ITASCA
Consulting Group, Inc.

13 October 1987

David Tiktinsky - SS623
U.S. Nuclear Regulatory Commission
Division of Waste Management
Washington, D.C. 20555

"NRC Technical Assistance
for Design Reviews"
Contract No. NRC-02-85-002
FIN D1016

Dear David:

Enclosed is Itasca's trip report for participation in ESF Title II 60 Percent Design Review Comment Resolution Session, Salt Repository (Houston, 28 September - 2 October). Please call me if you have any questions.

Sincerely,

Roger D. Hart
Project Manager

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

Encl.
rdh/ks

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ITASCA TRIP REPORT

DATE: 28 September - 2 October 1987

LOCATION: Hyatt Regency West
Houston, Texas

PURPOSE: To observe the ESF Title II 60 Percent Design Review Comment Resolution Session, Salt Repository

ATTENDEES: R. Hart and B. Brady (Itasca)
N. Tanious (NRC)
B. Cummings (Engineers International)

PREPARED BY: R. Hart and B. Brady

SUMMARY

The purpose of this meeting was to resolve comments presented by reviewers of the ESF Title II 60 Percent Design for the salt repository in Deaf Smith County, Texas. A list of the meeting participants is attached (Attachment I). Reviewers of the design submitted a total of 1,418 comments, 274 of which related directly to mining. As with the previous ESF design review meetings, this one was led by K. Beall and T. Goodell of the Battelle Design Review Board. Copies of all the comments and the responses by the designer, PB/PB-KBB, were distributed to everyone at the meeting. Each comment and response was reviewed in turn, and a final resolution was reached which was accepted by both PB/PB-KBB and the reviewer. Several comments (particularly those related to detailed analysis of the shaft liner) were deferred for resolution at the 90 Percent Design Review.

The NRC was invited to observe the resolution of the comments generated by this design review. The general and mining comments resolution was observed during the first two days of the meeting. Several documents supporting the ESF design were made available to the NRC for review at the Hyatt. Since these documents have not yet been formally released, the NRC attendees spent the majority of the remaining three days of the meeting studying these reports in detail.

Major Observations

As a result of this meeting, a better understanding was gained by the NRC on the assumptions and design methodologies used for the ESF design. This information is important for the clarification of concerns expressed by the NRC at the Technical Meeting on the DOE/SRP ESF (5-7 May 1987). It was evident at the 60 Percent Design Review that some of the NRC concerns are also concerns of the design reviewers. In particular, the analyses used to determine rock loading of the liner within the freeze zone and the salt zones were of concern. The detailed analyses for the liner design were not available for this meeting and the concerns were deferred for resolution at 90 Percent Design Review.

A particular concern at this review meeting was the lack in commonality between the ESF and the repository shafts and emplacement panels. There were obvious differences of opinions on the relationship between these facilities. Several components of these facilities are different; the most glaring are

(1) a difference in preliminary liner construction — a concrete block liner in the lower region of the aquifer for the ESF shaft versus a bolted cast iron (tubbing) liner with concrete for the repository shaft;

(2) a difference in lining through salt zones — the ESF shaft will be overexcavated through salt zones and a resin foam backfill placed between the salt and the liner, whereas the repository shafts are to be designed for lithostatic pressure of the salt;

(3) a difference in rockbolting strategy — virtually 100% bolting in the underground test facility versus limited bolting (only where required) in the repository panels; and

(4) differences between room dimensions and elevations in the ESF test facility versus dimensions and elevations for the repository panels.

It is curious that a comparative analysis of these different components has not been performed. The discussion of the designers and reviewers suggested that such analyses have not been conducted to date, even though the Title II design is at 60%.

In connection with the discussions on shaft liner design, questions were raised concerning the similarity between the ground freezing technique and concrete block liner proposed for the ESF and that used for the West German repository shaft at Gorleben, which collapsed in May 1987. Several opinions were voiced concerning the cause of this failure, although it was not evident that the exact cause of the failure had been determined. It is curious that DOE has not made an attempt to substantiate the cause of failure at Gorleben and demonstrate that such a failure would not occur at the ESF.

The discussions concerning the design life of operational seals indicated that the designer has not demonstrated that the seal design has been accomplished by using conservatism in the design approach. A Battelle reviewer commented that the proposed seals should have a redundancy seal since the expected design life is 25 to 30 years. The designer indicated that the technical feasibility of increasing the seal height or seal interval would have to be investigated. This discussion suggests a lack, on the designer's part, of understanding of the expected behavior of the seal system.

The discussion on decommissioning seals indicated a difference of opinion among the reviewers concerning the identification of potential decommissioning seal locations. The designer identifies a thickened lining region in the lower salt formations as a potential location of a decommissioning seal zone. It appears that the ESF design will only consider seals physically located in the lower salt formation for the post-closure seal system. A performance analysis to demonstrate that this system will meet 10 CFR Part 60 requirements was not available for this meeting.

Technical Comments

Shaft Lining

(a) Ogallala and Dockum Units — The pronounced divergence of opinion between Fluor/MK and PB/PB-KBB staff on the performance characteristics and advantages/disadvantages of concrete block and cast iron tubbing preliminary linings has some broad implications for the ESF. Failure to demonstrate unequivocally the superiority of one system over the other (bearing in mind the differences in operating principle for the two methods) implies that the short-term and long-term performance of the frozen ground-lining-thawed ground-asphalt-permanent lining system has not or cannot be analyzed with any degree of rigor. In either case, the NRC needs to assure itself that behavior can be predicted and defined in a technically credible way, as it bears on the retrievability performance objectives for the repository.

The mechanics of the concrete block preliminary lining, including the phase after placement of the permanent lining, are quite subtle and complex. The block lining is designed to accommodate changes in both earth pressure and lining pressure. It is unlikely that a comprehensive analysis of the wall operating characteristics has been conducted. In this regard, an axisymmetric version of FLAC would be appropriate for examining non-uniform thawing over the shaft column. MUDEC could be used for preliminary plane analysis of the block arch and loadings representing non-uniform near-field thawed soil conditions. In this matter, Fluor/MK concern about point loads developing on the outer wall of the cast concrete permanent lining must be given due consideration, and could be analyzed using current or enhanced Itasca codes.

In addition to the unresolved question of the type of temporary lining in the lower Dockum, some doubt must be entertained about the logic of using a cast-in-place concrete liner in the upper water-bearing sediments. Presumably, if problems of heat generation during setting and curing disqualify cast-in-place concrete for the lower section, a similar problem must exist for the upper section. There has not been any clarification or justification of the acceptability of cast concrete in one section of frozen ground, and not in another.

(b) Salt Beds — Due to the current state of modeling of salt creep, no convincing analysis has been presented to provide confidence in the capacity of the permanent lining to accommodate the stresses generated by salt loading of the walls. The role of the proposed compressible backfill must also be verified by analysis using a convincing analytical scheme based on a verified creep law.

(c) Clay Beds — Reservations were noted by Fluor/MK staff concerning lining stresses generated by clay beds subject to creep. The NRC may need to consider performing specific check calculations to assess the scope of the problem associated with clay creep.

(d) Decommissioning Seal Locations — There seems to be some justification in the NRC's taking an interest in preservation and maintenance of the integrity, from the shaft sinking phase, of rock in the more competent beds in the sequence. Such an interest is justified directly in terms of concerns about performance of particular barriers (i.e., shaft seals) after closure.

Shaft Foundation Keys

The shaft foundation keys are located in the more competent horizons, and serve the function of supporting the weight of the shaft column. In sections where asphalt forms part of the shaft lining, or salt or potentially softening claystones form the shaft peripheral rock, it must be assumed that no lateral resistance or skin friction supports the shaft column. Thus, the shaft keys must be designed to accommodate the full dead weight load of the linings. Inspection of some of the design drawings has suggested that only elementary limit equilibrium analysis has been applied to calculate the bearing capacity of the key foundations. Since the foundations are essential components in achieving the performance objectives of the shafts, the NRC may find it prudent to make its own assessment, through more rigorous analysis, of the design of these elements.

Roof Support in the At-Depth Facility

Significant time and discussion in the review were spent in considering the proposed design of roof reinforcement in the test facility. The design proposed by PB/PB-KBB required 4-ftx4-ft pattern bolting using (on average) 16-ft roof bolts throughout the facility. In an informed session outside the main meeting, PB/PB-KBB justified this proposal on the basis of the need to preserve the integrity of the repository horizon, in view of the specifications under which the ESF is to be constructed.

Several matters arise from the proposed roof control measures. First, it is inconceivable that pattern bolting on this design would be used throughout an operating repository. Second, mechanical and thermal testing of rock response to simulated repository conditions would be grossly distorted by the presence of such an intensity of roof reinforcement. Third, the basis for the design seems to be a quite rudimentary model of roof reinforcement. It may be a matter of some concern to the NRC to ensure that design of roof reinforcement, which has developed quite considerably in the last several years, is conducted using verified contemporary technology.

Pillar Stresses and Performance

Since the extraction ratio in an operating repository in salt will be relatively low compared with room and pillar mining practice, states of pillar stress sufficient to cause extensive pillar failure are not likely. However, a function of pillars in repository operations is control of heat and gas flow and air circulation in the host horizon. This function can be fulfilled only if the integrity of pillar rock is maintained. To this extent, design of repository pillars resembles the design of panel pillars in coal mine longwall extraction layouts. In that case, panel pillars are designed to prevent gas communication and transport between adjacent panels, as well as for ground control.

The review noted that the Wilson method, commonly used for coal mine panel pillar design, had been used to design repository pillars. There is no justification or precedent for such a design procedure in this case, and there are excellent reasons why it is not appropriate for salt. A particular reason is that the Wilson model assumes frictional constitutive behavior for yielded rigid-plastic rock, which in no way describes the behavior of salt.

An adequate analysis of pillar behavior should proceed from the known constitutive behavior of salt. It is anomalous that the accepted contemporary analytical techniques are not being applied in pillar design.

Integrity of Shaft Wall Rock

Some prolonged discussion in the review concerned acceptance criteria for the excavated surface of the shafts, with a view to control of boundary damage by excavation. Although consideration of this issue may be outside the NRC's terms of reference, there may be an opportunity to impress on the DOE and its agencies the preference for a geophysical method for assessing the mechanical state of shaft boundary rock. Laborious visual inspection of shaft walls is not likely to yield objective, quantitative information on the state of the boundary rock mass. A more attractive scheme involves prior characterization of the near-field rock by a seismo-acoustic technique in probe holes below the shaft sinking floor, and subsequent confirmation that the rock in the excavated shaft surface had not been excessively disturbed from its original state. Again, seismo-acoustic techniques may be satisfactory for this purpose.

Respectfully submitted,

Roger D. Hart
Program Manager

COST BREAK-OUT

Labor

B. Brady	44 hrs @ $31.25/hr	$ 1,375.00
R. Hart	44 hrs @ $24.04/hr	1,057.76
	TOTAL LABOR	$ 2,432.76

Actual Expenses

Travel	
Airfare	
Brady (Mpls-Houston-Mpls)	$ 460.00
Hart (Mpls-Houston-Mpls)	460.00
Miscellaneous Travel Expenses	
Brady (mileage, parking)	26.50
Hart (car rental, taxis)	89.46
Lodging	
Brady (5 nights at $60.00/night)	300.00
Hart (5 nights at $60.00/night)	300.00
Meals	
Brady	165.00
Hart	165.00
Miscellaneous Expenses	
Brady (telephone)	28.64
Hart (copies)	7.40
TOTAL EXPENSES:	$ 2.,002.00

Attachment 1

ESF TITLE II 60 PERCENT DESIGN REVIEW
RESOLUTION MEETING
SEPTEMBER 28, 1987

NAME	ORGANIZATION	ROOM NO.	~~HOME~~ OFFICE PHONE NO.
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* Germany shaft design expertise

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PDR-1
LPDR WM-10(2)
WM-11(2)
WM-16(2)

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