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Washington, D.C. 20555

"NRC Technical Assistance
for Design Reviews"
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FIN D1016

Dear David:

Enclosed is Itasca Review No. 001-02-25, "Draft Test Plan for In-Situ Testing in an Exploratory Shaft in Salt," by Golder Associates (Battelle Memorial Institute Draft Plan No. EA-0207, March 1985). Please call me if you have any questions.

Sincerely,

Roger D. Hart
Roger D. Hart
Program Manager

cc: J. Greeves, Engineering Branch
Office of the Director, NMSS
E. Wiggins, Division of Contracts
DWM Document Control Room

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ITASCA DOCUMENT REVIEW

File No.: 001-02-25

Document: "Draft Test Plan for In-Situ Testing in an Exploratory Shaft in Salt," by Golder Associates (Battelle Memorial Institute Draft Plan No. EA-0207, March 1985)

Reviewer: Itasca Consulting Group, Inc.
(M. Board and R. Hart)

Date Approved:

Date Review Completed: 20 October 1986

Significance to NRC Waste Management Program

This document presents a generic test plan for in-situ testing at the ES shaft in salt. The information needs for the salt repository are developed and used to provide the basis for a series of generic testing methods which may be used to resolve the information needs. The plan, therefore, reviews the current thinking of the Office of Nuclear Waste Isolation (ONWI) regarding their view of the role of in-situ testing in satisfying NRC regulations as well as design requirements. The plan will provide the basis for the ES design and test specification.

Summary of the Document

The document provides a generic test plan for in-situ testing in salt. The plan was written in March 1985, prior to selection of the Deaf Smith site and, therefore, all of the test descriptions are generic in nature.

The plan has many positive features. An attempt is made to provide a detailed rationale for the test plan by starting with the basic regulations to develop information needs. The process is illustrated schematically in Fig. 1 and 2; the ultimate result of this process is the information presented in Figs. 3 and 4 (which are Tables 4-1 and 5-1 from the test plan). The tables in these latter figures attempt, first, to link the information needs to regulatory requirements and, second, to link the information needs

to in-situ tests which can be used to resolve them. The background data for these summary tables are given in the report appendices. Each regulation is given in full, and the associated perceived performance issues or information requirements are stated in a very general fashion.

The methods available for resolution of the pre- and post-closure performance issues (derived from the above tables) are then defined. Three broad categories of methods are suggested: demonstration, empirical analysis, and numerical analysis. For each performance issue, the relative applicability of these analysis methods is given in detail. Finally, the current state of knowledge for each information requirement is reviewed, and the areas where additional information is needed is given.

This methodology represents a great deal of effort and attempts, in a straight-forward fashion, to define the in-situ testing needs from the basic regulatory requirements. The results are worthwhile, but there are several problems associated with the way in which information needs are developed. These are discussed in detail in the following section.

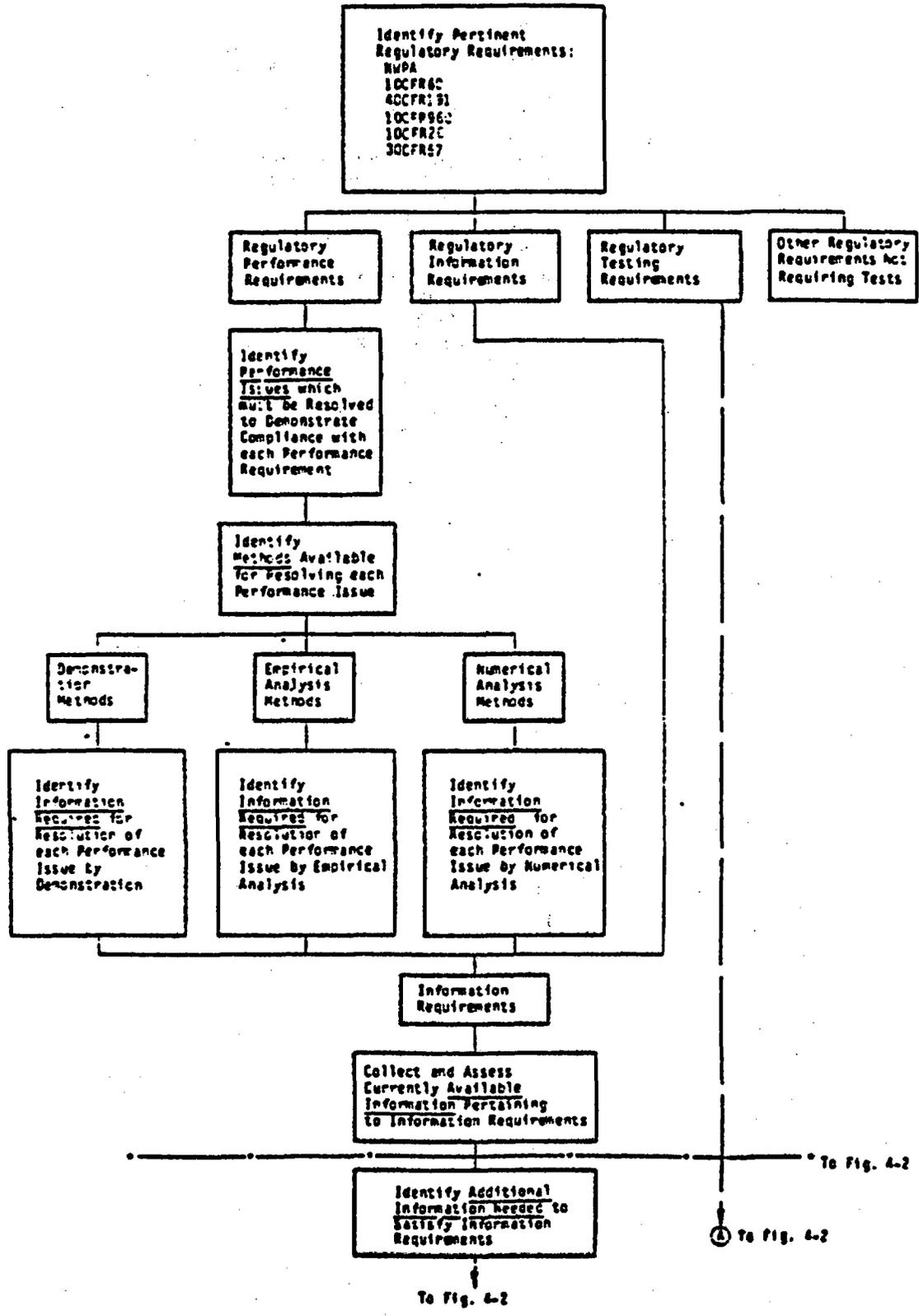


Fig. 1 Flow Diagram Illustrating the Test Plan Approach to Definition of Information Requirements (Fig. 4-1 in report)

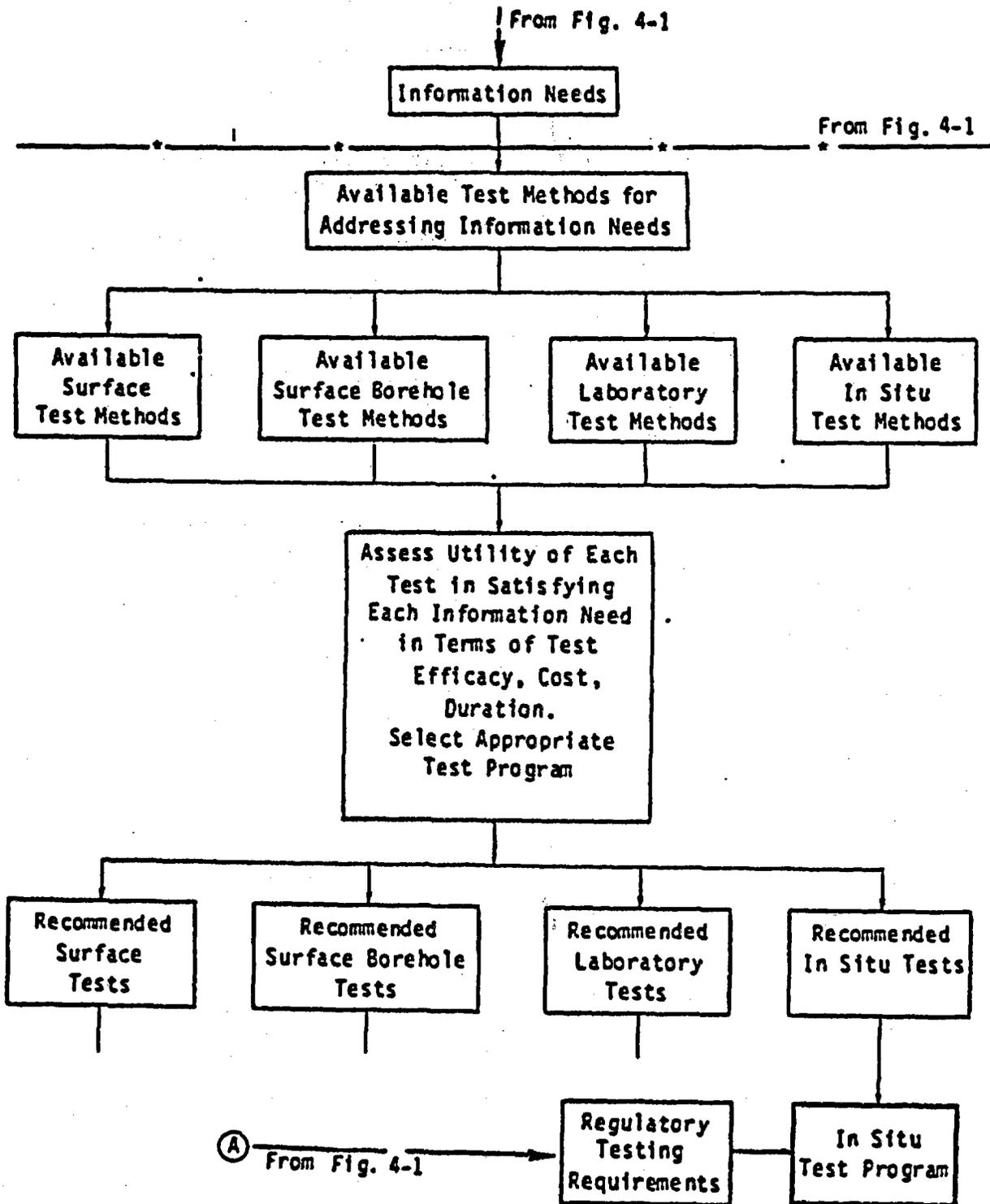


Fig. 2 Development of In-Situ tests from Information Needs (Fig. 4-2 in report)

Table 4-1. Information Needs/Regulatory Requirements

Regulation	Information Needs	Regulatory Requirements
40 CFR 150.101	Environmental baseline data	Baseline data
40 CFR 150.102	Impact analysis	Impact analysis
40 CFR 150.103	Public participation	Public participation
40 CFR 150.104	Record of Decision	Record of Decision
40 CFR 150.105	Monitoring and reporting	Monitoring and reporting
40 CFR 150.106	Emergency response	Emergency response
40 CFR 150.107	Quality assurance	Quality assurance
40 CFR 150.108	Administrative procedures	Administrative procedures
40 CFR 150.109	Public information	Public information
40 CFR 150.110	Record keeping	Record keeping
40 CFR 150.111	Compliance monitoring	Compliance monitoring
40 CFR 150.112	Environmental quality	Environmental quality
40 CFR 150.113	Resource management	Resource management
40 CFR 150.114	Public involvement	Public involvement
40 CFR 150.115	Record of Decision	Record of Decision
40 CFR 150.116	Monitoring and reporting	Monitoring and reporting
40 CFR 150.117	Emergency response	Emergency response
40 CFR 150.118	Quality assurance	Quality assurance
40 CFR 150.119	Administrative procedures	Administrative procedures
40 CFR 150.120	Public information	Public information
40 CFR 150.121	Record keeping	Record keeping
40 CFR 150.122	Compliance monitoring	Compliance monitoring
40 CFR 150.123	Environmental quality	Environmental quality
40 CFR 150.124	Resource management	Resource management
40 CFR 150.125	Public involvement	Public involvement
40 CFR 150.126	Record of Decision	Record of Decision
40 CFR 150.127	Monitoring and reporting	Monitoring and reporting
40 CFR 150.128	Emergency response	Emergency response
40 CFR 150.129	Quality assurance	Quality assurance
40 CFR 150.130	Administrative procedures	Administrative procedures
40 CFR 150.131	Public information	Public information
40 CFR 150.132	Record keeping	Record keeping
40 CFR 150.133	Compliance monitoring	Compliance monitoring
40 CFR 150.134	Environmental quality	Environmental quality
40 CFR 150.135	Resource management	Resource management
40 CFR 150.136	Public involvement	Public involvement
40 CFR 150.137	Record of Decision	Record of Decision
40 CFR 150.138	Monitoring and reporting	Monitoring and reporting
40 CFR 150.139	Emergency response	Emergency response
40 CFR 150.140	Quality assurance	Quality assurance
40 CFR 150.141	Administrative procedures	Administrative procedures
40 CFR 150.142	Public information	Public information
40 CFR 150.143	Record keeping	Record keeping
40 CFR 150.144	Compliance monitoring	Compliance monitoring
40 CFR 150.145	Environmental quality	Environmental quality
40 CFR 150.146	Resource management	Resource management
40 CFR 150.147	Public involvement	Public involvement
40 CFR 150.148	Record of Decision	Record of Decision
40 CFR 150.149	Monitoring and reporting	Monitoring and reporting
40 CFR 150.150	Emergency response	Emergency response
40 CFR 150.151	Quality assurance	Quality assurance
40 CFR 150.152	Administrative procedures	Administrative procedures
40 CFR 150.153	Public information	Public information
40 CFR 150.154	Record keeping	Record keeping
40 CFR 150.155	Compliance monitoring	Compliance monitoring
40 CFR 150.156	Environmental quality	Environmental quality
40 CFR 150.157	Resource management	Resource management
40 CFR 150.158	Public involvement	Public involvement
40 CFR 150.159	Record of Decision	Record of Decision
40 CFR 150.160	Monitoring and reporting	Monitoring and reporting
40 CFR 150.161	Emergency response	Emergency response
40 CFR 150.162	Quality assurance	Quality assurance
40 CFR 150.163	Administrative procedures	Administrative procedures
40 CFR 150.164	Public information	Public information
40 CFR 150.165	Record keeping	Record keeping
40 CFR 150.166	Compliance monitoring	Compliance monitoring
40 CFR 150.167	Environmental quality	Environmental quality
40 CFR 150.168	Resource management	Resource management
40 CFR 150.169	Public involvement	Public involvement
40 CFR 150.170	Record of Decision	Record of Decision
40 CFR 150.171	Monitoring and reporting	Monitoring and reporting
40 CFR 150.172	Emergency response	Emergency response
40 CFR 150.173	Quality assurance	Quality assurance
40 CFR 150.174	Administrative procedures	Administrative procedures
40 CFR 150.175	Public information	Public information
40 CFR 150.176	Record keeping	Record keeping
40 CFR 150.177	Compliance monitoring	Compliance monitoring
40 CFR 150.178	Environmental quality	Environmental quality
40 CFR 150.179	Resource management	Resource management
40 CFR 150.180	Public involvement	Public involvement
40 CFR 150.181	Record of Decision	Record of Decision
40 CFR 150.182	Monitoring and reporting	Monitoring and reporting
40 CFR 150.183	Emergency response	Emergency response
40 CFR 150.184	Quality assurance	Quality assurance
40 CFR 150.185	Administrative procedures	Administrative procedures
40 CFR 150.186	Public information	Public information
40 CFR 150.187	Record keeping	Record keeping
40 CFR 150.188	Compliance monitoring	Compliance monitoring
40 CFR 150.189	Environmental quality	Environmental quality
40 CFR 150.190	Resource management	Resource management
40 CFR 150.191	Public involvement	Public involvement
40 CFR 150.192	Record of Decision	Record of Decision
40 CFR 150.193	Monitoring and reporting	Monitoring and reporting
40 CFR 150.194	Emergency response	Emergency response
40 CFR 150.195	Quality assurance	Quality assurance
40 CFR 150.196	Administrative procedures	Administrative procedures
40 CFR 150.197	Public information	Public information
40 CFR 150.198	Record keeping	Record keeping
40 CFR 150.199	Compliance monitoring	Compliance monitoring
40 CFR 150.200	Environmental quality	Environmental quality

NOTE: * Regulation often used effectiveness and therefore refers to all information needs.

Fig. 3 Table 4-1 from Report Listing Information Needs Arising from Regulations

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Problems, Limitations and Deficiencies

Although the plan has positive aspects, there are problem areas, many of which are associated with the preliminar and generic nature of the plan. A listing of general problems is given below.

1. The development of information needs is done without analysis of any kind and is purely subjective in nature. It therefore is very difficult to assess the completeness of the information needs if one cannot track the basis from which they were developed. In other words, the plan presents pages of tables of non-detailed information without any detailed description or analysis. For example, information regarding the "disturbed zone" is given in Table 4-1 and in the in-situ test methods needs (Table 5-1) of the report. There is no overall discussion of performance assessment in salt and, therefore, the characteristics and effects of a disturbed zone in salt are not known. It essentially must be accepted on faith that the "disturbed zone" is of importance.
2. The test plan is not placed in the context of the on-going salt program. There should be greater detail on how this testing relates to the current numerical, laboratory, and A/E design work which is on-going. How this work will be utilized by the design contractor(s) must be reviewed. Also, the use of data from WIPP and Asse should be valuable and provide a basis upon which the plan may be built.
3. The resulting tabular listing of information needs versus regulations is a necessary first step which gives all data needs—regardless of level of importance. The plan does not take the next step, which is to define the level of importance of these needs and, consequently, which ones require in-situ testing. The end result is a very extensive listing of quite obvious information requirements but with no analysis to indicate the relative importance of the needs. What does not come across to the reader is—What are the most crucial problems which face the salt program and how will the ES facility be used to resolve them?

4. As above, the specification of in-situ tests suffers from a lack of analysis to determine whether or not the test actually will resolve the information need. The reader must assume that the personal judgment of the test plan writer is sufficient.
5. The in-situ testing program is not related to the numerical modeling effort. The models to be used for design and performance assessment are not discussed nor is their role in test design and interpretation. There is no apparent "feedback" loop illustrating how the in-situ test data is used in validation of models or design criteria. In its present form, the plan defines a very broad series of possible tests but does not go beyond this point. It is impossible to tell from the test plan how the test data is actually used to resolve information needs.
6. The test plan does not address some very crucial problems in salt and, in particular, does not distinguish the problems specific to domal and bedded salt. For example, the entire issue of formation variability or inhomogeneity and how this affects the in-situ testing needs and methods is not addressed. This includes such problems as interbedded seams and variability in the salt structure. Such problems must have a great effect on the amount of exploration drifting and testing methods required to characterize salt response. This is particularly true of the Deaf Smith site, where over 10% of the formation is composed of interbedded non-salt rocks.
 - The significant problem of retrievability is largely ignored, as are the present plans for backfilling and retrieving by excavation. Any practical demonstration within the ES of these concepts is not discussed.
 - The definition of a creep model for salt is not discussed. At present, there is a significant controversy in the ability of existing creep laws for prediction of long-term in-situ response. The test plan needs to address this problem in detail, relating the laboratory testing to in-situ demonstration in verification of creep laws.

- The possibility of water leakage into a repository at Deaf Smith is not considered. Here, the site is located in close proximity to aquifers and one of the greatest problems in salt or potash mining is the leakage of water into the mine. Exploratory techniques must be used to determine the proximity to groundwater from the repository.
- 7. The resulting listing of possible in-situ tests in the appendices is simply a "shopping list" of most standard techniques. The test plan does not detail how the measurements made during these tests will resolve information needs.
- 8. The schedule for the test facility is optimistic. Many of the tests, such as the heater experiments, are in operation only 2-3 months before a cut-off of data for the Draft Environmental Impact Statement is imposed.

Conclusion

The plan provides interesting background work which relates the regulatory requirements to information needs. The primary problem with the plan is that no analyses are given which illustrate the importance of the information needs. The crucial issues which must be resolved for a salt repository are thereby lost in an extensive listing of very general information needs and in-situ tests. In fact, some of the most important issues (such as variability of the formation, the development of a creep law, and retrievability) are not discussed in detail. The in-situ tests proposed are of a general nature and there is no detail suggestion of how these tests interface with the development and validation of models.

We feel that the test plan is a useful tool. It can be improved by providing the background analyses necessary to determine those information needs of greatest importance. A thorough discussion of the crucial issues for salt should follow and should contain a detailed examination of the use of in-situ tests for resolution of the issues. The specification of in-situ tests should be changed from a generic description to site-specific description.

Specific Comments

Page 3 Figure ES-2 shows the identification of information required for resolution of performance issues directly from the analysis method. There are no apparent parametric studies which support the development of information requirements. Therefore, the information requirements are developed from the personal experience of the individual.

Page 4 Figure ES-3 does not show any analysis to design and specific testing. There is no apparent interaction of this program with the overall ONWI program.

Page 5 The bulleted items refer to identification of performance issues without stating how this is done.

Pages 17-21

There is no detailed discussion of the existing laboratory and field testing results in salt. Here, critical issues regarding such items as a creep law for salt should be discussed. The problems discussed in this section of the report included some significant ones—particularly the different response from the corejack and laboratory results as well as the apparently poor predictability of the WIPP tests (not to mention the poor performance of instrumentation). Yet, nowhere in this plan are these problems discussed in detail, and a course of action given for rectifying problems (or re-designing tests for future testing programs).

Page 48 (Section 4.0) A general comment on this section—The information needs developed from the regulatory requirements are given in detail in the appendices. It is impossible to see if the needs are all-inclusive since there are no analyses to back them up.

Page 61 (Section 4.2) The plan does not describe well the process used by ONWI in a progression of knowledge from laboratory to in-situ testing. We know nothing about their plan for development of a constitutive law for salt, the philosophy regarding variability of the rock mass, or how it affects the type of testing, the numbers of tests and the test scale. There is no relationship of inhomogeneity of the rock mass and the need for extensive exploration drifting to define the variability. There is no attempt made to relate the in-situ testing to the design or numerical modeling effort. In other words, the actual definition of in-situ tests is very poor and does not provide some very basic information required to assess the utility of the program.

Page 66 Statements such as

"Several tests provide data for each information need. This is required in order to assess scale effects, calibrate the results of simple tests which can be used to index behavior through the site, and study responses under a full range of environmental conditions."

are somewhat meaningless. Nowhere in the plan are the details of scale effects and index behavior discussed. This is particularly important with regard to the inherent inhomogeneity at Deaf Smith.

Pages 66-70

There is no discussion of the relationship between the shaft and principal borehole—it is advisable that the shaft be sunk on the hole.

Pages 66-71

The plan discusses geologic characterization in a general, textbook fashion but does not discuss the problem of variability of the salt formation. This is particularly true at Deaf Smith, where numerous clay and anhydrite seams are found within the salt. Bedded salt is also typically inhomogeneous laterally. The effects of this variability on the need to explore by drifting rather than drilling of horizontal boreholes is not discussed. The problems associated with long horizontal drill bit wandering and the possible intersection of water-bearing features is also not discussed. In a related fashion, the effects of variability on in-situ testing is not described in the document.

Page 74 The block sampling program is valuable.

Page 78 The utility of the borehole torsional shear test is open to question. It would seem more realistic to obtain block samples of bedded material and perform direct shear tests.

Page 80 There is no discussion of the proposed model calibration from the mine-by test. No details are given regarding the types of models, the validation plan, etc.

Page 81 There are no data to indicate that simple rockbolt pull tests will allow the determination of the utility of rockbolts for support prior to backfilling.

Pages 81-87

The discussion of the mine-by, facility monitoring, room-scale heater test and facility thermal modeling must include the role of inhomogeneity of the rock mass on the results of the testing. Again, there is no detailed discussion on how the results of these tests will be used to provide design or performance assessment information. Also, there are no details concerning the modeling effort.

Page 97 The discussion of the ES facility conceptual layout does not review its relationship to the rest of the repository. The total facility is roughly only 600 feet by 600 feet in dimension. It would seem that a more significant area of exploration is necessary at Deaf Smith. We would feel that lateral dimensions of thousands of feet may be required.

Page 104 The schedule is highly optimistic. In particular, it shows that only a few months of data from the thermo-mechanical experiments will be available prior to the DEIS data cut-off. This is obviously unacceptable.

Recommended Action

It is recommended that the NRC review the latest revision of the in-situ testing plan for Deaf Smith when it becomes available. The plan should be reviewed with regard to the above concerns.