



Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

September 10, 1982

Our ref: G/82/300

U.S. Nuclear Regulatory Commission
High Level Waste Technical Development
Division of Waste Management
Washington, D.C. 20555

Attention: F. R. Cook

Subject: Contract No. NRC-02-81-027
Performance of Engineered Barriers in a Geologic Repository
Waste Package Workshop, BWIP - Trip Report
Letter #55

Gentlemen:

We are pleased to submit this report concerning the BWIP Waste Package Workshop at Rockwell Hanford Operations, August 9-12, 1982, which was attended by R. Talbot of Golder Associates.

The purpose of the workshop was to obtain information related to key issues contained in the Site Characterization Report, and plans to resolve those issues, to allow the NRC to scope their Site Characterization Analysis by October 1, 1982. The workshop was intended to focus on the data and analyses that have been used in the SCR to support conclusions drawn with respect to the site. Plans for future tests and analyses required to resolve key issues were also to be discussed.

The waste package team was instructed to focus on metal corrosion and waste form dissolution; information on backfill was of interest only to the extent that it influences the corrosive environment of the waste package. The main area of interest to Golder Associates within this workshop was the definition of the emplacement environment as it affects waste package performance and design. One specific area of concern, geochemical parameters and environment, was discussed in the Geochemistry Workshop, conducted at the same time, with which Golder Associates was not specifically involved.

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The waste package workshop was structured as follows:

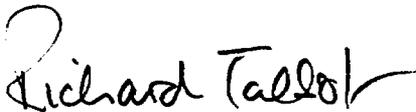
- Day 1. Presentations by the RHO staff.
- Day 2. Presentations by the RHO staff.
Discussions of corrosion - whole group.
- Day 3. Small discussion groups, specific topics.
- Day 4. Wrap up meeting with RHO.

It was unfortunate that this approach consumed far too much of the available time in either general presentations by RHO of only limited usefulness, or in detailed discussion of certain topics involving all workshop members but of specific interest to few. As a result, the remaining time was insufficient to allow more than a rather cursory review of topics of interest to Golder Associates. For future workshops, there is a clear need to provide Rockwell with a detailed list of discussion topics and/or questions that are of concern to the NRC well before the scheduled workshop dates.

The attached notes summarize information obtained in the areas of interest, and provide some conclusions. Please direct any questions or comments on this material to the undersigned.

Sincerely,

GOLDER ASSOCIATES



Richard Talbot
Assistant Project Manager

RT/lw

Attachment

cc: C. L. Pittiglio
J. Greeves
Division of Contracts

1. General Conclusions

- 1.1 An impression was gained that the program for waste package design, definition of environmental conditions around the waste package, and waste package performance analysis is in a relatively infant stage. It is likely that many questions concerning the adequacy of existing data and analyses will be unresolved in the SCR. However, the work currently in progress and planned to define the waste package environment, both during repository operations and post closure, appears to be focused on the major issues.
- 1.2 During discussions, it became apparent that the interfacing and information exchange between the various technical groups was not as positive as it should be and this could lead, under the worst circumstances, to erroneous conclusions. This was particularly noticed with respect to the near field hydrological modeling and the site hydrology. It is essential that alternative models, and assumptions used in modeling, should ultimately be consistent for the various design or site investigations. It is possible that the performance assessment activities that are now in progress will provide the integration needed.
- 1.3 The horizontal storage concept has been selected as the reference design for the SCR, primarily to reduce construction costs (excavated volume). No information was available to indicate that the feasibility of this concept had been adequately evaluated, or that tests were planned to confirm this.
- 1.4 The waste package has been simplified:

- o The 1½ inch thick carbon steel canister for spent fuel.
- o A carbon steel overpack for CHLW.

This design simplification has been justified on the basis that:

- o Reducing conditions (low oxygen fugacity) will be achieved rapidly in the repository; the basis for this conclusion is empirical and it is not clear that this will be substantiated by testing.
- o The canister is designed for hydrostatic pressure (1600 psi) at 1000 years, with a corrosion allowance of 1/2 inch.
- o Mechanical pressure on the canister will be effectively zero; data and analyses to support this conclusion were not readily available, and the interaction between the host rock/backfill/canister must be clearly established.

- o The backfill sorption provides a backup for early canister failure and functions as a diffusion barrier; while a considerable amount of data on backfill exists, the available data on possible retardation factors for backfill is poorly described at expected repository conditions. No analyses were available to support or quantify this role for backfill.

1.5 The selected backfill materials is 75% basalt/25% bentonite, chosen because:

- o The swelling bentonite will keep water away from the package for a period of time.
- o The crushed basalt assists in Eh control, reduces cost and provides a more mechanically stable backfill.

While considerable lab data exists on backfill thermo-mechanical properties, no full scale tests have been conducted to evaluate for the horizontal configuration:

- o Backfill placement techniques for either storage holes or the storage rooms.
- o Properties of the in-situ backfill for both cases.

The effect of keeping storage holes open for 50 years before backfill placement would have to be considered. It is not clear that this type of test is planned prior to license application.

1.6 Thermal analyses have been completed and are continuing for the revised storage configuration. These analyses (using HEATING5) have been done in one, two and three dimensions. The analyses have not been coupled with groundwater flow, and thus predict slightly higher rock temperatures than would be expected. The assumptions made in this work are conservative, and we consider this work to be adequate for design purposes at this stage. Temperatures predicted are in good agreement with other published data. Comparison predicted values and measurements in the NSTF have been made satisfactorily. It is not clear, however, that the limiting conditions of temperature gradient have been evaluated by considering combinations of different aged waste in a storage hole.

1.7 Near field hydrologic analyses are presently underway to evaluate:

- o Local flow conditions around the waste package.
- o Liquid/steam phases.

It is unlikely that this work will be reported in any detail in the SCR, and flow predictions around the waste package may be based on far field modeling completed to date. This

work will need to be completed to provide adequate definition of the waste package environment.

As stated earlier, we are concerned that the assumptions and boundary conditions used in this work should reflect the range of conditions likely to be found at the site. This work should be closely interfaced with the site hydrology studies. No data or analyses for this work were available.

DOE/NRC WRAP-UP MEETING
AUGUST 12, 1982

AttendeeAffiliation

P. F. Salter	ENIP
D. J. Brooks	NRC/IBSS
E. A. Hick	NRC/IBSS
R. Talbot	Goldier Associates
Phil S. Justus	USNRC/DWM/ENIP
Gary K. Jacobs	ENIP
F. R. Cook	NRC
Vfc Der	DOE/HQ
Chet Compton	DOE/RL
Michael McNeal	NRC/RES
Don Helmers	ORNL
Karl Saylor	BNL
Malcolm Stegel	SRL
H. J. Anderson	Rockwell/ENIP
Raul A. Deju	Rockwell/ENIP
Art Lassila	DOE/RL
Bob Wright	NRC
Dave Eder	ENIP
J. H. LaRue	Rockwell-Licensing

TO: R.J. WRIGHT
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For Joe LaRue

NUCLEAR REGULATORY COMMISSION

CLOSING MEETING MINUTES

AUGUST 12, 1982

The subject meeting started at 8:30 a.m. and was chaired by R. J. Wright. His comments are outlined below:

- o A decision has been made to change the engineering system definition in the TOCFRGO for final submittal. The 10-5 release rate boundary is now more flexible. DOE will now define and assess the release rate at the edge of the engineered system, which has been defined as at the edge of the host rock (borehole wall).
- o Because of the large data base on carbon steel, the primary candidate canister material, waste package has a strong data base for engineering purposes, based on years of material testing. Radionuclide migration has not been studied as much in the past; therefore, the current data base is more limited. As a result, the problem facing geochemistry is to identify the key data needs that can be satisfied during site characterization.

The meeting was then directed toward F. R. Cook, who commented that good documentation of the analysis in the preliminary design is needed. He further commented on key items concerning waste package activities that developed from the workshop (see attached).

Further key items concerning geochemistry activities were identified by P. S. Justus, which are also outlined in detail in the attachment.

R. A. Deju continued the meeting by stating some key points:

- o Waste package design performance versus cost must be kept in perspective.
- o Types of tests must be carefully selected, reviewed, and agreed upon by DOE/EMIP.
- o Amount of data to be collected must be optimized.
- o EMIP operating procedures which do not fall under a national consensus standard will go through a qualification process utilizing the EMIP overview committee to prove their validity.

A separate performance assessment workshop may be needed with EMIP personnel. Since the understanding of regional groundwater flow is critical to understanding of flow in the Pasco Basin, NRC would like to participate fully in the ongoing RHO/PNL/USGS coordination work. DOE/EMIP is studying this matter. RHO provided certain hydrologic information that was missed during the hydrological workshop. Also RHO provided some sample information sheets for a new system to track NRC concerns and DOE/NRC action items. NRC will provide input into the system, in the form of open items derived from past NRC trip reports. In addition, NRC will provide comments on the submitted plans for resolution of these items.

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**WASTE PACKAGE/GEOCHEMISTRY WORKSHOP
AUGUST 12, 1982**

IDENTIFIED ITEMS

1. The NRC believes that the engineered system provides greater reliability of performance than the geologic components and that statistical versus deterministic approaches for component performance assessment should be used.
2. The NRC is concerned that sufficient and traceable documentation of engineering analysis and data be available.
3. The NRC considers the incorporation of progressive failures is necessary in reliability assessments.
4. The NRC believes that the range of environmental conditions in regards to space and time must be considered in performance analyses rather than a nominal set of conditions.
5. The NRC is concerned that the backfill mechanical properties be appropriately applied in establishing external pressure on a canister.
6. The NRC is concerned that modeling reflects or accounts for the anisotropic hydrologic characteristics of the rock including off-normal conditions.
7. The NRC considers that a performance assessment must be conducted for off-normal as well as expected conditions.
8. The NRC is concerned that the internal loading from, for example, waste form swelling was not analyzed in the conceptual design.
9. The NRC believes that since pitting corrosion is considered by Rockwell to be the most probable initiating failure mechanism for canisters, the conceptual design should have been based on an analysis of pitting corrosion.
10. The NRC is concerned that the effect of radiation on the corrosion of waste package components be appropriately defined.
11. The NRC believes that an analysis of hydrogen effects on canister material is required and that testing be accomplished to confirm the analyses.
12. The NRC is concerned that the DWIP is not considering the favorable effect which a dissolution-resistant waste form has on preventing colloid and particulate transport.
13. The NRC would like to see solution chemistry analyses performed as part of corrosion testing.
14. The NRC would like to see alternative explanations and interpretations of existing geochemical data.

Identified Items (Continued)

- 5. The NRC would like to see Eh calculations corroborated by petrographic observations and further experiments on the rate of oxygen consumption by basalt. Sampling and analytical problems in CH₄-CO₂ analyses of ground-water makes these of questionable use.
- 6. The NRC believes that high temperature solubilities (steady-state concentrations) should be approached from both over- and under-saturation directives.
- 17. The NRC believes that in determining sorption behavior:
 - (a) Isotherms should be the minimum acceptable approach for quantitative analyses.
 - (b) Constant K_d's are only acceptable for comparative purposes.
 - (c) Materials for sorption determination should include altered basalt, fracture minerals, interbed materials, and fresh basalt, and
 - (d) The importance of colloidal transport should be addressed.
- 18. The NRC believes that performance assessment modeling should address:
 - (a) Uncertainties of input data.
 - (b) The importance of matrix diffusion,
 - (c) The applicability of a porous media model for transport calculations in the interflow zones and the very near-field, and
 - (d) The application of more comprehensive geochemical models to waste package performance assessment and far-field hydrologic transport codes.


 U.S. Department of Energy, Richland Operations Office

8/13/82

Date

Nuclear Regulatory Commission

Date

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Report on August 16
NRC (WMHL) - Sandia - General Atomics Meeting At General Atomics
To Review Progress on Waste Package Reliability Project

Attendees:

L. Rossbach, NRC	G. Reynolds, GA
R. Cook, NRC	R. Campana, GA
N. Ortiz, SNL	T. Gulden, GA
	F. Postula, GA (Systems study only)

I. Corrosion Data Base Review

Data bases from the following organizations were discussed: National Bureau of Standards (NBS), American Society for Testing and Materials, F. L. LaQue Corrosion Laboratory (FLLCL), U. S. Department of Defense, Panama Canal Company (PCC), pipeline companies and National Association of Corrosion Engineers. The most promising of these are: 1) NBS, they have a large underground corrosion data base going back to 1927, much of which is unpublished. NBS also has about eight years of unpublished seawater corrosion data. NBS is reluctant to release unpublished data, 2) FLLCL, they have extensive data on iron, steels, and non-ferrous alloys including titanium in atmosphere and marine environments, and 3) PCC, they have a large data base covering 15 years (maybe 30 years) underground, atmospheric, and seawater exposure for iron,

steels, and nonferrous alloys including titanium alloys. Some of the PCC data is unpublished and the principal investigatory is now deceased.

II. Reliability Data Review

Little failure rate data has been found. Significant potential sources remain for investigation and GA is continuing to review these. If failure rate data is not directly obtainable then considerable effort requiring additional time and money may be required to analyze raw data.

III. Systems Study for High-Level Waste Regulation Cost Estimates

I sent Sandia a draft copy of an SOW amendment defining the Systems Study Cost estimating work we were thinking of starting. Sandia is considering using GA as a subcontractor in that work. We briefly discussed the work described in the SOW amendment. GA described previous cost studies that they have done and expressed their interest in helping Sandia develop a cost estimating methodology and data base for the proposed project.

IV. Meeting Agreements

The following agreements were read, agreed to and signed by L. Rossbach, N. Ortiz, and G. Reynolds:

1. In the next month GA will obtain maximum available data from selected sources, concentrating on NBS, FLLCL, and PCC. GA

will also investigate pipeline companies and Navy data bases^s further for possible inclusion in the corrosion data base.

2. GA will begin statistical treatment of available data bases, looking for commonalities.
3. GA will look at sources of archeological and deep marine corrosion data, 55 gallon drum and food canning failure data for possible inclusion in the data base.
4. GA will attempt to get Cs capsule reliability data.
5. GA will seek corrosion data for low oxygen environments from SCRIPPS.
6. GA will look at TRIGA reactor fuel element failure data for possible inclusion in the corrosion and reliability data base.
7. After looking at the above data GA will notify SNLA if additional effort is needed to analyze the above raw data to complete the failure analysis, SNLA will then notify L. Rossbach.