U.S. NUCLEAR REGULATORY COMMISSION
DESIGN REVIEW OBSERVATION REPORT 93-01
FOR THE 90% DESIGN REVIEW OF DESIGN PACKAGE 2A
FOR THE EXPLORATORY STUDIES FACILITY

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1.0 INTRODUCTION

During July 19-22, 1993, members of the staff of the U.S. Nuclear Regulatory Commission Division of High-Level Waste Management observed a 90% design review for the Exploratory Studies Facility (ESF) Title II Design, Subsurface Facilities, Design Package 2A. The observation was conducted at the U.S. Department of Energy (DOE) offices at 101 Convention Center Drive in Las Vegas. In addition, after the observation a visit was made with an NRC On-site Representative to the Field Operations Center and the ESF construction site to obtain more information about the site for the observation of the design package. Participation as an observer of the design review was part of NRC's prelicensing activity, and concerns raised during the observation are documented in this report. Observation of a design review by NRC staff does not constitute an in-depth design review or imply NRC acceptance of the design.

2.0 OBJECTIVES

The objectives of the DOE design review are stated in Section 2, 'Purpose' of the *Project Milestone Review Plan, ESF Title II Design, Subsurface Design Package 2A* (PMRP): "The general purpose of this review is to help M&O and DOE managers and other interested parties assess whether the ESF design is technically correct and if it is in compliance with the project objectives." (TRW Environmental Safety Systems is the management and operating (M&O) contractor to DOE's Office of Civilian Radioactive Waste Management.)

The objectives of NRC staff observations of design reviews are to gain confidence that the designs are technically acceptable, the DOE's design review is effective, and by inference rather than direct observation, that DOE and its contractors and subcontractors are implementing appropriate controls in the design process.

3.0 SUMMARY AND CONCLUSIONS

For this design review, the NRC staff concentrated on the technical aspects of the design and made limited observations of the design control process and the conduct of the review. Based on these limited observations, it appears that the process used for this review was effective. Controlled documents were used in the review, and the PMRP, which is attached to this report, utilizes procedures for review and disposition of comments.

Little can be said about the conduct of the review because after distribution of the design package documents, reviewers and observers dispersed. The meetings that were scheduled for each afternoon for the observers to meet with DOE and M&O personnel were useful to the NRC staff because of the opportunity for discussion of areas of interest. Other potentially useful interactions were the meetings on comment resolution scheduled for August 4 through 6, but they were not attended by the NRC staff.

The NRC staff based its evaluation of the technical adequacy on the criteria of the Project Milestone Review Checklist which is Attachment 5 of the PMRP. When an item was identified by NRC staff that did not seem to meet the criteria, discussions were held with appropriate DOE and M&O personnel. The meetings with DOE personnel, the M&O liaison, and other M&O personnel

clarified some technical issues raised during the observation. Based on the sample of the design package reviewed during the time available, NRC staff did not identify any major design flaws. However, partly because of the limited time, some concerns were not completely addressed, and have been grouped into the following five general concerns of the NRC staff that are described more fully in Section 5.0 of this report:

- The Determination of Importance Evaluation (DIE) seems to rely upon judgment more than it relies upon data and analyses. For those cases for which data can be acquired and analyses performed, NRC staff is generally more comfortable with demonstrations and determinations based on data and analyses rather than those based on judgment alone.

- There is a recognition in the design package that Yucca Mountain is a jointed and faulted rock mass, and the response of the rock mass is affected by the discontinuities such as joints and faults. However, it is not clear that the models used in the analyses in the design package sufficiently represent the possible effects of the discontinuities.

- It is not clearly explained in the design package what is an appropriate level of conservatism to be used in the design to account for uncertainties, and therefore it is not clear that an appropriate level has been used.

- The wording of some of the stipulations in the design package may be sufficiently vague to prevent their implementation during construction.

- The presentation of some calculations may not meet all the requirements of the procedure for performing engineering calculations and analyses.

The main conclusions from the observation of ESF Design Package 2A are that NRC staff should: 1) follow the progress of this design review; 2) observe future design reviews to monitor whether the concerns described in this report are limited to this ESF design package, or whether they also exist for other design packages; and 3) expand its observation to include evaluations of other ongoing technical review activities of the ESF design and construction. It is reasonable to expect that a design review observation can generate a list of concerns, because the purpose of a design package review and observation is to identify possible deficiencies. More important to the NRC staff than the individual concerns identified during specific design reviews would be recurrent deficiencies in future design reviews or the lack of corrective action to address the individual concerns that might be indicative of flaws in the design process.

Another conclusion is that future design reviews could be enhanced by making the documents to be reviewed available as early as possible before the review. This would be particularly beneficial for those reviewers who do not work with the design on a daily basis.

It should also be noted that the five general concerns are not statements that the design is flawed or incorrect. Instead, the concerns can be linked by a common thread that there may have been insufficient information presented

and/or sampled in the design package.

4.0 PARTICIPANTS

William J. Boyle was an observer for the NRC and Phil S. Justus attended some of meetings of the design review for the NRC. The list of attendees, with their affiliations and titles, from the first day of the review is attached. The list of review team members is given in Section 5.0 of the PMRP. The following individuals (only two of whom were part of the design review team) were contacted by NRC staff during the observation of the review:

April Gil	DOE
Jaime Gonzalez	DOE
Ted Petrie	DOE
Peter Hastings	M&O
Rick Nolting	M&O
J. Peters	M&O
Scott Sinnock	M&O (Review leader)
E. Marshall Weaver	M&O (Design reviewer and M&O liaison to the observers)
Jay Keating	Reynolds Electrical and Engineering Company, Inc. (REECo)
Gerald Heaney	Science Applications International Corporation (SAIC)

5.0 OBSERVATION OF THE DESIGN REVIEW

5.1 Scope of the Design Review

The scope of the design review is given in Section 3 of the PMRP and is defined in part by the Basis for Design (BFD). "The scope of this review is limited to comments on design output documents, i.e. design drawings, design specifications, and design analyses produced as part of Package 2A and the BFD. Review objectives are limited to assessing the compliance of the subject design documents with applicable sections of the BFD and assessing the appendices of the BFD."

Applicable procedures and checklists for the design review were supplied in the PMRP.

5.2 Conduct of the Design Review

The design package is for the part of the ESF ramp that will be approximately 200 to 500 feet inside Exile Hill from the ramp portal. DOE supplied each of the reviewers and observers a set of controlled design documents (drawings, calculations, etc) that compose this design package, including DIEs, the Basis for Design, and assorted specifications and calculations. A complete list of the documents that were reviewed is given in Section 6.0 of this report.

As mentioned above in Section 3.0, the NRC staff based its technical evaluation of the design package on the checklist criteria of Attachment 5 of the PMRP. For those parts of the design package for which the NRC staff had comments, the observers did not submit written comments related to the design package directly to the design review secretary, but concerns were

communicated to a liaison with the M&O. When possible, the liaison provided information to immediately address concerns. For those cases when it was not possible to address the concerns, the liaison submitted written comments to the design review secretary reflecting the concerns of the observer. Although the NRC staff feels that the liaison accurately reflected the concerns of the observers with written comments, this report contains a more detailed description of the concerns of the NRC staff.

It is possible to group the concerns about the design package into the following five general topics which are described more fully below:

- Content of the DIE
- Modeling
- Conservatism of the design
- Implementation of the design
- Presentation of some calculations

Each of these topics, except that related to implementation of the design, was discussed, either generally or specifically, with DOE personnel and M&O personnel. The ESF construction site was visited following the observation, and concerns about implementation of the design were communicated to REECo and SAIC personnel, who said they would take the concerns into account when they examined the design package.

Concern 1: CONTENT OF THE DIE

The DIE included as part of Design Review Package 2A is the first DIE evaluated by one NRC observer. The initial reaction was that the DIE did not appear to have many data or analyses, but seemed to rely upon judgment instead. This impression was reinforced by inclusion in the DIE of a November 1992 letter from Tom Blejwas of Sandia National Laboratories (SNL) to Dick Bullock of Raytheon Services of Nevada. The letter states, "However, it must be emphasized that the recommendations that particular items or activities should or should not be considered as important to waste isolation are based primarily on judgment. Therefore, in some cases, it may not be possible to cite applicable references or data to support a particular recommendation; only that based on past experience and current knowledge of the site, a recommendation is tendered." It was explained by an NRC observer in meetings with DOE personnel and M&O personnel that NRC staff are generally more comfortable with data and analyses, rather than judgments, whenever data can be obtained and analyses can be performed.

The staff concern is not about the DIE for safety, because in the absence of analyses and data it has been conservatively assumed that the tunnel support is important to safety. The concern relates to the limitations put on activities and materials as a result of the determination of the importance to waste isolation (ITWI). On page 5 of 13 of the Waste Isolation Evaluation, it is stated "During the construction of the tunnel, rock is removed that contains water in the matrix. If the total volume introduced to the host rock as a consequence of the drilling and blasting is less than the volume of water removed by the excavation, then the effects on waste isolation due to the extension of the starter tunnel are expected to be insignificant." It may

prove to be true that the construction water used for Design Package 2A may be insignificant to waste isolation, but the reasoning in the DIE, presented above, may be flawed. The reasoning does not seem to acknowledge that the matrix water may be essentially immobile, while the construction water that is introduced is probably not immobile. It is preferable to NRC staff if test data (lab or field) and analyses are used to demonstrate that the construction water that will be used is insignificant to waste isolation.

Another specific example, from the DIE, that is related to the lack of data or analyses, and the use of judgment instead, occurs on page 13 of 27. In the last paragraph it is stated that drill and blast excavation will not cause sufficient damage to create preferential pathways. The statement does not seem to be based on data or analyses, and appropriately qualified people might take exception to the statement, because of the lack of supporting data and analyses.

Concern 2: MODELING

The second general concern of the NRC staff that was discussed with DOE personnel and M&O personnel relates to modeling a fractured rock mass such as Yucca Mountain with computer codes that are based on the assumption that what is being modeled is a continuum. For some phenomena, a continuum model cannot permit the inclusion of some modes of response that are known to exist for a fractured rock mass. For some of the phenomena, some of the non-represented modes of response may be important, but these modes are not being analyzed because they cannot be represented in a continuum code. Therefore, there may be modes of response at Yucca Mountain that could be important, but which may not be analyzed sufficiently.

One specific example, modeling fluid flow, is related to the concern about the DIE given above. In the ITWI determination, the volume of water in the rock is determined by calculating the volume of water in the matrix continuum. Yet, on page 5 of 13 of the evaluation it is stated, "The only plausible mechanism for significant water movement in 10,000 years ... is through fracture flow." Yet, the design package did not present analyses that represent fluid flow as occurring in fractures.

A second specific example discussed with DOE personnel and M&O personnel is the stability of the ramp roof. In Volume 2 of the Mining Calculations, it is acknowledged that blocks of rock could be a source of instability by falling from the roof, yet analyses are not presented to examine such discrete rock block failures. Instead, the analyses presented for ramp stability utilize a continuum code that cannot model a block fall. When this example was discussed with an M&O engineer, the observation was welcomed and it was said that it would be conveyed to others in the M&O about the possible need to conduct additional analyses that do permit discontinuous behavior of rock blocks.

Another specific concern that was discussed with DOE and M&O personnel is that no dynamic analyses concerning ramp stability are presented, but conservative static analyses are used instead. It is not clear whether this is sufficient. As with the concern about using continuum codes to represent the behavior of

discontinuous rock, it is possible that some conservative, static analyses may not sufficiently represent some dynamic aspects, and static analyses alone may not be sufficient. The observation was acknowledged, and M&O personnel said that additional modeling needs would be investigated.

Concern 3: CONSERVATISM OF THE DESIGN

It was mentioned to DOE personnel and M&O personnel that a staff concern about the conservatism of the design identified in an earlier design review observation for a different design package can also be made for Design Package 2A. In some of the calculations for Design Package 2A, it appears that the designers are relying upon prior experience with mines or tunnels, yet there does not seem to be an acknowledgement that the ESF/repository is neither a mine nor a highway tunnel, and that greater conservatism may be warranted. Even if greater conservatism is not warranted, the design package does not make clear what is an appropriate level of conservatism necessary to compensate for the uncertainties in the design.

A specific example related to conservatism is the issue of dynamic versus static analyses for the ramp, described in Concern 2 above. On page 13 of 153 of Volume 2 of the Mining Calculations, it is stated that dynamic analyses are not generally done for the design of underground facilities. While this may generally be true for mines and highway tunnels, dynamic analyses are not unprecedented and have been performed for underground designs, in particular for designs of structures that might be subjected to the effects of weapons. Furthermore, there are precedents of performing dynamic geomechanical analyses for those structures, the failures of which could be potential threats to public health and safety, with dams being one example. The design package does not seem to acknowledge that the design methods used for other underground structures, although of interest, may not be sufficient for the ESF/repository because the requirements of the potential repository at Yucca Mountain are different from the requirements of a mine or tunnel.

Another example related to conservatism is the design of the support for the ramp. As part of the design method for determining the support for the ramp roof and walls, a parameter called the Excavation Support Ratio (ESR) must be chosen. The smaller the value chosen for the ESR, the more support that has to be supplied for the ramp. If all other parameters in the support determination are kept the same, making the ESR smaller should make the ramp safer because more support will be added. It is stated in the Rock Mass Classification Analysis of Volume 1 of the Mining Calculations that an ESR of 1.3 is used. Yet it is also acknowledged in the calculation that major highway tunnels typically use an ESR of 1.0. This can be taken to suggest that a typical highway tunnel would have a more conservative roof support system than the ESF excavation, everything else being equal. While this may be appropriate, the design package does not explain the basis for the appropriateness of this ESR.

Concern 4: IMPLEMENTATION OF THE DESIGN

The fourth general concern of the NRC staff is related to the implementation of the design in construction, and the stipulations in the DIE that will

require monitoring of materials and/or activities in construction. While it is impossible to find fault with the implementation of Design Package 2A because it is not being constructed yet, those parts of the first 200 feet of the starter tunnel that have been constructed give an indication of whether it will be possible to comply with some of the stipulations of the DIE.

One stipulation of the DIE is in a February 2, 1993 memo from Les Shepherd of SNL to Russ Dyer of DOE that states ".. no pressure grouting be done within 50 feet of the two contacts [that is, the contacts between the upper Tiva Canyon Member and the vitric, non-welded Pah Canyon member, and between the Pah Canyon Member and the Topopah Spring Member] during ramp construction." Furthermore it is recommended that no pressure grouting be done within 100 feet of a fault zone. When the ESF construction site was visited by NRC staff, a discussion with a REECo engineer led to the observation that without a clear definition of "pressure grouting", it is unclear to the construction crew what the stipulation means.

A second stipulation of the DIE is that less than 325,000 gallons of water be used in construction of Design Package 2A, not counting the water used in the shotcrete and grout, because it is believed that shotcrete and grout water is bound in the cement. In a discussion with an SAIC engineer, it was determined that although water use is being metered presently, there is only one water meter and there may not be a method to separate the water used in construction (not counting that used in shotcrete and grout) from the total amount used, which presently does include that used for shotcrete and grout.

Concern 5: PRESENTATION OF SOME CALCULATIONS

The fifth general concern of the NRC staff is about the presentation of some of the calculations. This was not discussed in detail with DOE personnel and M&O personnel, but it was mentioned to them that the presentation of the calculations is variable in the level of detail used.

A specific example is related to requirement 5.1.3-I in the M&O's QAP-3-9 for Engineering Calculations and Analyses. This requires, "Complete presentation of the calculation such that anyone appropriately qualified could review the calculation without recourse to the originator." The design package document titled "Structural Calculations" has calculations that may not meet requirement 5.1.3-I because of insufficient text to explain the assumptions, methods of analysis, and variables that are used.

Another specific observation is related to the dates of the calculations, some of which were only days before the design review. It is possible that if some calculations are being done at the last moment, and are rushed, an uneven, and perhaps insufficient level of detail might result in the calculations.

6.0 LISTING OF DOCUMENTS AVAILABLE FOR REVIEW

The following documents were examined as part of the observation of Design Package 2A:

Determination of Importance Evaluation

Basis for Design
General Requirements Specification Sections
Sitework Specification Sections
Concrete Specification Sections
Conveying Systems Specification Sections
Mechanical Specification Sections
Electrical Specification Sections
Study (this concerned the justification for a flatter ramp slope)
Structural Calculations
Mechanical Calculations
Mining Calculations Volume 1
Mining Calculations Volume 2

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ATTENDANCE LIST
19 JULY 1993

No.	NAME	COMPANY	TITLE
1	John Peters	M&O/MK	Principal Mining Engr.
2	Jerry Naaf	M&O/MK	ESF Engr. Super Sub-Surface
3	Peter Hastings	M&O/Duke	DIE Manager
4	Hector R. Montalvo	M&O/FD	Lead Civil/Structual Engr.
5	Robert W. Kirk	M&O/Duke	Engineer (DIE Group)
6	William I. Boyle	US NKC	Geotechnical Engineer
7	Jim Grubb	State	Engineer
8	Robert Justice	M&O QA	Quality Engineering Manager
9	John J. Clarke	M&O MK	ESF Assist.Engr
10	Levent Ozdemir	CSM	Professor
11	Richard Fournier	TRW	Review Secretary
12	Grey Smith	TRW	Systems Engineer
13	Robert Saunders	M&O	Subsurface Excavation Lead Engineer
14	Jaime Gonzalez	DOE	Engineer ESF BR
15	Vernon E. Poe	Mineral Co.	Dir. Nuclear Project
16	T. Truong	DOE	Engineer
17	Ken Herold	M&O/MR	Lead Civil/Struct.
18	Ron Oliver	LANL	ESF Testing
19	Neal Pettit	M&O	ESF Sr. Engr.
20	Richard G. Kaish	LANL	ESF Testing
21	Ed McCann	SAIC	Environment
22	Scott Sinnock	M&O	Design Leader
23	Dan Buston	M&O	Systems Engineer
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No.	NAME	COMPANY	TITLE
25	Kenneth R. Keener	M&O	DCC Manager
26	Gary Teraoka	TRW	Requirements
27	Hemendra N. Kalia	Los Alamos	Technical Advisor - ED ED/YMPO
28	William P. Law	M&O	Systems Engineer
29	P.E. Sperry	NW TRB	Consultant
30	M.S. Rindskopf	M&O	Systems Engineer
31	Dan McKenzie	M&O	ESF PE Staff
32	Keith Roberts	M&O	Sr. Staff
33	Randolph L. Schreiner	RSN	Sr. P/E. Systems
34	Dana J. Rogers	M&O	RR P/E Sub Surf.
35	Raymond A. Mele	M&O/WCFS	Sr. Project Engineer
36	Bernard Verna	DOE	Engineer
37	Tom Fortner	DOE	Construc. MGR
38	Bob Sandifer	M&O/TRW	MGDS Dev. Mgr.
39	Phil Justus	U.S. NRC	On-Site Representative
40	Dan Zerga	Weston	Mine Eng.
41	Dennis Bechtel	Clark CO.	Coordinator
42	T. Arul Mozht	Weston	Systems Engineering
43	Ray Nations	M&O	Sr. Mgr. Safety
44	Jim Friant	CSM	Prof. Research
45	Ronald E. Smith	WCFS	Sr. Consultant
46	James L. Robertson	TRW	Specialty Eng. MGR
47	Glenn Vawter	M&O/TRW	Dep. Site Manager
48	Tom Leonard	REECo	Const. Dept. Mgr.
49	Ronnie Jarriel	TRW	Reliability Engineer
50	Jim Replogle	DOE	ESF BRDN
51	Don Vanica	M-K	Mechanical Lead
52	Jack Nesbitt	M&O	ESF Sr. PE

No.	NAME	COMPANY	TITLE
53	Markus Popa	DOE HQ	Engineer
54	Paul McKie	M&O/MK	Subsurface Design
55	E. Fred Homuth	LANL	Staff Member
56	William R. Jacobs	SAIC	Engineer II
57	John O. Cowles	M&O/TRW	Chief Engineer
58	John J. Miller	M&O/TRW	Mgr. Systems Engineering
59	Terry G. Nelson	RSN	Sr. Prin. Engr.
60	Marshall Weaver	M&O	Mgr. Reg. Interactions
61	Bert H. Anzai	RSN	Sr. Engineer
62	Scott Nordick	RSN	Princ.Engineer
63	Bob Waters	DOE	Engineer
64	Bill Reed	M&O/MK	Lead Engineer
65	Dick Bullock	RSN	Technical Advisor
66	Tom Geer	M&O	MGDS S.E. Mgr.
67	James Gill (P. Howell)	M&O	Elec. Engineer
68	Don Schutt	M&O	Sr. Staff Eng.