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CONSULTING GEOTECHNICAL AND MINING ENGINEERS

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'83 NOV 14 11:12

November 10, 1983

Our ref: G/83/428

U.S. Nuclear Regulatory Commission  
Division of Waste Management  
7915 Eastern Ave. - M/S 623-SS  
Silver Spring, MD 20910

Attention: John T. Buckley

Subject: Contract No. NRC-02-81-037  
Technical Assistance for Repository Design  
Task 6, Project 22  
Letter #99

WM Record File  
E 6983

WM Project E 11, 16  
Docket No.           
PDR           
LPDR (B, D, S)

Distribution:

J Buckley

(Contract to M/S 623-SS)

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Gentlemen:

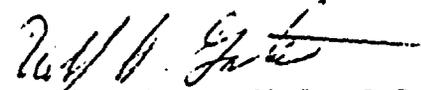
Please find attached two documents as follows:

- 1) Memo: Trip Report - NRC/DOE workshop on Salt, Columbus, OH, October 25/26, 1983 from Lou Gonano, October 27, 1983
- 2) Memo: Fourth DOE/NRC Pre-SCP Meeting, Columbus, OH, October 25/26, 1983, from J. Daemen

These memoranda and this letter are our letter report for the meeting in accordance with paragraph 4.5 of the subject contract.

Sincerely,

GOLDER ASSOCIATES

  
Richard H. Gates, Ph.D., P.E.  
Project Manager

RHG/kap

enc.

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MEMORANDUM

TO: Dick Gates

October 27, 1983

FR: Lou Gonano

RE: 813-1167V NRC/DOE Workshop on Salt,  
Columbus, OH October 25/26, 1983

The above workshop was attended by Jaak Daemen and myself as contractors to NRC on the subjects of In Situ Testing and Shaft Construction. A planning seminar consisting of NRC and its contractors was held in Columbus on October 24.

General Overview

As a forum for exchange of ideas and for notification of respective positions on the issues of preparation of data, plans and designs for SCP and LA, the meeting is considered highly successful. As a preliminary meeting on salt, the large attendance and the wide scope prevented detailed technical discussion of important issues. In any case, these technical aspects are more properly addressed in subsequent specialty sessions/workshops, for which the stage has now properly been set. The exposition of the licensing procedures and the constant emphasis on the need to explicitly integrate licensing issues into test plans and repository designs represented a new perspective to the DOE/ONWI members involved. The benefit and necessity of timely open interaction with NRC and the justification of designs and plans relevant to rule requirements was also apparently accepted in good faith. However, I believe that to succeed in a significant and adequate re-orientation of DOE efforts towards licensing issues, the above points will need to be continually reinforced in subsequent communications and meetings. For this reason, it is imperative that "Technical Positions" such as for In Situ testing be transmitted at the earliest to establish a basis for dialogue and eventually consensus. As discussed with John Greeves, and based also on the tenure of the meeting in Columbus, the "Technical Position on In Situ Testing" has been reviewed and slightly modified. This is included for your comment and hopefully finalization in the near future.

The main points of relevance to In Situ Testing and Shaft Construction and Sealing have been incorporated in the meeting minutes. These are reiterated here for completeness, in summary form.

1. The licensing issues such as potential effect of site characterization in compromising isolation capability of the site and capacity for testing have not been considered up-front in the selection of the shaft construction method (slide 10). DOE appears to justify this on the basis that two types of seals will be utilized and that lining and sealing can be considered independently from construction. This is not so. Construction method affects not only the seal performance long term (and this is a critical issue for salt) but also the regional groundwater regime and the predictability of construction and the

flexibility to cope with unexpected conditions without resulting in a substandard or compromised structure. This is a major consideration for a "first" shaft at any site.

The rationale for the selection of the method is of direct concern to the NRC, whether or not it is used for site characterization purposes. Also, the design of the shaft lining and sealing needs to be integrated into the selection of the sinking method.

2. It appears that the Golder shaft sinking report has been taken out of context, with DOE suggesting the report to be an endorsement of the acceptability of the blind drilling method and even its favorability/preference. Qualifications and disclaimers contrary to this are contained in the report. Perhaps DOE should be advised that the report is an indication of what type of evaluation is appropriate. A copy of their trade-off study (decision recommendation paper) should be requested and evaluated.
3. There appears to be some confusion in terminology as to what "site suitability studies" is meant to cover.

Work for the SCP and LA includes two categories of work - defining the site characteristics and defining the engineering behavior. Both are needed to establish the performance of an integrated repository/site system and so all such testing and exploratory work which helps to demonstrate "reasonable assurance" constitutes site suitability studies. This is my particular interpretation.

4. The rules were directly quoted when presenting DOE's interpretation of exploration requirements. However, no such approach was evident in arriving at what in situ testing would be required. The importance of using the licensing issues to focus an approach to the development of an in situ test program was correctly stressed and should be further reinforced by using the "Technical Position" as a basis for further clarification and refinement of our position.

The adoption of a logical defensible probabilistically based methodology for developing in situ testing needs is required for the following reasons.

- to establish what information needs and tests are required to resolve issues
- to determine which parameters are significant to the resolution of issues and to define the "quality" of data required by testing
- to establish yardsticks for quality of data to guide the conduct of tests according to encountered conditions and changing design needs.

- to justify to the licensing board, using probabilistic descriptions of data and performance predictions, the defensibility of predictions on performance.
- to permit probabilistic descriptions of failure of multi-unit components i.e. breaching histogram for 1000 cannisters for example

In many cases, a rigorous quantitative probabilistic description of a phenomena will simply not be possible. The level of understanding may permit only a qualitative description or even may be represented as a divergence of expert opinions as to the likely outcome. This in itself represents an estimate of the level of uncertainty. In all cases however, it will be necessary to define a critical bound to the outcome, its relationship to the specification and how this bound was arrived at. (See Ch 6 in Monsees and Munson Paper, 1982 for definition of critical bound).

LPG/10/27/83/803-1167V

## MEMORANDUM

TO: Dick Gates, Project Manager

FR: J. Daemen

SUBJECT: Fourth DOE/NRC Pre-SCP Meeting, Columbus, Ohio, 10-25/26-83  
Repository Design, Exploratory Shaft and In Situ Testing

### General Comments

1. The meeting was exceptionally successful in two main areas of information exchange:
  - the concept of the NRC information needs, based on providing "reasonable assurance", within the overall regulatory framework, at the time of License Application, was transmitted forcefully and clearly. There is strong evidence that this viewpoint came through very clearly, both by apologetic acknowledgments from several speakers in their introduction that their presentations did not directly or entirely address NRC concerns, and from acknowledgments during informal discussions with personnel from ONWI and from contractors that they only now recognized many of the licensing implications.
  - the total lack of awareness on the part of ONWI of the information requirements that need to be fulfilled at the time of License Application came across very clearly to NRC. This was indicated primarily by the fact that all of the presentations addressed marginally, if at all, the primary NRC concerns.
2. The meeting was very disturbing in some major aspects:
  - NRC licensing issues are explicitly defined as a low priority, and the total lack of attention to these issues in ES, design and in situ testing might result from this.
  - if my understanding of the scheduling of the ES sinking is correct, it is difficult to see how a significant in situ testing program can possibly be accomplished by the time of License Application.
  - the vagueness and shallowness of the overall technical status is striking, especially in view of the long period for which salt repository research has been active.
  - one has the impression that this program does not incorporate much if any of the results of previous or closely related salt repository investigations, nor does it refer to a considerable body of information developed within ONWI. Time might not have permitted presentation of how the information has been integrated, but the impression of entirely new work from scratch, or at least with a very narrow previously developed information basis (as compared to the extensive basis available) is given also by major references cited (ONWI 390-391-392).

- the appearance is given that the lack of site selection, and the need for site specific design, is used as an excuse for lack of progress in areas which can readily be addressed generically for bedded salt, e.g., logic, selection and design of sealing tests along shaft, especially below aquifers and above salt; grout selection; grouting procedures; grouting monitoring. Even though final details might have to be site specific, considerable generic progress is possible in many areas, especially for a project limited to salt.

10-26-83

- even close to the very end of the meeting, after three excellent, forceful and clear presentations by NRC of their information needs at LA, supplemented by frequent rewording, rephrasing and repeating of the position during the discussions, several questions were raised, by several people, that clearly indicate that the specific NRC needs had not been understood. In addition, one of the very last speakers did not address or mention LA concerns, and appears to have totally missed LA information needs. This should emphasize to NRC the urgency and the importance of expressing its needs at every possible occasion to the broadest possible technical audience that is involved in generating information for an eventual LA.

In addition, it would be desirable to communicate explicitly to DOE that a clear shortcoming appears to exist in the understanding of LA information needs at the contractors level, and that this might result in inappropriate focusing of efforts, especially in the immediate future, with respect to SCP.

- by the end of the meeting it became strikingly obvious that various subaspects of this program appear to be totally independent and uncoordinated, and largely unaware of previous and/or related work (this observation must be qualified by the fact that time constraints might have prevented some or most speakers from giving full details). The sealing presentation was the only one in which an explicit inclusion was made of the broad results of previous and related (e.g., Sandia) work. This should be of serious concern, because "reasonable assurance" at LA could be strengthened considerably by invoking supporting information from outside ONWI programs.

The apparent lack of interaction was particularly obvious between in situ testing/stable opening/THM modeling. Whether and how in situ testing might be related to modeling remains a total mystery, the connection between in situ testing and opening stability is very vague and based on broad generalities, and the links between modeling and opening design remain equally unclear.

- too many topics were scheduled to permit detailed exchange of technical information. This was particularly obvious the second day, when presentations had to be extremely brief (superficial) and raising questions became virtually impossible.

- for future meetings it would be highly desirable if participants could be provided, well in advance, with a complete reference list of documents on which presentations and discussions will be based, and with a relatively easy procedure for obtaining copies of those documents of which they may not already have a copy.
- the severe time limitations might have prevented ONWI from presenting its case fairly. It is known from the literature, e.g., ONWI reports, that a considerable body of back up information and evidence exists which was not presented. To some extent this was due to time restrictions. To some extent it was due to the fact that the presentations were not at all prepared to address NRC information needs, i.e., try to resolve specific concerns, but appeared to be very general broad introductions to ONWI programs, intended for a lay audience. Related to the impression of general superficiality is the fact that very little reference is made to documentation and detailed justification. In general, one readily recognizes the published sources on which statements are based, but unless ONWI is more helpful in providing back-up references to specific information it is unlikely that all of them will be recognized by NRC. Providing a maximum possible of specific references to specific concerns and issues might assist considerably in developing credibility, and would help NRC in clarifying where credibility might be questioned.

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Specific Technical Questions and Comments, Listed  
by Page Number of the ONWI Notes Provided at the Meeting

p. 6 Is it implied that only holes will be used to provide data for the geologic section?

p. 7 Will sufficient coordination be provided contractually between ESF A/E, TC and CM to assure that testing will be possible, especially monitoring the early and complete response of the in situ rock?  
(This question is based on the difficulties observed at many projects for integrating these aspects).

p. 10 Exploratory shaft construction technique selection.

- It is disturbing that site characterization and particularly site response characterization (e.g., hydrological response to shaft sinking) are not considered among the important criteria (except for shaft mapping and instrumentation) and hence certainly not among those with high priority.

In this context, it is important to point out that the quoted Golder report (NUREG/CR-2854) explicitly deals with production shafts, and ranks inspection/testing low because it is assumed that the information is available already from the ES (p. 153, top paragraph).

- Long term isolation/containment is addressed only in terms of ability to control water behind the liner. Even for conventional salt mining, making the liner tight is one of the most important design criteria.

- ES shaft is intended only to provide access to salt, not to aid in site characterization for which holes are considered sufficient. Geologists will have to evaluate uncertainty associated with site characterization based on a very small number of holes only.

p. 12 It is unclear how casing design takes into account the need to minimize damaged zone extent by minimizing displacements. A deformation design number of 1" was mentioned. Justification would be desirable. Of particular concern are disturbances of aquicludes directly above salt horizon.

It is unclear how the last point, depth and thickness of key seal zones, have influenced casing design.

No indication is given whether casing removal (for permanent sealing) has been considered.

No indication has been given as to the type of operational sealing grouting details that have been designed.

No indication is given of durability considerations on casing, piping behind casing, attachments, grout, etc. . . , even though it is obvious that the operational repository phase will exceed considerably the life of a typical salt mine shaft.

In light of all these remaining design uncertainties, many of which can be addressed generically, (and more can be generated readily,) it must be considered very disturbing that the ESF design effort has been suspended.

- p. 28 It is disturbing to hear that a Testing Coordinator will be contracted shortly, and will assist in issue identification. For a salt repository program that has been ongoing for many years, in one form or another, one might expect the issues to have been identified.
- p. 32 Frank Hood, Parsons-Redpath, repeatedly expressed his clear cognizance that NRC licensing is needed. It appeared several times as if he implied that QA would suffice to assure licensability.
- p. 33 It should be of extreme concern that shaft sinking will start only in middle '86. As a consequence, only eight months of in situ testing appears to be provided prior to license application. Given the logistics constraints (single small deep shaft), given the fundamental importance of time-dependency in salt, and the importance of testing temperature (heating) effects, it is very difficult to see how a comprehensive suite of tests could possibly be performed in eight months.

Repeated reference has been made (here and at BWIP) to blind boring experience for shaft sinking developed at NTS. Documentation for NRC (and its contractors) of this experience would be highly desirable.

#### NEFF Presentation

Amoeba natural analog is highly appropriate, as it indeed appears very strongly that licensing information requirements have not been transmitted, not only not to ONWI contractors, but not even to ONWI itself. The total lack of concern about licensing was fairly obvious from all presentations during this meeting, most of which addressed NRC concerns tangentially only, at best. Some concern must be expressed as to whether this attitude might have been reinforced by the very low priority ranking given to the LA. (Although my impression was that the forceful and clear presentation of the NRC position counterbalanced this and in fact dominated the meeting.)

Twice, 8 month in-situ testing was mentioned. This obviously inadequate testing period appears to be entrenched firmly.

- p. 41 Has drilling mud contamination on sealing been assessed? Is pre-grouting cleaning planned?
- p. 50 Point 4 of Purpose of ESF, demonstration of operation-phase sealing, needs to be amplified: method, logic.
- pp.51-52 ESF functional design criteria do not include:
- maintain site isolation/containment capabilities
  - characterize site
  - characterize site response

- p. 53 Shouldn't NRC be informed at the very least of conceptual changes?
- p. 54 NRC information needs are not considered when change levels are defined.
- p. 56 This appears to be an outline of a response. Specifically addressed was the second bullet under E, and it appears that no in situ testing is planned.

Preliminary performance assessments (INTERA) have been mentioned, indicating that the shaft sinking technique has no significant impact on isolation (and maybe shaft sealing has no impact). Need independent assessment of this work, especially input assumptions.

- p. 64 All statements have an extremely strong positive presumption, suggesting or implying a commitment to a site rather than an objective (neutral) evaluation or assessment.

Considering the explicit statement that no testing will be performed above the salt horizon, it is difficult to see how the third point, performance of shaft, liner and seal designs will be accomplished. (By quantitative assessment based on visual inspection?)

The last point is utterly presumptuous. A few hours of literature search (starting for example with Djahanguiri and Mathews, 1983) would indicate that the probability of this is negligibly small!

- pp. 65-70-72-79-81 quote 10 CFR 60

The connection between the pages following the quotes and the rule is tenuous, at best, vague and in the preconceptual stage.

Several major concerns are listed, then not addressed at all. Examples:

- p. 65: first bullet: of particular concern for caprock, overlying and underlying aquicludes: will not be investigated at all from ESF
- p. 65, bullet 4: no response monitoring during shaft sinking and ESF excavation
- p. 65, last bullet: salt response only, overlying, adjacent and underlying strata not to be monitored
- p. 70, (4): where is regional ground-water flow system considered in in situ testing?
- p. 70, (10): where is dissolution addressed in in situ testing, specifically at salt-cap interface, at shaft - caprock penetration, etc. . . ?

- p. 70, (11): what in situ testing addresses uplift, subsidence, folding?
- p. 72 (20): where does in situ testing address sealing?
- pp. 79-80: self-explanatory.

p. 68 The point raised by Ed Hollop is very important. Only one pillar will be tested, probably at considerably smaller loads than will exist in the repository. This will not allow verification of computer codes, because representative loading will not be achieved. This is of particular concern in light of the very serious doubts expressed by EI (NUREG/CR-3489) about the feasibility of retrieving in salt.

p. 75 It is not obvious at all why the location of these sections cannot be identified generically, and has to await site selection. This is particularly true for the development of a location logic, e.g., referring back to p. 12, at key seal zones.

No hydrological testing planned from shaft, but could put in portholes if required. (Mentioned as if this were a trivial matter).

10-26-83

John Greeves Presentation:

A significant consensus appears to be developing, as expressed explicitly by Bob Wunderlich, about the need to use performance assessments, some type of systems analysis, to identify program issues that are critical with respect to meeting licensing information requirements.

Jerry Szymanski raised several questions, e.g., will shaft construction be subject to NRC review, is it correct that design aspects which do not influence performance objectives are not subject to NRC review, must LA give reasonable assurance that both EPA and NRC requirements are met, or is one or the other sufficient, would like more explicit definition of "performance requirements and criteria", is concerned that performance assessment/systems analysis might lead to commitments that might prove to be difficult to meet later on (particularly in the geotechnical area).

p. 86 See comment under p. 68.

pp.89-94 Any connection to NRC LA information requirements?

pp.95-107 Any relation to NRC LA information needs?

pp.101-103 No major issues related to LA information (e.g., isolation, retrievability).

pp.108-114 Appears very preliminary. Difficult to assess to what extent NRC information needs might have been addressed. Apparently not very explicitly. (Speaker was well aware of it, and stated that

presentation did not include sufficient tracing back to rule).

p. 109 Site characterization, site response characterization, maintaining isolation do not appear to be part of functional design.

p. 110/111 QA is only NRC concern that has been addressed.

p. 113 Four reports should be provided to NRC.

Jim Gould

pp.114-120 Introduction primarily concerned with pre-emplacment stability, but later addressed retrievability issue.

Probably need better focusing as to what this design specifically addresses.

Stable opening design appears to be in very early stages. An important, if not the most important consideration, during pre-emplacment as well as beyond should be prevention of flooding or water intrushes. This almost certainly requires that the design explicitly addresses excess deformations/stresses in protective caprock, and/or aquacludes directly above, below or adjacent to host formation.

Because conditions will be much more severe after waste emplacment, it has to be assumed that this design will apply only in areas away from waste or that more stringent design will overrule this design in waste emplacment areas.

p. 117 Pillar stability is likely to be critical for long term isolation, especially to maintain overall integrity of host formation.

p. 118 Retrievability introduced.

p. 119 How will impact of interbeds on canister/package performance (including retrievability) be studied?

What design basis is being used for canister/package if interbed behavior is unknown?

p. 120 Clearly needs considerably more work on isolation/containment/retrieval.

pp.121-126 Retrieval. Appears to be in very early pre-conceptual stages.

pp.127-129 Canister (Package) Failure. Appears to be in very early pre-conceptual stage.

pp.130-133 Engineered Barriers. Appears to be in very early pre-conceptual design, but based on a clear direct understanding of the rule, i.e., of what needs to be accomplished.

pp.134-139 Thermal-Mechanical-Hydrological Factors in Design.  
No indication anywhere of any licensing concerns. Presumably this modeling is to be used for long term performance assessments:

- release rates not mentioned
- no indication anywhere of computer program verification
- no connection to in situ testing
- no information on input data acquisition
- "issues" are not related to, nor do they address any of the LA concerns
- QA not mentioned

p. 139 Computer modeling appears to exist in a total vacuum, entirely unrelated to any other work.

- does "further systematic studies" refer to computer analysis only, or to experimental verification?
- how will important coupling effects be identified? . . . in what region? . . . for what time periods?
- what previous systematic studies have been done, leading up to the "further" ones, and where are they documented?

#### Sealing

p. 142 Concern has to be expressed about "simplifications" in current design. Current designs already appear extremely simplistic compared to

- successful plug designs that have been used in the past
- long term isolation requirements to be imposed on plugs.

p. 142 First point is encouraging, although it would be preferable to replace "recognizing" by "meeting", "complying with" or some such term.

pp.144-145 It would be highly desirable to associate specific references with specific accomplishments in order to assure that NRC is not overlooking any references. Without details it is difficult to make precise comments.

Highlights state that methodology for longevity studies has been established. 1983 - 1987 plans do not indicate longevity studies will be performed. Is methodology (as presently available) by itself considered sufficient for LA?

Considerably more detail on 1983 - 1987 program would be highly desirable, particularly on disturbed zone directly above salt formations, and in substantial non-salt-beds within the formation.

- p. 146 The peer review provisions are a very favorable development in the sealing program.
- What will be done about data deficiencies, and how will major issues be resolved? (The 1983 - 1987 program on p. 144 provides for neither.)
- Our understanding from the in situ test/exploratory shaft presentations is that no exploratory shaft characterization will be performed, and explicitly not before license application.
- It seems risky to propose that "all issues will be resolved" at licensing. Only reasonable assurance is needed.
- p. 147 The design goal is too narrow, does not meet all requirements of the rule.
- p. 148 It would be desirable to base the ultimate design goal very directly and explicitly on the rule.
- Last two bullets appear to be comments or parts of a method of approach rather than ultimate design goals.
- p. 149 It might be desirable to define more clearly "seals". p. 157 does not show crushed salt in shaft seals.
- p. 150 First bullet closely approximates rule requirement, might more appropriately be considered part of the ultimate design goals.
- Second bullet needs a clear definition of shaft and borehole sealing. As written suggests that only short-term sealing will be performed in shaft. When is "later"?
- p. 151 System Design.  
Confusion between seal, engineered barriers, backfill?  
"Can" be tested - no commitment.
- p. 153 Nothing on shaft seals.
- p. 154 "Good data base"? Most salt shafts leak. Very few experimental in situ data (e.g., incorporating emplacement, scale, time effects) to our knowledge.
- Any intention to demonstrate very long-term stability?
- pp.156-161 Appear to be extremely preliminary. Need a great deal of amplification before well-based comments could be made.
- p. 162 First bullet needs considerable justification in light of fairly recent disastrous consequences from a borehole accidentally penetrating a salt mine.

Bullets 2 and 3 suggest that attention is being paid to seal problems, but it is not clear whether this has an impact on site characterization program (e.g., will exploration holes be at shaft locations?) How will sealing of cased holes be demonstrated?

p. 163

Major issues should include regulatory requirements.

p. 166

Which of these will be in progress, and how far advanced by License Application?

Although the presentation of sealing (as glanced from the published viewgraphs) summarizes very well the technical aspects of the post-sealing programs (as we know it), it appears to represent a step backwards in addressing NRC concerns, because none of the previously available (d'Appolonia) expertise in connecting sealing technical aspects to 10 CFR 60 is reflected here. The fact that no further sealing research is planned suggests that ONWI considers these issues/concerns resolved. NRC needs to seriously think through its position on this, both in light of the revisions in the rule, and on the basis of the DOE/ONWI response to the 6-15-83 Chase to Neff letter, presumably to be received shortly.

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