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MEMORANDUM FOR: Malcolm Knapp  
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FROM: Michael F. Weber  
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SUBJECT: DEBRIEFING MEMORANDUM ABOUT PERFORMANCE ASSESSMENT  
TOPICS DISCUSSED AT THE NRC-ONWI-DOE MEETING, APRIL  
19-20, 1983, AT COLUMBUS, OHIO

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This memorandum documents the performance assessment topics that were discussed at the NRC-ONWI-DOE meeting in Columbus, Ohio, held on April 19-20, 1983. Most of this information was discussed outside of the formal session during a meeting between myself and John Kircher, who is the coordinator of performance assessment activities for the ONWI salt projects. The first portion of this memorandum provides a summary of the information discussed. This is followed by documentation of the question-answer session with Dr. Kircher.

This memorandum is not a substitute for the minutes of the meeting.

#### SUMMARY

ONWI presented overviews of work to date and schedules for distribution of performance assessment products during FY83. This work is being conducted under the Systems Function of ONWI, which is managed by W.M. Hewitt. Mr. Hewitt did not attend the meeting. Performance assessment for the salt project(s) will be conducted in the Performance Assessment Department, which is managed by J.F. Kircher. The Systems Function also includes the Regulatory Department (managed by M.A. Glora) and the Systems Engineering Department (managed by J.R. McDowell). All of these managers did attend sessions of the meeting between NRC-ONWI-DOE.

After describing the scope of ONWI performance assessment (PA) activities for the salt projects and the principal subcontractors in PA, Dr. Kircher described the release schedule for products of the PA Department, including a broad Performance Assessment Plan, code documentation,

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results of the SCEPTER program, and a listing of the codes to be used in SCP and post-SCP activities for the salt projects. The scope of the PA activities by ONWI includes the development of performance assessment methodology for the salt sites and deliniation of the pre- and post-closure assessments to demonstrate compliance of a HLW repository in salt to the various regulatory criteria (40 CFR 191 and 10 CFR 60). Dr. Kircher was clear in emphasizing that over 50 % of the PA activities are being conducted within ONWI. The results of this work will be documented in the PA Plan, which is currently under first order review within ONWI. The NRC can expect this document prior to receipt of the SCP, and it may be available late this summer (8/83). ONWI encouraged NRC comment and guidance on the methodology after NRC review. ONWI was not aware of the Risk Methodology for HLW repositories that was developed for the NRC by Sandia National Laboratories.

The principal subcontractors to ONWI on PA activities include the following groups:

- Intera Environmental Consultants - SCEPTER program, methodology development, incorporation of uncertainty in PA, site PA, and waste package modeling.
- ORNL- Adjoint uncertainty analyses.
- PNL- Benchmarking of siting codes and development of geostatistical modeling techniques.
- Battelle-Columbus- Computer coding and development of Adjoint modeling techniques.

Dr. Kircher identified stress failure as the most probable failure mode of waste packages at the salt sites. He did not elaborate on this subject. To assess waste package performance, the computer code WAPPA will be used; the NRC can expect documentation of WAPPA along with at least 19 other PA codes by June. The documentation has been prepared to NRC specifications (by S.Silling) and is being printed. ONWI had no problems implementing the NRC recommendations for code documentation. I encouraged their comments and suggestions. The processes that have been identified by ONWI as being significant for PA of repositories in salt are documented and will be justified in the PA Plan. Diagrams from the Plan have been attached to this memo among the slides from Dr. Kircher's presentation on PA activities. PA modeling on the repository scale will

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model to the edge of the engineered barriers. This is the extent of the "disturbed zone" as considered by ONWI. Repository scale modeling is not as advanced for the salt sites as are the waste package scale and regional scale modeling studies because of the dependence of the repository characteristics on the repository design in addition to the site specific characteristics. Unlike NRC modeling, repository-scale modeling does not extend to the edge of the control zone.

Larger-scale models (e.g. regional groundwater flow and transport simulations) may or may not include thermo-mechanical-hydraulic effects. These effects have not been analyzed on this scale by ONWI to determine their significance in repository performance. Models of this scale will evaluate and simulate discharges to the accessible environment, boundary conditions for smaller-scale models, and regional control on groundwater flow and transport.

ONWI has identified the need to assess operational phase radiological safety.

By July 1983, the NRC will have received documentation for the 20 codes listed on the slides used in Mr. Kircher's presentation on PA. Among these codes will most likely be the codes that will be used in PA of the salt sites. Some of these codes will not be used in PA activities, but they are being documented anyway in case another group wishes to use the codes. Tapes of all of these codes will be supplied to the NRC upon the NRC request for the code listings.

Draft reports on regional groundwater modeling studies for the three salt sites are currently in the review process and should be released prior to NRC receipt of the salt SCP. Although the three sites were not specified by Dr. Kircher, they most probably include Paradox Basin, Paloduro Basin, and Richton Dome. The reports are preliminary performance assessments of the sites undertaken to predict groundwater flow paths and travel times to discharge points on the regional scale for pre-emplacement conditions. These reports may also include results from kriging and adjoint modeling studies of the regional groundwater flow systems. The modeling studies were undertaken to support geologic and hydrologic site characterization as well as preliminary recommendations for site selection. Various subcontractors to ONWI are participating in conducting their own modeling studies to aid in the understanding of hydrology, geology, and geochemistry. ONWI (Battelle-Columbus) is primarily concerned with the development of PA methodology.

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#### OBSERVATIONS ABOUT ONWI'S PA PROGRAM

- ° The NRC review of PA activities that are conducted by ONWI will be aided substantially by the complete documentation of PA codes prior to the receipt of the salt site SCP.
- ° ONWI's definitions of validation and verification are consistent with NRC definitions as included in the Chapter 9 of the BWIP DSCA.
- ° ONWI is willing to interact with the NRC in the development of probabilistic risk assessment methodology for HLW repositories in salt, formulation of scenarios, establishment of benchmarking guidelines, and refinement of PA methodology.
- ° ONWI is unaware of the NRC computer code benchmarking project, the SNL risk methodology for HLW repositories, and NRC Performance Assessments of other non-salt potential repository sites.
- ° ONWI's willingness to share available computer codes with the NRC will aid in the review of PA activities.
- ° ONWI's development of a data baseline to coordinate site characterization should strengthen the ONWI PA program.
- ° Because ONWI's PA activities do not question the validity of the input to the computer codes, the NRC is uncertain how modeling results will be interpreted and checked for validity and accuracy.
- ° The establishment of a code custodian may aid the NRC review process of the ONWI PA activities in supplying code information; the ONWI program should also be strengthened by encouraging responses from the NRC.
- ° The incorporation of uncertainties and parameter ranges into PA activities for the salt sites should strengthen the ONWI program if the techniques are valid and defensible.

#### QUESTIONS-ANSWERS

(Session between J. Kircher and M. Weber, with L. Casey observing for NPO/DOE)

1. Should the NRC expect to see numerical modeling results in the salt site SCP?

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Three regional groundwater flow models have been completed for inclusion in the Salt SCP--one model for each of the salt sites. The documentation of these simulations is currently in review and will be supplied to the NRC prior to NRC receipt of the SCP. The models are a first attempt by ONWI to determine minimum groundwater travel times under pre-emplacment conditions. Simplifying assumptions were made where the data base was insufficient. The documentation of these models stressess that they are a first attempt; they are only as valid as the assumptions that were made to execute the simulations. The computer code SWENT was used for these simulations. SWENT is a sister code to SWIFT and was developed by Intera.

2. What types of models have been applied at the different sites?

Besides the application of deterministic codes such as SWENT, ONWI has been using kriging and adjoint models to support the data collection effort and to incorporate uncertainties in evaluations of the sites (e.g. estimating the uncertainty in darcy velocities due to uncertainties in transmissivities and hydraulic gradients). The Performance Assessment Plan to be released during FY83 describes the effective use and application of these various numerical and statistical techniques in the overall risk assessment methodology. Inverse modeling has been considered, but has not been executed to date.

3. What modeling has been done of salt dissolution at the various salt sites?

No modeling of salt dissolution has been conducted by ONWI or its subcontractors to date.

4. Has ONWI modeled regional solute transport from the repository sites to the accessible environment?

Contaminant transport models have been constructed for the various sites, but, according to Dr. Kircher, these models were not executed to determine compliance with the EPA release limits to the accessible environment. Rather these models were executed to determine order of magnitude estimates of systems performance.

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5. Have dose models been executed to evaluate pre-closure performance?

Dose and radiological assessment models have not been executed to date.

6. Have thermo-hydro-chemo-mechanical models been used to date?

ONWI has considered using these models, but has not executed them to date.

7. As you are aware of the recent controversy about the ability of the convective-dispersive transport formulation of many solute transport codes to realistically simulate field-scale dispersion, has ONWI used stochastic approaches to solute transport codes?

Stochastic approaches have not been used to date, although ONWI is vaguely aware of the controversy.

8. Does ONWI plan to use fracture flow (e.g. dual-porosity) codes to simulate regional and/or repository scale flow and transport?

The significance of fracture flow has been examined by ONWI for the salt sites. Although it may be important in crystalline rocks, fracture flow is not considered to be important in regional models of the salt sites by ONWI at this time. Fracture flow modeling may be required to simulate a repository scale flow if, for example, the drifts are back-filled with crushed salt. The decision to implement fracture flow codes is a problem of scale.

9. What about the significance of fracture flow in the dissolution process especially when groundwater flows through fractures in the confining units adjacent to the salt deposits?

ONWI has not thoroughly investigated these processes to date. Bounding approaches to the evaluation may be adopted.

10. What computer codes of groundwater flow and transport will be used to simulate brine flow and dissolution?

SWENT handles brine flow/transport as well as dissolution. To evaluate dissolution, the accompanying process of precipitation must also be considered. SWENT will be examined in the latter half of FY83 for its capability to simulate brine flow, dissolution, and precipitation of salt.

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## 11. What problems are being used by ONWI to benchmark the PA codes?

Problems are specific to each code. The benchmark problems will be described and documented in the documentation for each code. From these problems and others, ONWI is attempting to select a small suite of problems that may be used to benchmark all of the relevant codes for the salt project.

## 12. What computer codes have been benchmarked in the SCEPTER program?

Most of the codes benchmarked in the SCEPTER program are included in the documentation list from the set of slides about ONWI's performance assessment of the salt sites (see attached set of slides).

## 13. To what extent is ONWI participating in the INTRACOIN program?

ONWI participated last year in the INTRACOIN program, but is no longer an active member.

## 14. Are the regional groundwater flow models of the salt sites being calibrated against historical data?

Yes, the models are being calibrated wherever possible, given the sparse data base.

## 15. What release scenarios have been evaluated from repositories at the various salt sites and where are they documented?

The scenarios have not been documented and distributed to date. Most of the plausible and defensible scenarios involve either borehole penetrations (single or multiple) or fault rupture with perturbations to the regional groundwater flow system. These scenarios probably will not be included in the SCP.

## 16. How are the probabilities of the release scenarios being assessed?

No probabilities of the scenario occurrence have been determined because ONWI views the release scenarios as processes rather than events. The incorporation of release scenarios and their evaluation is addressed in the Performance Assessment Plan. This document also discusses the validity or justification of probabilistic risk assessment for HLW repositories.

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17. In the engineering portion of this meeting ( the main session), performance assessments were cited as having contributed to the establishment of siting criteria for the salt sites. Are these performance assessments documented and available to the NRC?

This reference was most probably a mistake in terminology. Dr. Kircher is not aware of any performance assessments to justify these siting criteria.

18. Has ONWI PA considered the importance of resaturation after waste emplacement?

Resaturation of the repository has only been evaluated in regard to brine migration up the thermal gradient back into the repository after the waste begins to heat up the host salt. These analyses provide rates of brine influx as a function of the thermal gradient.

19. When will the data baseline be established for the salt site?

The schedule of completion is uncertain. DOE-HQ has the lead on determining this baseline. It is probable that the baseline will not be established prior to SCP receipt by the NRC.

20. Are there any long term head-monitoring wells that are completed in both the aquifers and aquitards at the salt sites?

Probably, but G. Heim would be more capable to answer this question.

21. Has the PA methodology begun to determine the extent of the disturbed zone around the repository after waste emplacement?

Some modeling has been done to compare with the effects on salt blocks in laboratory investigations. The disturbed zone is taken to be the mechanically-disturbed zone around the excavation, which is consistent with the mining engineering concept of the zone.

(Author's note: ONWI and DOE need NRC recommendations for the extent of the disturbed zone and a definition of the disturbed zone. The concepts of the DOE and NRC are not compatible, as the NRC considers a more extensive zone around the repository, where the isolation system is perturbed by the thermal, chemical, hydraulic, and/or mechanical effects of the repository. In the near future, the NRC should prepare a staff technical position on the deliniation of the disturbed zone.)

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22. Will all PA computer codes used in preparation of the SCP and pre-licensing activities be documented prior to receipt of documents that describe these activities?

Yes.

23. Will the plan for code documentation, benchmarking, and validation/verification be included in the Performance Assessment Plan by ONWI scheduled to be released in FY83?

No, the code validation and benchmarking plan will be documented separately from the PA Plan. This too should be completed in the immediate future, and NRC comments and recommendations will be appreciated and possibly incorporated in the plan when finalized.

#### RECOMMENDATIONS TO ONWI

During the course of the official meeting with ONWI and DOE, Jeff Smith requested responses from the technical working staff as to how the SCP for the salt site will be evaluated and critiqued. These recommendations were couched as those of the technical staff and not necessarily the official position of the NRC. I responded with the following generalities:

In preparing the salt site SCP, ONWI and DOE should provide sufficient information so that the NRC can conduct an independent and unbiased review in a timely manner. The Performance Assessment sections will be critiqued based upon

- how well have the site issues been identified and addressed?

- how well have the uncertainties been included and accounted for in the analysis?

- how detailed are the project plans and how well do these plans address the resolution of the site performance issues?

More specifically, if analytical or numerical analyses are included in and support conclusions of the SCP, they will be critiqued on

- whether or not all assumptions are clearly defined and supported if questionable?

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- how consistent are the data used as input in the analyses with information contained in other sections of the SCP (e.g. geology, hydrology, design, etc.)

- how well are the limitations of the analyses described?

- how much confidence is placed in the results of the analyses?

- is the overall framework for PA a sound technical approach?

- how well are the uncertainties in the data and techniques incorporated in the analyses?

- how well are the computer codes, if used, benchmarked, calibrated, and verified?

- are the modeling techniques technically justified (I provided the example from the BWIP SCR where the meter-scale fault is damped out in the kilometer-scale grid block)?

- when sophisticated modeling or analytical techniques are used, do their resolution of the performance quantities justify the more elaborate technique, or are less sophisticated techniques more defensible?

- are processes which are not modeled shown to be insignificant in terms of repository performance?

- given a limited data base, are statistical and uncertainty assessments more appropriate than deterministic analyses?

- how well does the overall performance assessment methodology relate to the regulatory criteria included in 10 CFR 60 and 40 CFR 191?

The most significant question that ONWI and DOE should consider in their evaluation of what to include in the performance assessment sections of the SCP for the salt sites is the following:

Is the sophistication of the numerical and analytical analyses included in the SCP consistent with the adequacy and completeness of the site specific data base?

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ACTION BY NRC

1. NRC should provide guidance to the DOE and ONWI as to what is meant by the term "disturbed zone" in the near future, so that all DOE contractors can begin to incorporate this concept in their PA work at BWIP, NNWSI, Salt sites, and Crystalline Rock.
2. NRC should expect ONWI to include less detailed technical work within the SCP for the salt site. Supporting work (e.g. performance assessment modeling studies) will either be attached to the SCP as an appendix or included in the SCP as a primary reference only.
3. NRC will forward to ONWI (DOE) copies of the products developed under the NRC code benchmarking contract for ONWI's information.
4. NRC should expect the following key documents about PA for the salt sites from ONWI (DOE):
  - results of the SCEPTER program,
  - documentation of all PA computer codes to be used in the SCP and post-SCP activities by ONWI,
  - the ONWI Performance Assessment Plan for DOE salt sites,
  - the ONWI Code Documentation and Verification Plan, and
  - a listing of all codes to be used by ONWI in preparation of a license application for a HLW repository in salt.

All of these documents should be delivered to the NRC by the conclusion of FY83. Many of them should be released during the period from June to August, 1983.

OPEN ITEMS

A workshop will be scheduled between the NRC, ONWI, and DOE to discuss performance assessment topics which are generic among the salt sites prior to NRC receipt of the SCP for salt. This workshop will discuss, among other topics, the following:

- ° The validity of Probabilistic Risk Assessment for quantifying the risk associated with HLW repositories in salt.
- ° The determination of scenario probabilities or their consideration as processes rather than events.

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° The process of benchmarking, documentation, and verification of computer codes which will be used in performance assessment of HLW repositories in salt.

° The use of geostatistical modeling and analytical techniques in support of site characterization and performance assessment.

° Overall program plan for performance assessment of HLW repositories in salt.

° The significance of thermal, chemical, mechanical, and hydraulic effects on repository isolation within the disturbed zone.

° ONWI's computer codes to be used in performance assessment of HLW repositories in salt.

° The incorporation of uncertainties in data and techniques into performance assessment of HLW repositories in salt.

#### CONCLUSION

This memorandum should provide some insight into the approaches and tools that ONWI will use in the pre-licensing and licensing activities for a HLW repository in salt. It represents my current understanding of information presented at the first NRC-ONWI-DOE meeting.

#### **Original Signed By:**

Michael F Weber  
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