review panelists concurred in the way in which his comments were represented in this report (see App. B), and a draft of the report was sent to DOE's Salt Repository Project Office on May 24, 1983.

CONTENTS

PEER REVIEW PANEL MEMBERS.....	vii.
SUMMARY OF RECOMMENDATIONS.....	1
1 INTRODUCTION.....	3
2 REGULATORY GUIDE REQUIREMENTS.....	4
2.1 Isotopic and Regional Geochemistry and Hydrochemistry and Groundwater Age.....	4
2.2 Geochemistry.....	5
2.2.1 Host-Rock Geochemistry.....	5
2.2.2 Hydrogeochemistry.....	5
2.2.3 Chemistry of Waste, Barriers, and Environment of a Conceptual Design Repository Appropriate to Site	5
2.2.4 Natural Analogs.....	5
2.2.5 Geochemical Stability.....	6
3 COMMENTS ON TECHNICAL ISSUES NOT HAVING A DIRECT EFFECT ON LICENSING.....	7
3.1 Major Comments.....	7
3.2 Minor Comments.....	8
4 MANAGEMENT ISSUES AND COMMENTS.....	10
5 PAGE-BY-PAGE COMMENTARY.....	11
APPENDIX A: U.S. DEPARTMENT OF ENERGY LETTER REQUESTING PEER REVIEW.....	13
APPENDIX B: CONCURRENCE SHEET.....	17
APPENDIX C: CREDENTIALS OF PEER REVIEW PANEL MEMBERS.....	21

PEER REVIEW PANEL MEMBERS

Professor Douglas G. Brookins
Department of Geology
University of New Mexico
Albuquerque, New Mexico

*Mr. David F. Fenster
Geoscience and Engineering Group
Energy and Environmental Systems Division
Argonne National Laboratory
Argonne, Illinois

**Dr. Wyman Harrison
Associate Director for Geoscience and Engineering
Energy and Environmental Systems Division
Argonne National Laboratory
Argonne, Illinois

Professor Abraham Lerman
Department of Geological Sciences
Northwestern University
Evanston, Illinois

†Dr. Martin G. Seitz
Geochemistry Group
Chemical Technology Division
Argonne National Laboratory
Argonne, Illinois

Ms. Mary W. Tisue
Geosciences Editor
Energy and Environmental Systems Division
Argonne National Laboratory

The credentials of panel members are summarized in App. C.

*Core peer review staff.

**Review panel and review session chairman.

†Assistant review session chairman.

RADIOACTIVE WASTE ISOLATION IN SALT:
PEER REVIEW OF THE OFFICE OF NUCLEAR
WASTE ISOLATION'S GEOCHEMICAL PROGRAM PLAN

prepared by

W. Harrison, M. Seitz, D. Fenster, A. Lerman,
D. Brookins, and M. Tisue

SUMMARY OF RECOMMENDATIONS

The following recommendations have been abstracted from the body of this report. The Office of Nuclear Waste Isolation's Geochemical Program Plan should:

1. Describe the management program for coordinating subcontractors and their work, and integrating research results. Appropriate flowcharts should be included.
2. Provide more information on the overall scope of the program. Detailed milestone charts for the first year and general milestone charts for the following years would be desirable.
3. For each subcontractor, provide specific workscopes that indicate whether analytical activities are developmental or routine, approximate number of analyses to be made, and something of the adequacy of the analyses to meet program goals.
4. Indicate interfaces with other earth-science disciplines like hydrology and with other groups doing relevant geochemical research and engineering design.
5. Address the priorities for each activity or group of activities. High priority should be given to early development of a geochemical statement of what constitutes suitable salt for a repository.
6. Reference standard procedures for sampling, sample preservation, and sample analysis wherever appropriate or, if not appropriate, indicate that any deviations from standard procedures will be documented.
7. Ensure that appropriate quality assurance procedures will be followed for the procedures listed under (6) above.

8. Include specific procedures for the choice, verification, validation, and documentation of computer codes related to the geochemical aspects of repository performance assessment.
9. Include activities addressing regional hydrochemistry and make clear that each principal hydrogeologic unit at each site will be studied geochemically.
10. Indicate that proposed plans for obtaining hydrogeochemical data will be included in each site characterization plan.
11. Describe how site geochemical stability will be handled, especially with respect to dissolution, postemplacement geochemistry, human influences, and climatic variations.
12. Refer to the particular section of the U.S. Nuclear Regulatory Commission Regulatory Guide 4.17 that is being addressed under each listed activity or group of activities.

Minor recommendations and suggested improvements in the text of the plan are given in Sec. 5.

1 INTRODUCTION

Geochemical information is essential to many phases of the Civilian Radioactive Waste Management Program, the most important of which are selection and characterization of repository sites, design and testing of waste packages, and repository performance assessment. The Office of Nuclear Waste Isolation (ONWI) at Battelle Memorial Institute is to develop a program plan to acquire and interpret sufficient geochemical information for the U.S. Department of Energy's (DOE's) application to the U.S. Nuclear Regulatory Commission (NRC) for a license to construct a repository in salt, whether or not such application is actually made.

Argonne National Laboratory's peer review of the ONWI Geochemical Program Plan involved obtaining written critiques of the plan from two of Argonne's core peer review staff, and from one Argonne and two extramural experts having broad experience in the fields of isotope and aqueous geochemistry, groundwater geochemistry and transport, and trace-element migration. The review session chairman, with the assistance of Argonne's core peer review staff, then reviewed all of the comments and drafted the present report. Panelists did not contact ONWI personnel, and none of the panelists has been involved in any DOE-sponsored or ONWI-directed programs such that their participation in the review could be construed as a conflict of interest.

Although no specific guidance was provided to Argonne by DOE on the manner in which the review was to be conducted, the following questions were prepared by DOE to assist in the review process:

1. Does the plan provide for activities to address (and eventually resolve) the issues listed in the NRC Regulatory Guide?
2. What activities planned are either insufficient or superfluous?
3. Are the activities logically presented? Do they represent the most appropriate methodology?
4. What recommendations does the review board have for improving ONWI's geochemical program relative to NRC's requirements?

Throughout its review, the Argonne panel referenced its comments on the ONWI plan to two documents: (1) 10 CFR Part 60, NRC's proposed rule entitled *Disposal of High-Level Radioactive Wastes in Geologic Repositories*, Fed. Reg., 46(130):35,280-35,296 (July 8, 1981) and (2) Regulatory Guide 4.17, NRC's guide 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.

2 REGULATORY GUIDE REQUIREMENTS

Although the Argonne peer review panel was able to determine whether the ONWI Geochemical Program Plan addressed the geochemical issues in the Regulatory Guide, it was unable to determine whether the work projected in the plan would be able to resolve those issues. The plan does not give detailed workscopes for subcontractor activities and is unclear about management mechanisms for integrating the results of the various research activities in a way that promises comprehensive answers. This deficiency is covered in detail in Sec. 4 of this review but is also referred to in the following discussions of specific sections of the Regulatory Guide.

2.1 ISOTOPIC AND REGIONAL HYDROCHEMISTRY (SEC. 5.7.3) AND HYDROCHEMISTRY AND GROUNDWATER AGE (SEC. 5.9.5)

Because Secs. 5.7.3 and 5.9.5 of the Regulatory Guide are somewhat redundant, they will be considered together. After examining ONWI's plan for compliance with the requirements of these sections, the panel concluded that (1) ONWI's plan should make it clear that "regional hydrochemistry" (Sec. 5.7.3) will be addressed, and (2) the plan should state explicitly that "each principal hydrogeologic unit" (Sec. 5.9.5) will be sampled and analyzed. Although ONWI undoubtedly intends to comply with these specific requirements of the Regulatory Guide, its intent should be documented.

It appears that some of the activities listed under Part I of the ONWI plan are designed to address items in the subject sections of the Regulatory Guide. In future revisions of the ONWI plan, it would be useful if the sections of the Regulatory Guide being addressed were referenced. If this had been done in the instance of Sec. 5.7.3, for example, the authors of the plan might have realized that they had omitted reference to the Regulatory Guide's requirements for determination of major dissolved gases and ambient groundwater temperatures. Finally, the requirement that H_2 be determined has apparently been overlooked. Even if ONWI has good reasons for not making such an isotopic determination, it would be desirable for it to justify its position.

It is not clear how the geochemical information relating to these sections of the Regulatory Guide will be evaluated and integrated into a report or reports on the geochemical work and later into the site characterization plans (SCPs). There are many ONWI and DOE subcontractors. Who is responsible for quality control? Who will evaluate, interpret, and integrate the data? Is ONWI planning to do this? The plan should be clear on these points.

2.2 GEOCHEMISTRY (SEC. 6)

2.2.1 Host-Rock Geochemistry (Sec. 6.1)

The Regulatory Guide requires a description of the petrology and mineralogy of "rocks and fracture fill materials along credible pathways to the accessible environment." An NRC staff member contacted on this point indicated that although the Regulatory Guide is ambiguous, the intent is to elicit characterization of the fractures and the materials filling the fractures throughout the relevant stratigraphic section, not just in the salt host rock. The ONWI plan, however, refers only to the "salts" or to the "salt core" as far as mineralogic and petrologic analyses. This deficiency in the plan should be corrected.

2.2.2 Hydrogeochemistry (Sec. 6.2)

The ONWI plan should at least acknowledge the Regulatory Guide's requirement that a description of proposed plans for obtaining missing hydrogeochemical data be included in Part C of the SCP. Furthermore, the plan makes no mention of the quality assurance programs that will be applied to the methods used to collect data. Finally, having considered the 25 items listed in this section, ONWI should make explicit in its plan the items it will or will not include as part of its geochemical data-collection activities. For example, acquiring pH data (item 4) is not mentioned in the ONWI plan although this important variable will undoubtedly be measured.

2.2.3 Chemistry of Waste, Barriers, and Environment of a Conceptual Design Repository Appropriate to Site (Sec. 6.3)

Section 6.3 of the Regulatory Guide is dealt with primarily in Parts V and VII of the ONWI plan. However, the plan does not adequately address the requirements of this section with respect to "anticipated interactions among the waste form, engineered barriers, and environment of a conceptual design or a repository." A close working relationship with the engineers responsible for the waste form and package is clearly desirable so that at least generic interactions may be specified. Also, the ONWI plan does not address the three points in the second paragraph of Sec. 6.3.

2.2.4 Natural Analogs (Sec. 6.4)

The Argonne panel agrees with ONWI that this is a neglected area of the ONWI plan. One panelist stated that "there are so many good potential analogs for bedded salts that it is surprising that none have been listed." A revised plan should remedy this deficiency if possible. Two such analogs that might be developed, either through literature studies or field work, are:

1. Igneous dikes cutting bedded salts. The dike, which acts as a high-temperature heat engine, is typically very rich in rare earth elements, actinides, and other elements to be expected in high-level nuclear waste. The bedded salts, on the other hand, are typically very impoverished in these elements. Because of the high temperature of the dike and the pronounced chemical gradients for these elements, the extent of elemental migration from the dike to the bedded salt can be studied. The results could be extrapolated to interactive systems of high-level waste and salt.
2. Clay mineral seams in bedded salts. This analog addresses the interactions between salt and the backfill materials. Because clay minerals in the seams are commonly detrital, it is possible to assess the degree of resetting of their isotopic systematics as a function of reactions with evaporitic brines.

2.2.5 Geochemical Stability (Sec. 6.5)

The ONWI plan does not address either "potential human influences" or "natural changes due to climatic variation." Unless there is some reason for not doing so, the plan should address these issues. Under Part II (Optimization of Repository Location), it is not clear how the salt history (stability) is to be established. Will this be done by radiometric dating?

3 COMMENTS ON TECHNICAL ISSUES NOT HAVING A DIRECT EFFECT ON LICENSING

Several technical issues that do not directly affect licensing are addressed in this section. These issues were raised by members of the Argonne peer review panel as a means of directing DOE's attention toward areas that were not explicitly addressed by 10 CFR 60 or the Regulatory Guide but which, if addressed by ONWI or its subcontractors, would lead to a more thorough technical understanding of the geologic systems to be studied or improve the management aspects of the Geochemical Program Plan.

3.1 MAJOR COMMENTS

The panelists generally agreed that the issue-oriented organization of the plan was effective and that most of the activities were presented in a logical order. Because the methodologies to be used for each activity were not described, their appropriateness cannot be assessed at this time. For example, standard procedures for sampling, sample preservation, and analysis, as well as related quality assurance procedures, should be referred to wherever appropriate. Such reference is required by the Regulatory Guide and may take the form of referring to widely accepted methods, such as those in the *National Handbook of Recommended Methods for Water Data Acquisition*. If standard methods are not appropriate or are not used, ONWI should request the subcontractor to document the procedures used.

Argonne was also requested by DOE to comment on whether the ONWI plan contains any superfluous activities. It was difficult for the panelists to decide whether any of the listed activities are superfluous because the descriptions of those activities are so superficial. Because the methods to be used and the scope of effort are not known precisely, no comments in this regard can be made at this time.

The ONWI plan would be a more effective document if the individual activities or possibly groups of activities made reference to pertinent sections of the Regulatory Guide or 10 CFR 60. This approach would have the merit of preserving the issue-oriented organization of the plan while being responsive to NRC licensing requirements.

The plan should set priorities for the proposed technical activities, not only with respect to their importance but also with respect to the order in which they should be carried out. Some activities are clearly more critical to site characterization and performance assessment than others. Also, some of the activities require prior completion of another activity. For example, high priority might be assigned to activities to define geochemical criteria for determining a suitable purity for the salt. Part II of the ONWI plan implies that the presence of hydrated minerals is an unfavorable characteristic of salt found in the Paradox Basin. In some bedded salts, hydrated minerals formed penescontemporaneously with anhydrous, primary

evaporite minerals and have retained their isotopic and chemical integrity since formation. Research activities that address salt suitability (cf. 10 CFR 60.122[g]), if accomplished early in the program, would provide valuable guidance for subsequent geochemical studies.

Future revisions of the plan should structure the program, possibly through the use of priorities or sequences of activities, to generate the data or experimental results needed as input for the geochemical and coupled models. Because site-specific geochemical field data and experimental results will ultimately serve as site-specific input for performance assessment, the panelists concluded that the next revision should ensure that the field, experimental, and other data generated are in a form that will be useful for performance assessment. In addition, modeling should not be deferred until later in the program, that is, only after vast amounts of data are available. Modeling activities should be coordinated with data gathering and experimental activities. A way to coordinate these activities should be included in subsequent revisions of the plan.

The ONWI plan would also benefit from drawing clearer distinctions between efforts to characterize the geochemical environment prior to development of the repository and waste emplacement (baseline studies) and efforts to define the geochemical environment after the waste is in place. In general, the geochemical activities should form a framework for resolving the issues that will be dealt with in Part C, Sec. 10 of the SCPs.

Two of the panelists were concerned that the work outlined under several activities could not be accomplished successfully using core or groundwater samples already collected. It may be necessary, for several activities, to analyze newly collected rock or water samples.

One panelist stated that the list of isotopic analyses under Part I, activity (2), is fairly complete. However, this list might be expanded to include Sr(87/86) ratios. Because brines often have different signatures than other fluids, fluid flow could be traced using these data.

Because performance assessment is of major concern to NRC, the ONWI plan should contain explicit plans for computer code choices, verification, validation, and confirmation. This portion of the geochemical plan should be compatible with ONWI's Performance Assessment Plan.

3.2 MINOR COMMENTS

Measuring ambient brine temperatures is recommended as an additional activity. Such measurements would provide useful data and should be part of the groundwater studies. Also, a study of brine pockets should be included with the work on groundwater chemistry. The ONWI plan is not clear as to whether brines are ancient, diagenetically derived fluids or the result of groundwater intrusion. It may be important to attempt to make this

distinction. Also, near-field modeling (Part VIII, [1][b]) should include radiolysis.

The ONWI plan does not provide for fluid inclusion studies. Inclusions in the host rock are a source of fluids that may be chemically different from brines and that may affect interactive chemistry. Given that fluid inclusion studies received a great deal of attention in the work conducted at the Waste Isolation Pilot Plant (WIPP) site, the absence of such studies in the ONWI plan appears to be an omission. The plan should provide for future activities as well as the gathering and interpretation of generic data obtained from other but applicable investigations.

4 MANAGEMENT ISSUES AND COMMENTS

A much-expanded, all-inclusive workscope should be developed for the plan. At present, the plan reads like a budget document for a specific fiscal year. Because some of the activities are certainly multiyear efforts, milestone charts should be provided. These charts should be rather detailed for the forthcoming year but abbreviated for following years.

Of equal importance to adequately defining the scope of the plan is the need to illustrate the interactions among data generators, data evaluators, numerical modelers, and the individuals or groups that will interpret and synthesize the results. Information flows and associated management actions should be explained via an appropriate series of flow diagrams that describe the geochemical program itself but also its relationships to other closely related programs like hydrology, waste-package design, and repository performance assessment. Also, the present format, which sometimes lists several contractors opposite a single activity in the plan, fails to show who is doing what and how the subcontracted work fits together. Further, it is impossible to tell from the plan whether there is duplication of effort, both within and beyond the geochemical sphere of activity.

Finally, the matter of early interaction between modelers and data generators is of particular concern. An appropriate management mechanism is needed to ensure that the modelers will be confident that the data they will be getting will be adequate for their needs.

5 PAGE-BY-PAGE COMMENTARY

<u>Page</u>	<u>Line(s)</u>	<u>Comment</u>
5	21	Insert "Basin" after Permian.
5	23	From what unit (lithology?) will the groundwater samples "immediately above the salt section" be obtained? Is it a principal aquifer?
6	4-5	This item should read, "A 1000-year <u>prewaste emplacement groundwater travel time to the accessible environment.</u> " (The underlined words should be added to conform to the original meaning of the NRC statement.) Also, this requirement is from 10 CFR 60, Sec. 60.112, not Sec. 40.112.
6	26-28	Add "and dissolved gases" after "ground waters." Also, under activity (1) there is no mention of analysis of fluid inclusions. Or, do the authors intend for such analyses to eventually be included under Part II?
7	2	The list under activity (2) is fairly complete but could be expanded to include Sr(87/86). Also, what is the extent of effort under activity (2) at each candidate site? What is the role of GJO? How do they fit into the NWTs program? (Similar queries could be made throughout the plan.)
8	21-23	Are these dates still valid? Subsequent revisions of this plan should be based on a revised schedule.
9	1	This title seems too general and needs explanation.
9	10	What is meant by "testing conditions"?
9	15-30	(1) See pages 7-8 of this report regarding priorities and criteria for defining favorable or unfavorable aspects of salt. (2) How can "areas of high gas pressure" be detected? (3) How will "salt stability" be determined? By radiometric dating? (5) This item is not clear. Are brines ancient, diagenetically derived fluids or are they the result of groundwater intrusion, or are they a product of both processes? Such distinctions must be made.

<u>Page</u>	<u>Line(s)</u>	<u>Comment</u>
10	1	Does the word "these" refer to the preceding list?
12	1-12	The emphasis on salt dissolution is well justified.
12	17	Add the word "concentrations" after ^{36}Cl .
12	28-31	Is activity (2) being performed in the Palo Duro Basin?
14	3	How is "site geochemical stability" defined?
16	1	The words "expected" and "anticipated" may cause confusion if used interchangeably. The use of "expected" in this title for Part V seems appropriate, because one is referring to conditions before waste emplacement. Its use in line 4 on page 22 seems inappropriate because NRC uses "anticipated" to mean conditions after waste emplacement (e.g., see Sec. 6.3 of the Regulatory Guide).
17	1	Are any of the listed activities directed toward examining the thermal response of the proposed repository salt in the Palo Duro Basin?
17	6	The significance of activity (3) is not clear. Doesn't the metamorphism of NaCl to MgCl_2 brines occur through diagenetic reactions (i.e., an old as opposed to a recent event)?
22	1	To conform with the usage in ONWI's Preliminary Performance Assessment Plan, this title should read "Very Near Field Modeling." However, consider that item (d) (line 16) actually deals with the near field.
22	16	What about interactions between brine fluids and seals?
22	21-25	In activity (3), near-field or very near field data may not be directly applicable to the far field. This qualification should be included. Also, "and predictions of the <u>very near field and near-field</u> geochemical states" would be a more accurate wording.
23	1	What is meant by "competent for"?

APPENDIX A

U.S. DEPARTMENT OF ENERGY LETTER REQUESTING PEER REVIEW

**Department of Energy
National Waste Terminal
Storage Program Office
505 King Avenue
Columbus, Ohio 43201**

January 21, 1983

Dr. Wyman Harrison
EES-362
Argonne National Laboratory
Argonne, Illinois 60439

Dear Dr. Harrison:

PEER REVIEW OF ONWI GEOCHEMICAL PROGRAM PLAN

Enclosed is a copy of the subject report which we request be reviewed in accordance with Work Package No. ANL 053 00 83. Provisions of the recently enacted nuclear waste legislation (H.R. 3809) will result in some adjustments to the planning schedule that is attached to the work package; we will be in contact with you later about schedule revisions.

Also enclosed is a memorandum to me from Tom Baillieu of my staff outlining the items on which we wish the reviewers to focus. He has included portions of NRC's guide for Site Characterization Reports that are relevant to the review.

Reviews of the geochemical report and that of the Socioeconomic Program Plan should provide us the material necessary to initiate and, as necessary, to fine tune our peer review procedures.

Please contact me when I may be of assistance.

Linda K. McClain for

Maxwell B. Blanchard
Director, Site Exploration and
Related Geoscience Research
NWTS Program Office

NPO:MBB:rkg//738A

GS# 231-83

APPENDIX B

CONCURRENCE SHEET

APPENDIX B

CONCURRENCE SHEET

I concur that the Argonne National Laboratory report on ONWI's Geochemical Program Plan fairly represents my comments, where incorporated, to the peer review panel.

Douglas G. Brookins

David F. Fenster

Wyman Harrison

Abraham Lerman

Martin G. Seitz

APPENDIX C

CREDENTIALS OF PEER REVIEW PANEL MEMBERS

Douglas G. Brookins

Santa Rosa Junior College: A.A. (1956)

University of California, Berkeley: A.B., Geology (1958)

Massachusetts Institute of Technology: Ph.D., Geochemistry (1963)

Professor Brookins joined the faculty of the Department of Geology at the University of New Mexico, Albuquerque, in 1971 and served as Chairman from 1976 through 1979. He holds part-time positions with the geological surveys of Maine and the United States. Dr. Brookins has been an active participant in several symposia on the scientific basis for nuclear waste management and an active researcher on the Oklo natural reactor and natural analogs. He has served as a consultant to Sandia Laboratories for geochemistry and geochronology at the Waste Isolation Pilot Plant site.

Prior to accepting the position at the University of New Mexico, Dr. Brookins served first as Assistant and then as Associate Professor of Geology at Kansas State University from 1963 to 1971. During that time he had a part-time appointment as a geochemist with the Kansas State Geological Survey. Professor Brookins had had prior experience at the Geochronology Laboratory at MIT; ANCO Corporation, Wilmington, Mass.; California Co., Wy.; Cabot Spectrographic Laboratory at MIT; and Bear Creek Mining Co.

Professor Brookins has published extensively in the fields of geochronology, trace-element studies, isotope geochemistry, uranium deposits, and radioactive waste disposal. His publications related to radioactive waste isolation are on such topics as isotope composition of halite and included brines, the Oklo natural reactor, shale as a repository host rock, thermodynamics of radionuclide migration, Rb-Sr systematics of the Salado Formation (Upper Permian), clay minerals suitable for overpack material, clay mineral-brine interaction during evaporite formation, long-term stability of evaporites, and near-field reactions in evaporites.

Professor Brookins is a member of 31 honorary and professional societies. He is a Fellow of the Geological Society of America and a member of the American Institute of Chemists, the Mineralogical Society of America, and the Explorers Club.

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

Dr. Harrison is Associate Director for Geoscience and Engineering at 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.

Abraham Lerman

The Hebrew University: M.Sc., Geology (1960)

Harvard University: Ph.D., Geology (1964)

Dr. Lerman joined the Department of Geological Sciences at Northwestern University, Evanston, Ill., in 1971 as an associate professor and has been a professor since 1975. Dr. Lerman has extensive experience in aqueous geochemistry, geochemistry of brines, isotope geochemistry, and radionuclide migration. He is a resource consultant on waste packaging and geochemistry for the Basalt Waste Isolation Project Overview Committee. During 1980 Dr. Lerman was a member of the Backfill Evaluation Panel for Battelle's Pacific Northwest Laboratory.

While associated with Northwestern University, Dr. Lerman has served, at various times, as a visiting professor at several European universities. Prior to joining the faculty at Northwestern, he was a Research Scientist in Chemical Limnology at the Canada Centre for Inland Waters (1969-1971), a Visiting Investigator and Senior Scientist in Isotope Research at Weizman Institute of Science (1966-1969), an Assistant Professor of Geology at the University of Illinois at Chicago Circle Campus (1965-1968), a Visiting Investigator (geochemistry) at Lamont-Doherty Geological Observatory of Columbia University (Summer, 1965), and a Lecturer and Assistant Professor of Geology at the Johns Hopkins University (1964-1965).

Dr. Lerman has published extensively in the areas of geochemical processes in water and sediments, halite and brines, chemical limnology, geochemical cycles, and radionuclides in sediments. He is a member of five professional societies and a Fellow of the Geological Society of America.

Martin G. Seitz

University of Missouri: B.S., Engineering Physics (1966)

Washington University: Ph.D., Geophysics (1971)

Dr. Seitz is a geochemist in the Geochemistry Group of the Chemical Technology Division of Argonne National Laboratory, where he manages applied and basic experimental programs. Ongoing applied programs related to nuclear waste disposal are to investigate interactions of materials proposed to be used in disposing of nuclear waste and to learn how backfill materials would be affected by the conditions of nuclear waste disposal. The basic research program of the group is to study trace-element migration in the earth's crust. Current work focuses on the role of organics in mobilizing heavy metals and on the movement of phenol compounds through water-bearing rock.

In the past year, Dr. Seitz served with seven others on the Panel to Assess the Technical Basis of 10 CFR 60, the proposed U.S. Nuclear Regulatory Commission rule for licensing a high-level waste repository. Dr. Seitz also completed experimental work on radionuclide retention in salt (Waste Isolation Pilot Plant) and helped develop logging methods in bore holes to detect petroleum. He has organized workshops on nuclear and hazardous waste disposal and has done geologic field work with university and U.S. Geological Survey staff.

Before coming to Argonne, Dr. Seitz worked as a fellow at the Geophysical Laboratory of the Carnegie Institution of Washington, where he studied the chemical partitioning and solid diffusion of trace elements in igneous rock. Having received a National Defense Act fellowship for graduate work, Dr. Seitz determined rock ages from products of spontaneous fission and studied the distributions of uranium and thorium in igneous rocks.

Dr. Seitz has published over 60 papers in scientific journals, primarily on geochemical topics.

Mary W. Tissue

Beloit College. B.S., Geology (1961)
Yale University: M.S., Geology (1963)

Ms. Tissue has been employed since 1979 as a technical editor for the Energy and Environmental Systems Division of Argonne National Laboratory. From 1981 through 1983, she was part of a research team that gathered geologic information on the crystalline rocks of the northeastern and north-central United States, with a view to assessing their suitability as sites for repositories for high-level radioactive waste. Other projects have involved the editing of reports, journal articles, conference papers, and proposals on such topics as transportation, decision analysis, particulate control, industrial process energy conservation, economics of gasohol, chemistry of synthetic fuel process waters, environmental studies of ocean thermal electric conversion, recycling, petroleum geology and resource assessment, and socioeconomic impact of energy development.

Prior to accepting a position at Argonne, Ms. Tissue worked as a technical writer and marketing assistant for an instrument company and as an editor for the Metals Research Laboratory of what was then the Olin-Mathieson Chemical Corporation.

Ms. Tissue is a member of the Society for Technical Communication and the Association of Earth Science Editors.