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FINAL REPORT ON THE ENHANCED CHARACTERIZATION OF THE REPOSITORY BLOCK (ECRB) PLANNING EFFORT

Volume 2 of 3

102-8

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Civilian Radioactive Waste Management System
Management and Operating Contractor

Final Report on the Enhanced Characterization of the Repository Block (ECRB) Planning Effort

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Revision 0

Volume 2 of 3

November 4, 1997

APPENDIX A COMMENTS ON PLANNING EFFORT

To: Larry Hayes, Jean Younker, Richard Snell
cc: James Beyer
From: Michael Voegele
Date: 03/20/97 10:48:26 AM
Subject: Integrated Planning Committee

To: Robert Sandifer
cc: Jerri Adams, Michael Voegele, Dennis Williams, Mark VanDerPuy, Ned Elkins
From: Wesley Barnes
Date: 03/20/97 10:46:24 AM
Subject: Integrated Planning Committee

Mr. Chairman,

Please remember that YMPM wants early testing in this "Cross Drift" that will allow confirmation data entry to the VA. I have discussed the issue with Dennis Williams and he informs me that my request is in his level of consciousness and my desires will be taken into consideration. Please make sure that the entire committee does the same. If this request is not possible, please take the time to explain the situation to me.

Wes

Michael Voegele
03/21/97 01:26 PM

To: Wesley Barnes@CRWMS
cc: Robert Sandifer@CRWMS, James Beyer@CRWMS
Subject: Enhanced Characterization Program planning focus

Mr. Barnes:

The planning groups are working to develop evaluation criteria that address the following overall objective (which wil be shared withthe Integrated Planning Committee for valivation next Monday):

Develop a recommended approach for the enhanced site characterization effort incorporating a drift across the potential repository block and other investigations. The approach should address work that will enhance scientific understanding of the behavior of the site, as well as enhance understanding of engineering; construction, health and safety; cost; and regulatory and performance aspects of the potential repository. The study should consider the relationship between ongoing characterization activities, particularly how the current programs could complement and be complemented by the enhanced characterization effort. The approach should identify data needs that would support more rigorous compliance demonstrations for the siting criteria, design criteria, performance objectives, and Safety Analysis Report content requirements in the disposal regulations (10 CFR Part 60), while avoiding limitations on characterization activities listed in 10 CFR 60.15(c). It should also address potential efficiencies in the enhanced program by providing for additional or subsequent characterization efforts. It should reflect the latest scientific understanding of the behavior of the site. The extent to which enhancements in the program can confirm the data supporting the Viability Assessment also should be incorporated into the prioritization of integrated activities.

I would appreciate any comments that you might have on this statement of objectives.

To: Ken Ashe, Jim Houseworth, Ned Elkins, Peter Hastings, William Kennedy
cc: Ralph Rogers, Jeff Skov
From: James Beyer
Date: 04/10/97 01:06:25 PM
Subject: ECRB Guidance Clarification

Additional info for your use.

To: Robert Sandifer, James Beyer
cc: Dennis Williams, Russ Patterson, Ron Oliver
From: Michael Voegele
Date: 04/10/97 11:12:43 AM
Subject: Guidance Clarification

In a meeting of Site Testing working group of the Enhanced Characterization of the Repository Block effort, clarification was requested relative to on going planning for changes and future changes to the test program that could result from this effort. Specifically, the DOE is at this time planning modifications to the current surface based drilling program and is well along the Change Request process for adding two boreholes, WT-24 and SD-6 to the current program. Of concern to the working group was delaying the WT-24/SD-6 CR to await the results of the Enhanced Characterization of the Repository Block effort.

I do not believe that it is in the interests of the program to delay processing of this CR for the several months that it will take to complete the effort and prepare the ECRB CR. Accordingly, I advised the working group to proceed as if the CR for WT-24 and SD-6 was in place and to assume those two boreholes to be a part of the characterization program being examined for enhancement in the Enhanced Characterization of the Repository Block effort.

This information probably should be made available to the other working groups as well.

3/31/97
RDSnell

COMMENTS ON ENHANCED CHARACTERIZATION OF REPOSITORY BLOCK

A. OVERALL

1. The drift development must be conducted in such a way as to provide data to the Project throughout the development period.

2. The data we expect to acquire should be related (in advance) to data already acquired to:

   a. Confirm current expectations
   b. Reduce current areas of uncertainty
   c. Fill any "data gaps" which may now exist

3. Safety must be a high priority item (secondary egress/refuge chambers??).

4. This work should be planned and conducted in concert with other project activities (i.e., other necessary work should not be sacrificed or delayed to support this effort) and it should not be allowed to distort the overall characterization program.

5. What basis for selecting a North, Mid-Block, or South location for the E-W crossing?

B. RISKS

1. Cannot be "constructing a repository."

2. Proximity to expected repository emplacement horizon should be selected to provide useful data but must not introduce/create weakening of the potential repository.

3. Drainage implications of the drift need to be considered.

4. Proximity to, or penetration of, the Solitario Canyon fault needs careful consideration (structural weakness, drainage from West to East side of fault, etc.).

5. Interference with water mobility patterns from the potential repository.

C. ADDITIONAL DATA

1. Variations in geochemistry (West side to East side).

2. Variations in rock matrix porosity and saturation percentages (West side to East side).

3. Correlation of data with borehole data to confirm site stratigraphic models.

4. Influences (localized) of Solitario fault on West block characteristics.

TRW Environmental
Safety Systems Inc.

1180 Town Center Drive
Las Vegas, NV 89134
702.295.5400

WBS: 1.2.6
QA: N/A

Contract #: DE-AC01-91RW00134
LV.SCO.RMS.6/97-037

June 23, 1997

J. J. Adams, DOE/YMSCO, Las Vegas, NV
R. L. Craun, DOE/YMSCO, Las Vegas, NV
V. F. Iorii, DOE/YMSCO, Las Vegas, NV
J. M. Replogle, DOE/YMSCO, Las Vegas, NV

Subject: Enhanced Characterization of Repository Block (ECRB) Issues and Concerns

Enclosed is a copy of the Heavy Construction Cost Data and the M&O Rationale for ECRB Launch Chamber. The minutes from the June 20, 1997, ECRB meeting and the ECRB Cost Estimates, which were forwarded to you via Lotus Notes on Friday, June 20, are also enclosed.

If you have any questions, please call me at 295-5504.

T E Touchstone for

Robert M. Sandifer, Manager
Site Construction and Operations
Management and Operating Contractor

Enclosure:
1. 6/20/97 ECRB Meeting Minutes
2. ECRB Cost Estimates
3. Heavy Construction Cost Data
4. M&O Rationale for ECRB Launch Camber

cc w/encl:
J. R. Beyer, M&O, Las Vegas, NV
I. R. Cottle, M&O, Las Vegas, NV
R. C. McDonald, M&O, Las Vegas, NV
T. E. Touchstone, M&O, Las Vegas, NV
RPC - 10 pages

This documents the discussion held on June 20, 1997 concerning issue associated with the East-West Drift portion of the ECRB proposal.

Attendees included Bob Sandifer/Vince Iorii/Ric Craun/ Tommy Touchstone/Jim Beyer/Ivan Cottle/Dick McDonald/Rufus Taylor

The meeting began at 8:30 AM. with discussions centered around the following questions:

1. Why is a 16 foot diameter tunnel was needed?

- It was stated that this was needed to provide large enough access to allow the alpine miner into the ECRB as mechanical excavation is required for the two niches in the drift.
- The core drill rigs need a minimum of a 14 foot diameter to operate.
- Tunnel services i.e. vent tubing, rails etc. take up a lot of space and therefore restrict work space and access requiring a larger diameter tunnel.
- The intended diameter also mimics the size of the observation drift as well as the waste emplacement drifts. This would allow the drift to be used in a repository if and when a repository is authorized.

2. Why is such a large launch chamber required?

- A launch chamber enables the TBM and all the trailing gear to be lined up at the face and ready to work.
- To minimize the interference between the work and ongoing science work that must pass to get to areas beyond the launch chamber (also maintains a double egress path).
- Enable all support equipment and supplies to be safely out of the main drift.

- It provides necessary space for conveyor transfer, conveyor belt "take-up" assembly, motor control centers (larger at the chamber mouth), space for a side track so trains can cross (there will be single trackage in the E-W drift).
- Provides room for an air filtration spot filter.
- Provides a larger more effective working space for TBM assembly.
- Launching without a chamber will cause uneven loading on the head and main bearing - major risk.
- Launching from the existing tunnel will be a difficult method with a launch cradle in the main tunnel and during the initial turn-under.

The final dimensions of the launching area will be optimized in the design process through interaction between the AE, CMO and Constructor. It is expected that the detailed planning with the actual TBM will reduce the size and cost for the launch chamber.

3. Costs are too high for the TBM Excavation, what is the break down of these cost and how do they compare?

The attached information was presented that outlined principal work elements, their costs, and cost per meter of excavation. Circumstances unique to our situation were also pointed out. Questions were asked regarding the validity of the costs. Response was given that cost estimates described were reasonable when compared to the Means Heavy Construction Cost Data (10th Annual Edition - 1996) and that the M&O was comfortable with them. The Means data was presented and will be sent under separate cover.

4. Have you looked at what (TBM) is available in the market place?

Initially Kiewit had two 16' main beam Robbins machines in their yard in Omaha. Both were well suited for our excavation work and could be put in rehab immediately without any procurement action (Kiewit is designated to supply the machine). This obviously is the shortest time line to start excavation. Because of this, no market availability search was done. However, due to the interest expressed in what other alternatives may exist, we have now initiated a market search; the results of which we will forward to interested parties when complete.. It was explained that it is common practice in the industry not to rehabilitate a machine after it finished a job. It is common for a unit to "sit" in some location until another job was contracted and then the unit would be fixed up to meet that new requirement. However, the current constructor, Kiewit, already had a compatible unit that could be refurbished to meet YMP needs. The long lead time mandated by the government procurement process coupled with the tight schedule to begin E-W drift excavation was the driver in selecting the Kiewit machine.

Two additional questions had been asked although they were not discussed in the meeting. The response to these questions is included as information.

1. Why not conform to the standard industry practice of leasing equipment suitable for the project with the vendor providing any needed rehabilitation?

The cost of the TBM for the cross drifts consists of two components. One, the usage or ownership cost for the existing TBM and two, the cost of the refurbishing the used machine to meet project requirements. The M&O's strategy for establishing price for the TBM is to separate the two cost components to avoid a constructor's windfall profit if the length if the period of TBM excavation is extended (Solitario Canyon and Calico Hills extensions). This allows the project to pay for the project specific modifications separate from the lease rate for the basic machine.

Another option is to roll the modification cost into a lease rate for an established period of recovery and establish a second lease rate for any extended time requirements. We choose the first option to make the cost visible and guard against any double charges.

2. What are the component of the $9.5m estimate for the crossdrift.

Direct cost of T.M. excavation is currently 7,976546 without PM&I or $9, 444 with PM&I

The components are:

Labor - 37%

Permanent Materials - 29%

Supplies - 34%

ECRB Cost Comparison (Based on 2300 meters)

Activity	Activity Cost ($)	Total Cost ($)	Cost Per Meter/Foot
Excavate ECRB Cross Drift	$ 9,444,304		
ECRB Direct Supervision and Engineering	$ 1,590,015		
#1 Subtotal	$ 11,034,319	$ 11,034,319	$ 4,797/ $ 1,463
Lease Construction Equipment for ECRB	$ 1,822,188		
ECRB Muck Handling	$ 419,800		
#2 Subtotal	$ 2,241,988	$ 13,276,307	$ 5,772/ $ 1,760
TBM Mobilization and Rehabilitation	$ 2,717,450		
Excavate ECRB Launch Chamber	$ 1,756,015		
Install Excavation Equipment	$ 976,802		
ECRB TBM Demob	$ 828,990		
#3 Subtotal	$ 6,279,257	$ 19,555,564	$ 8,502/ $ 2,592

06/13/97 *This comparison is shown in three steps. #1 represents direct drift excavation cost. #2 represents the additional cost imposed by equipment lease and mucking handling. #3 represents additional cost that are primarily unique to the YMP E-W drift starting and ending underground in an existing operating facility.

Means®

Heavy Construction Cost Data

10th Annual Edition

1996

022 | Earthwork

		022 700 | Slope/Erosion Control	CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	1996 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
716	5100	Setting stone, dry	D-1	100	.160	C.F.		3.67		3.67	5.7[illegible]
	5600	With mortar	↓	120	.133	•		3.06		3.06	4.[illegible]
		022 800 | Soil Treatment									
804	0010	TERMITE PRETREATMENT									
	0020	Slab and walls, residential	1 Skwk	1,508	.005	SF Flr.	.14	.14		.28	.3[illegible]
	0100	Commercial, minimum		2,496	.003		.07	.08		.15	.21
	0200	Maximum		1,645	.005	↓	.10	.13		.23	.31
	0400	Insecticides for termite control, minimum		14.20	.563	Gal.	9.80	14.60		24.40	34.5[illegible]
	0500	Maximum	↓	11	.727	•	16.75	18.85		35.60	48.50

023 | Tunneling, Piles & Caissons

		023 010 | Tunnel Construction	CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	1996 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
014	0010	TUNNEL CONSTRUCTION Bored tunnels, incl. mucking, 20' diameter									
	0100	Rock excavation, minimum				L.F.				345	355
	0110	Average R023-110								725	830
	0120	Maximum								1,730	1,900
	0200	Mixed rock and earth, minimum								575	635
	0210	Average								1,250	1,380
	0220	Maximum								2,000	2,200
	0300	Earth excavation, minimum								290	315
	0310	Average								695	760
	0320	Maximum				↓				1,675	1,850
	0400	Shaft excavation, rock, minimum				C.Y.				47	52.50
	0410	Average								68	75
	0420	Maximum								135	150
	0430	Earth, minimum								26	29
	0440	Average								42	47
	0450	Maximum				↓				115	126
	0500	Tunnel liner invert, incl. reinf., for bored tunnels, 20' diam., rock				L.F.				300	325
	0510	Earth								210	230
	0520	Arch, incl. reinf., for bored tunnels, rock								315	345
	0530	Earth				↓				300	325
	0800	Contact grouting incl. drilling and connecting, minimum				C.F.				6.15	6.80
	0820	Maximum				•				36.50	40
	2000	Cut and cover, excavation, not incl. hauling or backfill	B-57	80	.600	C.Y.		13.50	13.40	26.90	36
	2100	Decking on steel frames, concrete				S.F.				19	21
	2110	Steel plates								25	27.50
	2120	Wood				↓				13.50	15
	2500	Shotcrete applied in tunnels				C.Y.				225	245
	3000	Ventilation for tunnel construction									
	3100	Duct, 48" diameter, 20 ga., spun on site				L.F.				13.50	15
	3200	Fan, 48" diameter, 125 H.P., incl. starter				Ea.				17,300	19,000
	9000	For sheeting, lagging, and dewatering, see div. 022									
		023 100 | Tunnel Construction									
150	0010	MICROTUNNELING									
	0100	30" diameter, average 50'/day				L.F.					600

		023 100 | Tunnel Construction	CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	1996 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P	
150	0110	Adverse conditions, add				%					50%	150
	1000	Rent microtunneling machine, 4 months minimum				Month					58,000	
	1010	Operating technician				Day					450	
	1100	Mobilization and demobilization, minimum				Job					80,000	
	1110	Mobilization and demobilization, maximum				•					500,000	

		023 400 | Tunnel Support Systems	CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P	
404	0010	ROOF BOLTS for mines and tunnels 5/8" diameter, 24" long				Ea.	3.55			3.55	3.91	404
	0200	60" long					6.05			6.05	6.65	
	0400	3/4" diameter, 36" long					6			6	6.60	
	0600	96" long					12.60			12.60	13.85	
	0650	1" diameter, 48" long					8			8	8.80	
	0660	96" long					14.30			14.30	15.75	
	0800	Washers for above, 1/4" thick, 4" x 4"					1.35			1.35	1.49	
	1000	6" x 6"				↓	1.45			1.45	1.60	

		023 550 | Pile Driving	CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P	
554	0010	MOBILIZATION Set up & remove, air compressor, 600 C.F.M. R023-820	A-5	3.30	5.455	Ea.		108	12.80	120.80	186	554
	0100	1200 C.F.M.	•	2.20	8.182			162	19.25	181.25	279	
	0200	Crane, with pile leads and pile hammer, 75 ton	B-19	.60	106			2,725	2,350	5,075	7,150	
	0300	150 ton	•	.36	177			4,525	3,900	8,425	11,900	
	0500	Drill rig, for caissons, to 36", minimum	B-43	2	24			520	835	1,355	1,725	
	0520	Maximum		.50	96			2,075	3,350	5,425	6,950	
	0600	Up to 84"	↓	1	48			1,050	1,675	2,725	3,475	
	0800	Auxiliary boiler, for steam small	A-5	1.66	10.843			215	25.50	240.50	375	
	0900	Large	•	.83	21.687			430	51	481	740	
	1100	Rule of thumb: complete pile driving set up, small	B-19	.45	142			3,625	3,125	6,750	9,525	
	1200	Large	•	.27	237	↓		6,050	5,200	11,250	15,900	
	1300	Mobilization by water for barge driving rig										
	1310	Minimum				Ea.				5,850	6,450	
	1320	Maximum				•				38,000	42,000	
558	0011	PILING SPECIAL COSTS pile caps, see Division 033-130 R023-820										558
	0500	Cutoffs, concrete piles, plain	1 Pile	5.50	1.455	Ea.		37		37	65	
	0600	With steel thin shell, add		38	.211			5.35		5.35	9.40	
	0700	Steel pile or "H" piles		19	.421			10.65		10.65	18.80	
	0800	Wood piles	↓	38	.211	↓		5.35		5.35	9.40	
	0900	Pre-augering up to 30' deep, average soil, 24" diameter	B-43	180	.267	L.F.		5.75	9.30	15.05	19.35	
	0920	36" diameter		115	.417			9.05	14.55	23.60	30	
	0960	48" diameter		70	.686			14.85	24	38.85	50	
	0980	60" diameter	↓	50	.960	↓		21	33.50	54.50	69.50	
	1000	Testing, any type piles, test load is twice the design load										
	1050	50 ton design load, 100 ton test				Ea.				10,000	10,500	
	1100	100 ton design load, 200 ton test								10,800	12,000	
	1150	150 ton design load, 300 ton test								14,130	15,700	
	1200	200 ton design load, 400 ton test								18,900	21,000	
	1250	400 ton design load, 800 ton test				↓				28,350	31,500	
	1500	Wet conditions, soft damp ground										
	1600	Requiring mats for crane, add								40%	40%	
	1700	Barge mounted driving rig, add								30%	30%	

		023 600 | Driven Piles	CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P	
604	0010	PILES, CONCRETE 200 piles, 60' long R023-820										604
	0020	unless specified otherwise, not incl. pile caps or mobilization										
	0050	Cast in place augered piles, no casing or reinforcing										
	0060	8" diameter	B-43	540	.089	V.L.F.	1.45	1.92	3.10	6.47	8.05	

Why is the Launch chamber required?

A Launch Chamber has advantages over TBM mobilization and set-up in the North Ramp, when a total project approach and schedule is considered. These include:

1. A larger more effective working space for TBM assembly.
2. Reduced reliance on South Ramp access to the testing areas and reduced logistical costs on the movement of men, materials, and equipment from the primary support facilities at the North Portal.
3. Avoids uneven loading on the head and main bearing - major risk.
4. Difficult method for launch cradle in main tunnel and initial turnunder.
5. Provides a more effective layout for the interfaces of rail tracks and conveyor.
6. Provides a more effective logistical support and staging area for TBM operations.
7. Supports parallel science work and schedule optimization.

The final dimensions of the launching area will be optimized in the design process through interaction between the AE, CMO and Constructor. It is expected that the detailed planning with the actual TBM will reduce the size and cost for the launch chamber.

Comments were made by outside organizations in various documents and forums. The following documents are included for the record:

1. Statement of Dr. Jared L. Cohen, Chairman, NWTRB, before the U.S. Senate Committee on Energy and Natural Resources, 2/5/97, 4 pages

2. NWTRB Viewpoint, April 1997, 2 pages

3. Article from May 5, 1997 issue of Nuclear Fuel entitled "DOE Wraps Up ESF Construction, Readies for Work on East-West Tunnel", 2 pages

Beyer
O-RMS
XC-staff

Note E-W
Drift Disc.,
2nd page.

Statement of
Dr. Jared L. Cohon, Chairman
Nuclear Waste Technical Review Board
before the
Committee on Energy and Natural Resources
United States Senate
February 5, 1997

Good morning, Mr. Chairman and members of the Committee. My name is Jared Cohon. I am here today in my role as Chairman of the Nuclear Waste Technical Review Board. I have been a member of the Board since 1995 and three weeks ago I was appointed Chairman by President Clinton. I am trained as a civil engineer with a specialty in water and environmental systems analysis My full-time job is dean of the School of Forestry and Environmental Studies at Yale University.

Today I will focus my remarks on three areas: the status of the scientific work at Yucca Mountain; the technical implications of the provisions of S. 104, which would establish a centralized storage facility for spent fuel; and the provisions of S. 104 that would undermine the effectiveness of the Nuclear Waste Technical Review Board. I would like to request that the two one-page summaries attached to my statement describing the Board and its views on spent fuel storage be entered into the hearing record.

The Role of the Board

As you know, Mr. Chairman, the Board was created as part of the 1987 amendments to the Nuclear Waste Policy Act. Under its charter, the Board conducts an independent evaluation of the technical and scientific validity of activities undertaken by the Secretary of Energy to implement that law. We are charged with reviewing the country's waste management system with a focus on the suitability of the Yucca Mountain site as the proposed location of a permanent repository for the disposal of civilian spent fuel and some high-level radioactive waste. The Board is required to report to the Congress and the Secretary of Energy twice a year on its findings and conclusions. The eleven members of the Board are appointed by the President from a slate of candidates selected on the basis of their expertise by the National Academy of Sciences.

Status of the Yucca Mountain Site Characterization Program

I will begin today with a short discussion of the status of the Yucca Mountain site-characterization program. As you know, Mr. Chairman, the DOE has nearly completed excavation of a large repository-level tunnel that is being used to conduct important exploratory studies. The Board has long encouraged the DOE to construct this underground facility and commends the DOE for the progress it has made in this important area. DOE scientists have been analyzing data obtained from the facility for the past year or so. In many ways, the new information that has been gathered has confirmed beliefs about the site and about how well a disposal facility might perform if constructed there. But, in other important ways, the data collected has forced scientists to reevaluate some of their prior understanding of the site.

For example, in 1987, when it was selected as the only site to be characterized, one of the primary technical advantages of Yucca Mountain appeared to be that it was "dry." And as recently as ten months ago, the amount of water estimated to enter the repository horizon was thought to be approximately 0.1 mm per year. However, new data collected in the exploratory tunnel last fall suggest that the amount of water percolating through the mountain could be significantly greater than anticipated.

What are the implications of this new information? Our expectations about the performance of the repository will depend most on estimates of how much water percolates through the site. We expect that water eventually will contact and corrode the waste packages and will, over thousands of years, dissolve the waste, perhaps carrying some of it to the accessible environment. While the new data do not necessarily mean that the site is unsuitable, it is clear that understanding how the natural and engineered barriers would act in combination to limit these releases is of crucial importance to the determination of whether this site can be judged suitable.

It is important for the Committee to understand that the current exploratory tunnel is located at the same level and close to, but *not in*, the proposed repository area. While extremely important data are being obtained from the current exploratory tunnel, direct observation of the repository block is necessary to address remaining uncertainties about water movement and faulting, and to help in determining the most appropriate design and operational strategy for the proposed repository. In the Board's view, the best way to obtain the data needed is to construct a 4000-foot-long tunnel, 2-3 meters in diameter, starting at the current main tunnel and extending west directly into and across the proposed waste emplacement area. Constructing this east-west crossing conforms to standard engineering practice, you simply should not decide to embark on a major underground project without seeing firsthand what the relevant geology is like. We estimate that excavation of this tunnel would take about 6 months to complete and would cost about $10 million.

Comments on S.104 pertaining to a centralized storage facility

I now would like to comment briefly on some key aspects of S. 104 from the Board's perspective. Mr. Chairman, as I know you remember, last year the Board released a report on spent fuel storage. There were two key conclusions:

- First, a centralized storage facility *will be needed*. Planning for it should begin immediately. However, there are no compelling *technical or safety reasons* to move spent fuel to a centralized storage facility for the next few years.

- Second, significant advantages can be derived from siting a storage facility adjacent to a repository. However, to maintain the credibility of the site-suitability decision, siting a centralized storage facility near Yucca Mountain should be deferred until *a technically defensible site-suitability determination* can be made at Yucca Mountain. We have estimated that such a determination could be made within about four years, if current rates of progress continue at the site.

S. 104 would link a decision on siting a centralized storage facility to a viability assessment. The Board believes the viability assessment can serve an important function in focusing and integrating the program, but it will not be a technically defensible suitability determination. The viability assessment will be based on very preliminary repository and waste package designs and insufficient data about the waste emplacement area. Thus, linking a decision about siting a centralized storage facility to the viability assessment could, in the Board's view, jeopardize the credibility of the technical site-suitability determination.

But developing a storage facility requires more than a siting decision; it also requires the development of a transportation system. The Board believes that the risks associated with transporting spent fuel are very low and are likely to remain low even when the number of shipments increases. However, the country currently has a capacity to transport only a few hundred metric tons of spent fuel a year. This is about 10-15 per cent of the commercial spent fuel generated annually. Developing a transportation infrastructure, including the transportation casks and enhanced safety capabilities along the routes, necessary to move significant amounts of waste will likely take a few years longer than will be needed to develop a simple centralized storage facility. Therefore, if we focus now on developing the transportation infrastructure, siting of a centralized storage facility could likely be deferred for a few years without significantly affecting the amount of spent fuel that will actually be moved from reactor sites.

Mr. Chairman, the Board believes that siting a centralized storage facility now at the Nevada Test Site will do little in the way of providing actual storage capacity while creating a real risk to the credibility of the process for determining the suitability of the Yucca Mountain site for repository development. At the same time, we understand that other considerations, including the need to accommodate judgments about waste acceptance, will enter into a final decision by the Congress and the administration on this complicated issue.

Comments on S. 104 pertaining to the Board's operations

I would like to place on the record the Board's deep concern about language in S. 104 that would seriously limit the Board's ability to perform the job given it: To provide the Congress and the Secretary of Energy with an independent – and credible – technical review of the civilian radioactive waste management program. This program is complex, and its various elements are closely tied together — at least they should be. Limiting the Board's review to specific, and narrow, areas, as S. 104 would do, could adversely affect the relevance and completeness of the evaluation that the Board provides the Secretary and the Congress.

S. 104 would stringently limit the amount of time the Board could meet with the Secretary's representatives. Aside from serious questions about how this provision might be implemented, the Board believes that such a limitation is inappropriate, especially now when new data and analyses are beginning to pour in and when critical judgments, such as those included in the viability assessment, will have to be made soon.

Language in S. 104 also eliminates the Board's authority to obtain and review draft program documents. When the Board was created, the report accompanying the legislation stated: "The Board is expected to review the activities as they are occurring, rather than after the fact." Early access to draft material has been essential to the timeliness and relevance of the Board's independent technical review.

In conclusion, Mr. Chairman, the Nuclear Waste Technical Review Board looks forward to continuing to provide an unbiased and independent technical and scientific evaluation of this important and complex program. We are eager to support the Secretary and the Congress in achieving our common goal of finding a credible solution to the problems associated with spent fuel and high-level radioactive waste management.

This concludes my statement. I will be happy to answer any questions the Committee might have.

NWTRB Viewpoint
April, 1997

Why is an East-West Tunnel at Yucca Mountain Important?

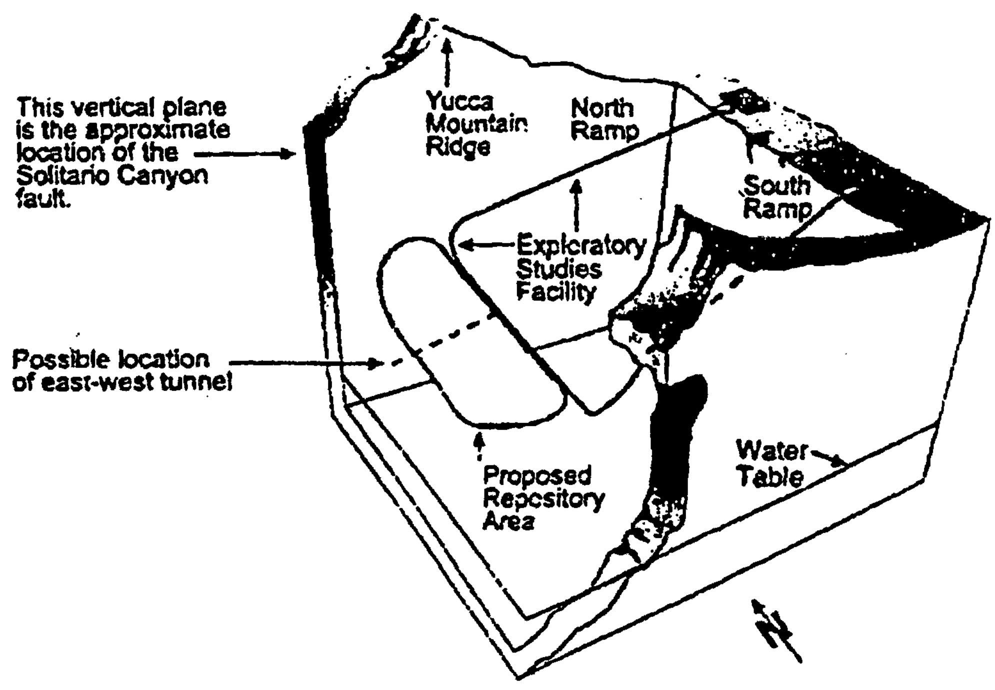
What is a repository and how would it work?

A permanent repository at Yucca Mountain would isolate spent fuel and high-level waste from the environment in three principal ways:

- Deep burial (about 1,000 feet below the earth's surface) would prevent most types of accidental human contact with the waste and would protect the waste from many natural disruptive forces, such as severe weather.
- Engineered barriers, such as thick, corrosion-resistant waste packages, would be designed to contain the waste for thousands of years.
- The waste would be placed in the unsaturated zone, an area of rock well above the water table, where direct contact of the waste with groundwater would be minimized. This is important because water is the primary means for transporting harmful radionuclides to the environment.

What is an east-west exploratory tunnel?

The Nuclear Waste Technical Review Board has recommended that the Department of Energy (DOE) construct a tunnel across the proposed repository area (see figure). This tunnel should provide the data needed to complete a credible assessment of the scientific and technical suitability of the Yucca Mountain site for repository development within the next four years. The tunnel should be approximately 10–16 feet in diameter and should extend about 4,000 feet from the exploratory studies facility (ESF) through the Solitario Canyon fault, which lies along the western edge of the proposed repository area. The Board believes that the tunnel can be completed in less than a year and should cost no more than $10 million. Data collection and initial analysis should take less than two years. The DOE announced in March 1997 that it intends to excavate such a tunnel.



Why is an east-west tunnel needed?

An east-west tunnel is the best way to obtain data needed to assess the site's long term performance. The suitability of Yucca Mountain as a potential repository site depends strongly on the geologic and hydrologic conditions within the mountain. Existing studies conducted in the ESF have helped the DOE characterize the geologic structures and movement of water in the region *adjacent to* the proposed repository area. But important geologic properties of rocks often vary highly from one area to another. Direct observation of the geologic and hydrologic conditions inside the potential repository area is needed.

Nuclear Waste Technical Review Board 2300 Clarendon Blvd. Suite 1300 Arlington, VA 22201 (703) 235-4473 FAX (703) 235-4495

NWTRB Viewpoint

April, 1997

What can we learn from an east-west tunnel?

An east-west tunnel is the best way for scientists to collect data needed to improve their understanding of the faults and fractures in the proposed repository area and the role those geologic structures play in controlling the movement of water through Yucca Mountain.

Data collected in the ESF during 1996 greatly increase the need for an east-west tunnel by raising important questions about the movement of water from the surface down to the proposed repository area. High concentrations of chlorine-36, a radioisotope generated by atmospheric nuclear weapons testing, exist at several locations in the ESF. These high concentrations indicate that rainwater has traveled through faults and fractures from the surface of Yucca Mountain to repository depth in fifty years or less. In addition, surface studies indicate that the amount of rainwater reaching repository depth on the western side of the proposed repository area may be substantially higher than on the eastern side near the ESF. Together, these findings indicate that the proposed repository area may be wetter than previously thought and some water may travel through the mountain faster than expected. Either condition could reduce the ability of a repository at Yucca Mountain to isolate wastes from the environment.

If enough water were to enter the repository, it could eventually corrode the waste packages, solve or leach harmful radionuclides from the waste, and carry them downward to the water table. The contaminated water could then flow horizontally, carrying radioactive material into the adjacent environment. Therefore, it is important to understand where and how much water could enter a repository and how fast the water could transport radioactive material from the repository area to the environment.

How might the information obtained from the east-west tunnel affect decisions about the repository?

The direct observations that can be made in the east-west tunnel will help determine whether the Yucca Mountain site is suitable for repository development. If the site proves suitable, the east-west tunnel also will provide important information for repository design and construction. Information on the amount of water present and its transport in the proposed repository area is important for designing engineered barriers and for estimating how long radionuclides can be isolated from the environment.

What is an ESF?

The DOE has nearly completed a five-mile-long exploratory tunnel at Yucca Mountain, Nevada. The tunnel, called the exploratory studies facility, helps the DOE evaluate the waste isolation potential of the adjacent proposed repository area deep inside the mountain.

NWTRB Viewpoint is a collection of short papers that summarize the major positions of the U.S. Nuclear Waste Technical Review Board. The Board was created by the U.S. Congress to evaluate the technical and scientific validity of the U.S. Department of Energy's program to manage the permanent disposal of the nation's spent nuclear fuel and high-level radioactive waste. The Board is an independent agency of the U.S. government.

DOE WRAPS UP ESF CONSTRUCTION, READIES FOR WORK ON EAST-WEST TUNNEL

Tunneling equipment at DOE's proposed repository site in Nevada hit daylight last month, ending a five-mile journey that took nearly three years and over $500-million to complete.

If Yucca Mountain is found to be suitable for a high-level nuclear waste repository, another 100 miles of smaller tunnels could be needed. And that prospect has raised concerns at the Nuclear Waste Technical Review Board (NWTRB). "Excavation efficiency must be improved beyond that demonstrated in constructing the ESF (the five-mile exploratory studies facility) or the cost of repository construction would be exorbitant," the board said in its latest annual report to Congress.

Excavation on the horseshoe-shaped ESF, or main test tunnel, began in September 1994. The cutterhead of the tunnel boring machine (TBM) broke through the mountain on April 25, roughly 31 months later. Total cost of the ESF is estimated at $566-million, according to DOE spokesman Erik Olds.

That figure, however, includes planning and design expenses incurred before 1992 and projected maintenance and operation costs of the tunnel until 2001-2003, he said. Also in the tab are the cost of equipment and personnel; construction of the main tunnel and its seven adjoining test alcoves; data gathering and scientific tests conducted in the tunnel and alcoves; maintenance and overhead; and safety and health requirements. Those costs are calculated through March 1997, putting the total tab still higher.

Olds said it would be difficult to break that total down into the different cost categories due, in part, to the overlap of some work activities. Work whose cost is accounted for in one category might actually overlap into another.

Nonetheless, an earlier DOE estimate put the cost of construction activities alone at the site at $73.9-million for FY-95 through February 1997. That figure, however, does not include such things as the cost of the ESF design, safety and health, and management and overhead. Several sources outside the department last week speculated that the inclusion of those costs would push the construction tab much higher.

Sources familiar with the commercial tunneling industry point to a Las Vegas water tunnel as an example of the gap between federal and commercial projects. That 20,000-foot, or 3.78-mile, tunnel was constructed and lined in a matter of months. As at Yucca Mountain, the project involved tunneling through tuff. The project came in at $20-million, or $1,000 a foot.

DOE, however, has always argued that the ESF, with its scientific orientation cannot be compared to water, sewer or other tunneling projects.

East-West Tunnel Planned

After persistent urging by the NWTRB, DOE now plans to tunnel into the actual area that would be used to bury the waste at a Yucca Mountain repository. Russ Dyer, DOE's deputy project manager, said the tunnel would have a smaller diameter than the main test tunnel's 25-foot diameter and would be about 4,900-6,560 feet long.

Tunnel construction would start in fiscal 1998, which begins October 1, Dyer said. DOE's FY-98 budget request includes $20- to $25-million for the additional excavation, he said. However, he added, the tunnel is expected to take $15-million and eight to 10 months to complete.

Based on the department's cost and schedule projections, that would put the construction cost at roughly $3,000-$2,200 a foot.

The NWTRB has pushed for the tunnel in hopes that data gathered from the area would help resolve some technical uncertainties about hydrologic conditions in the mountain. Currently, DOE has only one borehole that actually penetrates the proposed disposal area, giving it a small vertical look at the geologic formations there.

Dyer noted that part of the earlier resistance to the tunnel came from project scientists and engineers who feared the work would take money away from their projects. After a very lean FY-96, in which program funds were cut 30%, the Yucca Mountain project has been "very gun shy," Dyer said.

A projected FY-97 budget carryover, however, was a factor in the department's decision to proceed with the new tunnel, he added.

The tunnel is expected to add to the department's data inventory. Rock characteristics and water flow will be among the geologic features studied, including a seismic fault the tunnel is slated to cross.

Information already retrieved from elsewhere at Yucca Mountain suggest that the desert site might be wetter than DOE first thought it to be and that water may be traveling through the highly fractured rock faster than expected. Both conditions are factors that could affect repository design and operations.

The amount and rate of water flowing through the mountain will be a factor in when waste packages corrode and collapse. Water also would provide any radionuclides escaping from the fuel an escape hatch, carrying them through the rock and depositing them eventually in the groundwater below the repository. From there, the radioactive contamination could travel to the accessible environment.

"Infrequent small amounts of water may be unimportant, as may be water that moves so slowly that radionuclides can decay or be diluted to harmless levels before reaching the environment," the NWTRB said in its report. "At Yucca Mountain, however, fractures and faults may provide fast flow paths that allow water to move downward from the surface very rapidly, especially after infrequent periods of high rainfall."

Meanwhile, DOE plans to use the site's current construction contractor, Peter Kiewit, which also constructed the ESF, to excavate this smaller tunnel, Dyer said. However, this time DOE will require the company to supply its own TBM—the same approach used in the commercial tunneling industry.

DOE had purchased a $13-million custom-designed tunneling machine for the ESF. According to DOE, the General Services Administration has been asked to sell that machine. Revenues from the sale will be deposited in the Nuclear Waste Fund, the trust fund set up with ratepayer money to cover the cost of the DOE nuclear waste program.—*Elaine Hiruo, Washington*

PIT 9 CLEANUP *(continued from page 1)*

finished product or service. In this case, the $179-million contract DOE signed with LMAES in 1994 calls for the completion of the Pit 9 cleanup at the Idaho National Engineering & Environmental Laboratory by February 1998. How LMAES gets to the end product is, essentially, up to the company.

However, delays in the Pit 9 cleanup, which is 18-24 months behind schedule, have produced several hundred thousand dollars in fines that DOE has had to pay to the Environmental Protection Agency and state of Idaho for cleanup milestones that were missed, according to Bliley and Barton. Bliley is the chairman of the Commerce Committee. Barton chairs the panel's Subcommittee on Oversight & Investigations.

"Based on these recent developments, we are concerned that the department may not be capable of providing proper oversight over this new contracting method," they said in their April 17 letter. "Given the number and size of other 'privatized' fixed contracts the department has recently signed, this is a very serious issue."

The department has been counting on fixed-priced contracts as a vehicle that will allow it to do more work with less money. Spokesperson Anne Elliott said DOE now has seven fixed-price cleanup contracts in place.

At Idaho, LMAES ran into problems when it found it had to develop new technology to handle the highly oxygenated material in the burial pit (NF, 21 April, 3). The company absorbed all costs associated with the development of a new technology and the preparation of the pit, which covers an acre, for remediation, according to LMAES spokesman Scott Hallman.

DOE, however, has already paid the company $54-million in milestone and progress payments, according to the Bliley-Barton letter.

Last week, Debra Jacobson, chairman of the secretary's working group on privatization, said that DOE has learned some "valuable lessons" from the problems at Pit 9 but that 50 years of contracting practices can't be changed overnight.

DOE was to respond to the Bliley-Barton letter by late last week. Elliott added department officials are to brief the lawmakers on the Pit 9 situation this week.

Meanwhile, Bliley and Barton have asked the U.S. General Accounting Office to review issues associated with the Pit 9 contract.—*Elaine Hiruo, Washington*

DOE, WESTINGHOUSE CONSIDER REVIVING MPC PROGRAM ON COST-SHARE BASIS

DOE and Westinghouse have been discussing a possible cost-share venture that would revive the department's defunct multipurpose canister (MPC) program and supply the company with $3-million to help fund NRC certification of its design, according to a DOE official.

Lake Barrett, acting director of DOE's civilian nuclear waste program, told the House Commerce Committee during a hearing on nuclear waste legislation April 29 that Westinghouse is expected to respond to the offer this week. Westinghouse was the MPC program's sole contractor.

Telling DOE it should rely on the private sector, Congress killed the MPC project—aimed at developing a canister-based system with interchangeable overpacks that could be used to store, transport, and bury spent fuel—years ago while Westinghouse was working on the initial design of a storage-transport system. Work on the disposal overpack was to come later. The company received about $14-million for the design work.

Barrett told reporters following the committee hearing that the DOE funding would be equally divided between the civilian spent fuel and defense waste cleanup programs over two years. DOE, he said, would retain ownership of the design. It's not economically viable for the company to proceed with this work without some government assistance, Barrett said, noting that the cost-sharing would not give Westinghouse an edge but merely create an even playing field.

"Westinghouse has been asking us to do this for two years," Barrett said. He noted, however, that Sen. Pete Domenici (R-N.M.) recently inquired about possible federal financing of MPC certification.

But as NAC Vice President David Blee sees it, the limited cost-sharing program raises serious legal questions. "DOE cannot do a public-private partnership without asking other companies to participate," he said.

Currently, storage-transport canister systems developed by Sierra Nuclear, Holtec International, Vectra Technologies, and NAC International without taxpayer money are being reviewed by the NRC. NRC staff is slated to meet with Sierra Nuclear on May 6 and with Vectra on May 9.

—*Elaine Hiruo, Washington*

APPENDIX B QUESTIONS/CONCERNS IDENTIFIED DURING PLAN DEVELOPMENT

Enhanced Characterization of the Repository Block

Listing of Questions

Quest. No.	Date	Asked By	Question Asked	Action To	ETC
3-1	3/11/97	Dan McKenzie	What about the 200 meter cover issue?		
3-2	3/11/97	Wes Barnes	Can early scientific testing in the tunnel be beneficial to VA?		
3-3	3/11/97	Richard Wagner	What is the level of control expected from DOE?		
3-4	3/11/97	Peter Hastings	Is the drift to be considered part of the ESF, and will it be subject to ESFDR requirements?		
3-5	3/11/97	Peter Hastings	Is the drift to be considered part of the repository, and if so, to what extent will we comply with repository requirements at the time of excavation? Do we anticipate E-W drift ground support, for instance, to be designed and installed as "permanent"? As Q?		
3-6	3/11/97	Peter Hastings	Will a DIE be required prior to completion of the contractor statement of work? (If the constructor is Kiewit, or anyone else who knows anything about this project, they will likely be reluctant to sign up to a fixed price without knowing what their requirements are?)		

Enhanced Characterization of the Repository Block

Listing of Questions

Quest. No.	Date	Asked By	Question Asked	Action To	ETC
3-7	3/11/97	Peter Hastings	Can Kiewit be turned on to this effort on a fixed price under their current contract? Do we have time to go after any other contractor?		
3-8	3/11/97	Peter Hastings	Will this be considered a facility subject to existing requirements such as system safety, RAM, human factors analysis, etc.		
3-9	3/11/97	Peter Hastings	Will we allow alternate construction methods to replace whatever design we prepare for this drift?		
3-10	3/11/97	Peter Hastings	Is "proof-of-concept" for repository development considered performance confirmation?		
3-11	3/11/97	Peter Hastings	What is the priority for planning this work, as compared with: VA risk mitigation C/R, EIS support C/R, DOE SNF PWA, FY98 planning, VA Issue resolution, etc.?		

Enhanced Characterization of the Repository Block

Listing of Questions

Quest. No.	Date	Asked By	Question Asked	Action To	ETC
3-12	3/11/97	Peter Hastings	How will this new planning effort fit in to the other planning in progress? For instance, when we're asked to mark up an MPM for the E-W drift effort, will we start with the current baseline, the latest ETC, or the latest estimate that includes VA risk mitigation and EIS support? (Same question for FY98 planning.)		
3-13	3/11/97	Peter Hastings	When will we acquire, and how will we house, new staff to work on this effort? Do we expect that any staffing ramp-up to support this effort will be needed for other work in 15 months, or will we expect to have to deal with what to do with too much staff at that time?		
3-14	3/11/97	Peter Hastings	Will a revision to the ESF Concept of Operations be required?		
3-15	3/11/97	Peter Hastings	If the construction contractor is not Kiewit, how will we work conformance to a QA program? Are there any staff augmentation issues to worry about?		

Enhanced Characterization of the Repository Block

Listing of Questions

Quest. No.	Date	Asked By	Question Asked	Action To	ETC
3-16	3/11/97	Peter Hastings	If the new contractor is Kiewit, how will we prioritize their production, reporting, and submittal or records for the E-W drift as compared with records recovery for the main drift?		
3-17	3/11/97	Peter Hastings	Has the E-W drift been discussed in the context of waste isolation alternatives as required by 10CFR60?		
3-18	3/11/97	Peter Hastings	If we expect Kiewit to be the constructor (which is what I thought I heard, based on the contracts folks' belief that we don't have time to start a new contract from scratch), and if we expect them to meet essentially the same requirements as they have to meet today (except probably even more onerous in some areas, as we'll be working closer to the repository block), and if they have to work under the QA program, what is it we'll be doing "different"?		
3-19	3/17/97	Steve Brocoum	At what point in the (*planning*) process do we brief Lake Barrett		
3-20	3/17/97	Steve Brocoum	At what point in the (*planning*) process do we brief NRC, NWTRB, and the Repository Consulting Board?		

Enhanced Characterization of the Repository Block

Listing of Questions

Quest. No.	Date	Asked By	Question Asked	Action To	ETC
3-21	3/17/97	Vince Iorii	Will the magnitude of the change request (CR) trigger any Level 1 change thresholds?		
3-22	3/17/97	Beyer/Cottle	How do we handle the multi-yeatr cost issue?		

APPENDIX C ORIGINAL CRITERIA LISTINGS BY WORKING GROUP

3/26/97
1:30PM

ENHANCED CHARACTERIZATION OF THE REPOSITORY BLOCK CONSOLIDATED CRITERIA/ASSUMPTIONS LIST

Testing Working Group

Criteria

Are there location or layout specific considerations, including appropriate drifting, test alcoves, and subsurface boreholes, surface boreholes, and other investigations, that can enhance the scientific understanding of the site relative to:

1) fracture variability.

2) unexposed faults.

3) hydrologic properties, fracture properties and geotechnical properties in and near faults.

4) the characterization of the spatial distribution of moisture tension and saturation.

5) the age and distribution of perched water.

6) alternative conceptual models of perched water formation.

7) the distribution and mineralogy of fracture fillings.

8) the age and genesis of fracture filling minerals.

9) the distribution of environmental isotopes from systematic and feature based samples.

10) the spatial distribution of percolation flux.

11) fracture and matrix components of flow.

12) flow into openings.

13) temperature gradients in the repository block.

14) gas ages and flow patterns/distribution of gaseous environmental isotopes.

15) infiltration and percolation in and around faults.

16) pressure and chemical gradients and flow in the SZ in and around faults.

17) flow patterns in the UZ below the repository horizon.

18) the distribution and continuity of zeolitization in the Calico Hills Tuff.

19) the hydrochemistry of the UZ below the repository horizon.

20) the location and origin of the LHG north of the repository block.

21) dilution, mixing and flux distribution in the SZ.

22) the hydrochemistry of the SZ.

23) the spatial distribution of thermal and geomechanical properties of the repository horizon.

24) the location and continuity of stratigraphic contacts in the expanded repository block.

25) the distribution of hazardous minerals in ventilation, air and the rock mass.

Assumptions

Performance Assessment Working Group

Criteria

Are there location, layout, or test program specific considerations for enhanced characterization that can enhance the understanding of the site relative to:

1) water seepage into drifts to better define the mode of water contact with waste packages and the mode of potential radionuclide transport?

2) the distribution and concentration of environmental tracers in the PTn to better define the extent of fast transport pathways through the PTn?

3) the flux distribution, hydrogeologic and transport properties, and chemical and isotopic composition of the saturated zone?

4) the distribution and concentration of environmental tracers (perhaps traced construction water also), hydrogeologic properties, and fracture/matrix flow distribution in the CHnv (and CHnz if possible) to better define fast pathways for radionuclide movement below the repository horizon?

5) transport through a perforated waste package to see if radionuclide releases from waste packages can occur through the initial pinhole perforations?

6) in-drift water movement in the presence of a drip shield to better define the effects of such a barrier on water contact with waste packages and its potential effect on radionuclide releases?

7) cathodic protection to better define the effects on waste package corrosion?

8) the geochemical environment in the drifts (including the interaction with cement) to better define conditions affecting radionuclide solubilities and waste package corrosion?

9) water and tracer movement through welded and nonwelded tuff containing natural fractures to better define fracture/matrix interaction?

10) the geochemical and isotopic water composition along stratigraphic contacts to help bound the potential for lateral diversion of water and/or radionuclide pathways in the unsaturated zone?

11) the effects of EBS materials and waste heat on the geochemical environment outside the drift to better define the influence of the altered zone on radionuclide transport characteristics (solubilities, sorption, colloidal interactions) in the unsaturated zone?

12) the distribution of vitric/zeolitic rocks in the south and west portions of the block to better define potential for radionuclides to bypass zeolites?

13) the large hydraulic gradient, including distinguishing between perched water and the water table, and hydrogeologic properties in this area?

14) the unsaturated and saturated zone flow in and around Solitario Canyon Fault to better define the role of the fault as a potential pathway for radionuclides in the unsaturated zone and its role in the saturated zone relative to the moderate hydraulic gradient?

15) the identification and characterization of any pre-Tiva Canyon faults as potential fast pathways through nonwelded units?

<u>Assumptions</u>

Licensing/Regulatory Working Group

Criteria

1) Are there location, layout, or test program specific considerations for ~~an east-west drift~~ enhanced characterization ~~that can enhance understanding of the site relative to~~ to ensure that additional drifts or excavations do not violate the 200 meter overburden disqualifying condition of 10 CFR Part 960? [960.4-2-5(d)] [Note: There should be no need to enhance understanding relative to this condition; we know the surface topography. This criterion should only make sure that the project is careful to keep any new diggings below 200m. Compare underground surveying data to surface elevations. Shafts, boreholes, and their seals are excluded from this condition.]

2) Are there location, layout, or test program specific considerations ~~for an east-west drift~~ that can enhance the understanding of the site relative to necessary controls to limit impacts to the waste isolation characteristics of the site?

3) Are there location, layout, or test program specific considerations for an enhanced program that could strengthen the understanding of the site relative to the performance confirmation requirements in 10 CFR Part 60 to show that conditions have not varied beyond the limits assumed for design and to show that conditions are within the limits assumed for design? [The notion is to determine whether construction of the enhanced characterization facility(s) could provide facilities or opportunities to collect additional baseline data that could be used in compliance demonstrations for the performance confirmation requirements.]

4) Are there location, layout, or test program specific considerations for an enhanced program that can strengthen the understanding of the site relative to the requirements for underground records in 10 CFR 60.72 such that construction of another drift during site characterization could fulfill level of detail requirements (TBD) needed to satisfy some of the construction records requirements?

5) Are there location, layout, or test program specific considerations for the enhanced program that might compromise the ability to demonstrate compliance with the requirements of 10 CFR 60.15 regarding minimization of disturbances that could compromise repository system performance?

6) Could the additional data collected from the enhanced program compromise the ability to

demonstrate compliance with the siting criteria in 10 CFR 60.122 that require demonstrations that potentially adverse conditions that are present have been adequately investigated and adequately evaluated. [The point here is that data that has not been fully evaluated and integrated into descriptions and models of site features and processes could provide the basis for regulatory agencies or intervenors to question the adequacy and sufficiency of evaluations supporting the VA or the site recommendation, or of compliance demonstrations provided in the License Application.]

7) Are there location, layout, or test program specific considerations for the enhanced program that might be considered as beginning construction of the geologic repository operations area without a construction authorization as identified in 10 CFR Part 60.3? [The point here is that we can not begin "construction on the repository" until we get a Construction Authorization.]

8) Are there location, layout, or test program specific considerations for enhanced characterization to minimize any significant adverse environmental impacts identified in comments on the Site Characterization Plan or in the Environmental Assessment? [NWPA Sec. 113(a)]

9) Are there location, layout, or test program specific considerations for enhanced characterization that demonstrate that the data are required for evaluation of the suitability of the site for an application to be submitted to the NRC for a construction authorization or for compliance with NEPA? [NWPA Sec. 113(c)(1)]

10) Are there location, layout, or test program specific considerations for enhanced characterization to ensure that radioactive materials will not be used at the site without the NRC's concurrence that the use is necessary? [NWPA Sec. 113(c)(2)]

11) Are there location, layout, or test program specific considerations for enhanced characterization such that projected environmental impacts in the affected area can be mitigated to an acceptable degree, taking into account programmatic, technical, social, economic, and environmental factors? [960.5-2-5(a) and (d)]

<u>Assumptions</u>

Design/Construction Working Group

Design

Criteria

Are there location or layout specific considerations, including appropriate drifting, test alcoves, and subsurface boreholes, surface boreholes, and other investigations, that can enhance the scientific understanding of the site relative to:

1. Better Definition of Tsw3 Location/character (Particularly in Southwest Quadrant)

2. Better Definition of Structure & Thickness of Underlying Zeolitized Units

3. Location/character of Solitario Canyon Fault/splays

4. Definition/tunneling Characteristics of Lower Tsw2 Sub-units

5. "Prove Out" Northern Expansion Areas
   - A) Large Hydraulic Gradient
   - B) Second Penetration of Drill Hole Wash Structure
   - C) Better Define Fracture Orientations

6. Maintaining Emplacement Drift Orientation Flexibility

7. Confirming Preferred Emplacement Drift Orientation

8. Compliance with Applicable Regulations: 10CFR960 Siting Criteria of ≥200 M Cover

Assumptions

Construction

Criteria

Are there location or layout specific considerations, including appropriate drifting, test alcoves, and subsurface boreholes, surface boreholes, and other investigations, that can enhance the understanding of the site relative to:

1) Demonstrating Cost Effective Construction Approach

2) Demonstrating Effective Ventilation/dust Control

3) Demonstrating Integrated ES&H Approach

4) Implementing a Performance Based Approach to Design/const'n Including a Construction Based Tbm Configuration

5) Testing "State of the Art" Mechanical Excavators

Assumptions

Controls and Requirements Working Group

Criteria

1) Does the unrecoverable discharge of TFMs, including water, during the construction and testing of any excavations or boreholes planned for enhanced characterization have any adverse effects on the performance of the potential repository?

2) Does the layout of any excavations or boreholes planned for enhanced characterization, relative to the potential repository, have any adverse effects on the performance of the potential repository?

3) Do the construction methods for any excavations or boreholes planned for enhanced characterization have any adverse effects on the performance of the potential repository?

4) Is the 10CFR 60 subpart G QA program (QARD) the appropriate base QA document?

5) Are the design requirements in the ESFDR and RDRD interfaces appropriate?

6) Will procurement be handled under applicable QARD controls (criteria 4 & 7) and procedures, i.e. will it be a "Q" procurement?

7) Will design (analyses, specifications, etc.) be accomplished using QARD (criterion 3)?

8) Is field quality control going to be used to verify design during construction?

9) Are lessons learned from ESF construction applicable to construction of the new drift(s).

10) Are adequate procedures to implement design and QA requirements already in place?

11) If the site location is (Specific):

.1 If the site is off of the North Ramp:

- .1 What traffic problems will we have with other operational drifts?
  - .1 Transport others via South Portal (Alc 2 tours???)
- .2 Ventilation -Will the ventilation system be connected to current system?
  - .1 Yes:
  - .2 No:
- .3 Muck handling:
  - .1 Yes: Conveyor system- Will the conveyor system be a direct connection to current system?
    - .1 Yes:
    - .2 No:
  - .2 No: Muck cars- Will muck cars be used exclusively?
    - .1 Yes:
    - .2 No:
- .4 TBM vs other Excavation Devices

.2 If the site is off of the South Ramp

- .1 No major traffic problems with other operational drifts.
- .2 Ventilation - Will the ventilation system be connected to current system?
  - .1 Yes:
  - .2 No:
- .3 Muck handling:
  - .1 Yes: Conveyor system- Will the conveyor system be a direct connection to current system?
    - .1 Yes:
    - .2 No:
  - .2 No: Muck cars- Will muck cars be used exclusively?
    - .1 Yes:
    - .2 No:

.3 Others

- .1 Will there be traffic problems with other operational drifts(?)
- .2 Ventilation - Will the ventilation system be connected to current system
  - .1 Yes:
  - .2 No:
- .3 Muck handling
  - .1 Yes: Conveyor system-Will the conveyor system be a direct connection tothecurent system?
    - .1 Yes:

.2 No:

.2 No: Muck cars- Will muck cars be used exclusively?

.1 Yes:

.2 No:

.3 TBM vs others

12) Location (Non-specific):

.1 Will there be traffic problems with other operational drifts.

.2 Ventilation - Will the ventilation system be connected to current system?

.1 Yes:

.2 No:

.3 Muck handling:

.1 Yes: Conveyor system- Will the conveyor system be a direct connection to current system?

.1 Yes:

.2 No:

.2 No: Muck cars- Will muck cars be used exclusively?

.1 Yes:

.2 No:

.4 Will there be penetration of protective barriers?

.1 If yes, Erionite becomes a major issue (very similar to asbestos)

.2 Possible inability to make repairs to protective barrier

.5 Silica will continue to be an issue - adequate ventilation, water usage vs dry techniques, respirator usage, control techniques, etc.

.6 TBM vs other

13) If the Equipment Used is:

.1 TBM

.1 Wet (preferred by M&O Safety and Health for health reasons- better control of dust)

.1 Affect to repository/scientific evaluation

.2 Dry (preferred by scientific community- less chance to fowl up their work)

.3 Ventilation controls

.4 Muck handling

.2 Alpine Miner/ Road Header, etc.

.3 Drill & Blast

14) Are there location, layout or test program specific considerations for an east-west drift that can enhance the understanding of the site relative to storage location and reclamation of the mine muck removed from the drifts?

Assumptions

1) Quality Assurance will apply to the design, construction and procurement of the drift(s).

2) This activity is Q and therefore the QARD criteria apply. This would mean that M&O and OCRWM Q procedures would be invoked including those for activities such as procurement.

3) Assume that a readiness review would be performed to QAP-2-6 criteria.

4) Control measures required include (very expensive and time consuming):

.1 High efficiency particulate air (HEPA) filtration of ventilation system- handling problems (hazardous waste)

.2 Powered air purifying respirators (PAPRs) with HEPA filtration for workers- handling and cleaning problems (hazardous waste)

.3 Special coveralls for workers- handling and laundering problems (hazardous waste)

.4 Sealed work areas (entire drift/shaft, etc.)

.5 Handling of muck, etc., as hazardous waste, with all connotations (special packaging, special landfills, etc.)

.6 Equipment (locis, flat beds, etc.) And personnel will require decontamination anytime it leaves the regulated areas. Containment of the decontaminated materials (hazardous waste)

.7 Showering facilities for workers, with all connotations listed for hazardous waste

.8 trained staff to handle all decontamination processes

5) The mine muck shall be stored in the existing muck storage pile. [Note: there is a requirement to segregate Calico Hills muck from TS Loop muck; also the existing muck piles are approaching their max-allowed heights.]

6) The above ground conveyor system shall not be modified to handle the additional muck. [This may be required; see note above.]

7) A modification to the Underground Injection Control Permit will not be needed because no additional tracer use (other than what is already approved) is expected.

8) The mine evaporation pond will not be constructed.

9) The ventilation system shall be modified to handle any additional dust from the new construction.

10) Our first cut at the inputs from Safety Assurance & PA for a constructor's contract are listed below. These should be caveated with the fact that the constraints that will fall out

of the DIE/CA for this drift - and the time it takes to prepare the DIE and CA - may be extremely sensitive to the function and requirements for the use of this drift.

- The construction contractor shall be subject to requirements imposed by applicable Determination of Importance Evaluations (DIEs) and/or QA Classification Analyses (CAs), or to those requirements imposed through design specifications and drawings. Demonstration of satisfaction of these requirements shall be required under the QA program. These requirements are derived from limiting impacts on the repository natural barrier, limiting impacts on current or future testing, and preserving critical characteristics of designed items determined to be Important to Radiological Safety or Waste Isolation. Requirements typically include, but are not limited to: constraints on types and amounts of tracers, fluids, and materials (e.g., water, hydraulic fluid, oil, surfactants, etc.) used in construction and operation; requirements on requesting evaluation of those materials and reporting of their use by the constructor; requirements on maintenance and use of construction equipment (e.g., TBMs, roadheaders, etc.) to prevent leakage/spills of such materials; performance to line-and-grade tolerances; procedural requirements for training to certain construction tasks, such as installation of ground support; production and maintenance of construction records; and other similar requirements as deemed necessary by DIEs/CAs produced during design development.

- Access shall be allowed to construction sites by M&O and DOE surveillance and inspection personnel.

- The construction contractor shall be subject to requirements imposed though system safety analyses; Job Safety Analyses shall be performed by the construction contractor for activities not evaluated in system safety analyses, and requirements indicated therein shall be followed under the contractor's safety and health program.

- Access to testing locations shall be maintained and construction activities shall be coordinated with the M&O Test Coordination Office (TCO).

- Deviations from design shall be authorized by the A/E in advance.

Comment from Safety Assurance

We also suggest that the constructor's management and supervisory personnel be required to undergo some form of DIE/Classification/QA program orientation/training based on 10CRF60.15(c)(1) before the commencement of any construction activities. This may make the transition from normal construction contractor to one that will be required to work under a QA program easier and more effective up front. This type of training would go a long way in preventing the same type of QA problems and concerns from arising as we had in the ESF starter tunnel/north ramp.

Comment From DOE/AMAAM:

Based on the Objective statement, the planning effort may be growing out of hand. We may want to consider going back and reviewing "The Accelerated EWD for VA." which was part of a previous package for our review. We appear now to be including the complete scientific program and any other program activities into the EWD package. The EWD could be constructed as specified in the accelerated case in the time allowed. Any additions to that may mean a failure to meet schedule. We must maintain the block, but not reinvent the wheel.

Comment From Requirements:

The specific scientific, engineering, construction, health and safety, cost and regulatory and performance objectives should be identified before criteria can be developed. The criteria should then provide a basis or approach to how each of the specific objectives will be met/accomplished.

For the most part, the set of criteria delineated in the document *Draft Notes on a Process to Evaluate the Location and Scope of Enhancements to the Site Characterization Program Incorporating an East-West Drift* (Rev. 1) appear to ask whether certain data or information will be collected from an east-west drift. We should first identify what data or information is most needed, then answer the question of "what will provide us with this data/information?" and will an east-west drift provide us with these answers?

APPENDIX D OBSERVATIONS/SUPPORTIVE DATA FOR VIABILITY ASSESSMENT (VA)

Testing Working Group Perspective

1) fracture variability.

Reduce parameter uncertainties in the 3-D Rock Characteristics Models

Customer Needs Addressed: Mechanical stability and engineering design of drifts

Preliminary data will be available for VA, complete data set will be available for TSPA-LA

2) unexposed faults.

Reduce uncertainties in distribution of lithologies and structures in the 3-D Geologic Model and the UZ Flow Model

Customer Needs Addressed: Percolation flux in the unsaturated zone at the site scale, from land surface to the water table; including temporal and spatial variability, fracture/matrix interactions, and definition of fast and preferential flow pathways.

Preliminary data will be available for VA, complete data set will be available for TSPA-LA

24) the location and continuity of stratigraphic contacts in the expanded repository block.

Reduce uncertainties in the 3-D Geologic Model and the 3-D Mineralogy Model

Preliminary data will be available for VA and complete data sets will be available for TSPA-LA

25) the distribution of hazardous minerals in the rock mass.

Reduce uncertainties in the distribution of these minerals for ES&H and the 3-D Mineralogy Model

Preliminary data will be available for VA and complete data sets will be available for LA

Predictive reports concerning these items will be generated prior to any excavation or drilling. As excavation or drilling progresses, the actual conditions will be observed and compared to the predictive information. These comparisons will be available to support VA.

Performance Assessment Working Group Perspective

Our group didn't have much to say about timing of the planned activities. We believe that any new information would need to be available by the end of the fiscal year to be useful for TSPA-VA. Therefore, we are not expecting the enhanced characterization to support TSPA-VA. Data derived from enhanced characterization may be of some use as "confirmatory information". However, we don't expect anything but limited qualitative information from additional drifting to be available for VA. Borehole data may be available as confirmatory data for VA, but we were not sure of how quickly testing information could be taken and analyzed. Some of the benefits for better characterization of the EBS may also be available for as confirmatory data for VA, but we need to check this out more thoroughly. Presumably, all of the benefits are potentially available for TSPA-LA .

APPENDIX E WORKING GROUP AND INTEGRATED PLANNING COMMITTEE MEETING MINUTES & OTHER RELATED CORRESPONDENCE

E.1 Testing Working Group

Janet Christ
03/18/97 11:20 AM

To: James Beyer@CRWMS
cc:
Subject: Testing for Repository Block Characterization

To: William Boyle, Bo Bodvarsson, Steven Beason, Robert Craig, Ned Elkins, Ron Oliver, Jon White, Tim Sullivan
cc: Larry Hayes, Candace Lugo, Robert Sandifer, Michael Voegele
From: Ralph Rogers
Date: 03/18/97 08:58:00 AM
Subject: Testing for Repository Block Characterization

We have been identified as the testing working group for enhanced repository block characterization. We will be part of the Integrated Planning Team. The objective of the team is to define the methodology for achieving the enhanced characterization and develop the cost and schedule for the enhanced characterization effort.

Our first requirement is to develop testing objectives for the enhanced characterization and criteria for evaluating potential locations and layouts for an underground repository block crossing, such as an east-west drift. This requirement must be completed by Friday 21 March.

Initial planning indicates that we should be thinking in terms of underground workings, SD-6, WT-24, two additional crest boreholes and, possibly the STC. The layout of the underground workings is currently open for discussion and we have been encouraged to consider all possibilities.

Because of the extremely tight schedule for this planning effort I have been forced to setup a meeting without being able to contact everyone to determine availability. The meeting that I have setup is in Rm 817 Summerlin Bldg 8, on Friday 21 March from 8:00 a.m. to 11:00 am. If you can not attend in person the room does have telecon facilities. If you can not participate at all please contact me to give me your input seperately. I have included a file that contains a first cut at identifying testing objectives. Please provide comments on the file and anything that may be missing. What we come up with will have a big impact on testing that will occur over the next couple of years, so please give this some careful thought.

If you have any questions please call me at 295-5785.

Thanks

EWDATA

REPOSITORY BLOCK CHARACTERIZATION
FIELD REQUIRED INFORMATION

ITEM NO.	**CATEGORY** Scientific
TITLE Fracture/Fault Distributions	
DESCRIPTION OF INFORMATION REQUIRED There may be pre-Tiva Canyon faults present in the repository block. We need to verify the presence or absence of these faults and, if present, their distribution and offset. The orientation, abundance, and physical characteristics of fractures are poorly known within the repository block. Information on these features is needed for rock characteristics models, hydrologic models and repository design.	
RECOMMENDED METHODOLOGY FOR INFORMATION DEVELOPMENT Some information can be obtained from boreholes, but much better information would come from an east-west drift.	
SPECIFIC YMP PRODUCT THAT THE INFORMATION SUPPORTS 3D Geologic Model 3D Rock Characteristics Model	
EARLIEST DATE INFORMATION IS REQUIRED 8/98	
NOTES/ASSUMPTIONS	

REPOSITORY BLOCK CHARACTERIZATION
FIELD REQUIRED INFORMATION

ITEM NO.	CATEGORY Scientific
TITLE Moisture Distributions	
DESCRIPTION OF INFORMATION REQUIRED The distribution of saturation, fluid potential, and the dissolved ion and isotopic composition of pore water in the unsaturated zone provide important information for calibration of the UZ flow model and the drift scale models used by waste package design. The surface of the repository block includes areas of high infiltration (Yucca Crest). Testing beneath these areas of high infiltration will provide an opportunity to obtain more precise estimates of percolation flux, becuase the number will likely be higher and easier to measure, and information that will improve our understanding of flow in the UZ.	
RECOMMENDED METHODOLOGY FOR INFORMATION DEVELOPMENT Testing on core from boreholes and in-situ monitoring in alcoves off of the east-west drift. Testing in the east-west drift should include niche studies similar to those planned for the ESF and horizontal borehole arrays to characterize percolation flux and hydrologic properties in the potential repository horizon.	
SPECIFIC YMP PRODUCT THAT THE INFORMATION SUPPORTS UZ Flow Model ST24EM2 Near Field Environment Models ST27EM2	
EARLIEST DATE INFORMATION IS REQUIRED 2/99	
NOTES/ASSUMPTIONS	

REPOSITORY BLOCK CHARACTERIZATION
FIELD REQUIRED INFORMATION

ITEM NO.	CATEGORY Scientific
TITLE Mineral Distributions	

DESCRIPTION OF INFORMATION REQUIRED

The distribution of minerals in the bedded tuffs, facies changes in the PTn, and zeolite distributions in the Calico Hills have important implications for flow and transport models. Fine scale variations in the mineralogy of the PTn result from variations in the detailed stratigraphy of the unit and subsequent alteration. Sampling and laboratory testing are required to characterize the impact of these variations on hydrologic and transport properties. The distribution of zeolites in the Calico Hills has important implications for transport modeling.

RECOMMENDED METHODOLOGY FOR INFORMATION DEVELOPMENT

Information on the mineralogy of the bedded tuffs can be obtained from boreholes, and the detailed stratigraphy of the PTn will require core.

SPECIFIC YMP PRODUCT THAT THE INFORMATION SUPPORTS

3D Mineralogy Model
UZ Flow Model ST24EM2
UZ Transport Model ST25EM2

EARLIEST DATE INFORMATION IS REQUIRED 11/98

NOTES/ASSUMPTIONS

REPOSITORY BLOCK CHARACTERIZATION
FIELD REQUIRED INFORMATION

ITEM NO.	**CATEGORY** Scientific
TITLE Solitario Canyon Fault Testing	
DESCRIPTION OF INFORMATION REQUIRED The hydrologic properties of faults is a major issue for the development of the UZ Flow and Transport models. The physical characterization of faults are important to repository design and construction. In-situ examination and testing is the best way to address these issues. Data required include thermal and saturation profiles perpendicular to the fault, sampling for environmental isotopes in and near the fault zone, and air permeability and hydrochemistry testing in the fault zone, as well as mapping of fracture distributions and phsyical characteristics of the zone.	
RECOMMENDED METHODOLOGY FOR INFORMATION DEVELOPMENT Alcoves that allow access to the fault zone and its splays, with boreholes to conduct air-permeability and hydrochemistry testing. Our information from the Ghost Dance Fault indicates that characteristics will vary along strike, so more than one access for testing will be required for adequate characterization.	
SPECIFIC YMP PRODUCT THAT THE INFORMATION SUPPORTS UZ Flow Model ST24EM2 UZ Transport Model ST25EM2	
EARLIEST DATE INFORMATION IS REQUIRED 2/99	
NOTES/ASSUMPTIONS	

REPOSITORY BLOCK CHARACTERIZATION
FIELD REQUIRED INFORMATION

ITEM NO.	CATEGORY Scientific
TITLE Environmental Isotope Distribution	

DESCRIPTION OF INFORMATION REQUIRED

A variety of isotopic analyses of pore water, fractured and unfractured rock, and fracture fillings in the ESF have provided important information for identifying and delineating fast pathways that control the downward movement of water from the surface and for estimating the spatial and temporal distribution of water flux through the repository block.

RECOMMENDED METHODOLOGY FOR INFORMATION DEVELOPMENT

Samples can be obtained from boreholes and from the east-west drift. The east-west drift and the ESF provide better representation of infiltration controls through the rock mass because most of the controlling features (fractures and faults) are subvertical. Underground samples should be both systematic and feature based to identify potential fast paths and to determine the geologic controls that effect the scape-time variation in flux.

SPECIFIC YMP PRODUCT THAT THE INFORMATION SUPPORTS

UZ Flow Model ST24EM2
UZ Transport Model ST25EM2
Near Field Environment Models ST27EM2

EARLIEST DATE INFORMATION IS REQUIRED 2/99

NOTES/ASSUMPTIONS

REPOSITORY BLOCK CHARACTERIZATION
FIELD REQUIRED INFORMATION

ITEM NO.	CATEGORY Scientific

TITLE Repository Horizon Rock Properties

DESCRIPTION OF INFORMATION REQUIRED

It is important to determine the variations in lithologic/mechanical/hydrologic properties vertically through the potential repository horizon. Mechanical properties and the variations in these properties are required for repository design. Hydrologic properties and the variations in these properties are required for the UZ flow model. Information from the ESF suggests that, at least some of these properties, vary substantially with location.

RECOMMENDED METHODOLOGY FOR INFORMATION DEVELOPMENT

The east-west drift provides an excellent method of obtaining information through the vertical thickness of TSw2, because the dip of the units results in the drift traversing the full section of the potential repository horizon.

SPECIFIC YMP PRODUCT THAT THE INFORMATION SUPPORTS

3D Rock Characteristics Model
UZ Flow Model ST24EM2

EARLIEST DATE INFORMATION IS REQUIRED

NOTES/ASSUMPTIONS

Ralph Rogers
03/21/97 11:55 AM

To: James Beyer@CRWMS
cc: Michael Voegele@CRWMS, Larry Hayes@CRWMS, Ned Elkins@CRWMS
Subject: Objective of Enhanced Characterization

The testing WG suggests the following changes to the objective paragraph in the Draft Notes:

Change the first sentence to read "Develop a recommended approach for the enhanced site characterization effort incorporating a drift across the potential repository block and other investigations."

Change the last sentence to read "The extent to which enhancements in the program can confirm the data supporting the Viability Assessment also should be incorporated into the prioritization of integrated activities."

Testing Working Group

The purpose of this note is to document the minutes of the first meeting of the Testing Working Group of the Enhanced Characterization of the Repository Block (ECRB) 90-day planning effort. The meeting was held from 8-11 am on 3/21/97 in Rm 817 of the M&O Summerlin facility. In attendance were:

Mike Voegele	M&O
Bob Craig	USGS TPO
Tim Sullivan	DOE VA Team Lead
Bill Boyle	DOE Performance Confirmation Team Lead
Ron Oliver	M&O SPO
Steve Beason	M&O USBR
Bo Bodvarsson	M&O LBL
Ralph Rogers	M&O SPO
Jim Houseworth	M&O PA
Ned Elkins	M&O SPO

Mike Voegele gave a brief over view of the planning effort and the role of the testing group in that effort. Some discussion followed on possible testing in the repository block, including testing in boreholes and testing in a cross drift. The "Plan for 90 Day Planning Effort" was distributed to those who did not have a copy. The point was emphasized that at this stage we should consider all possible configurations and locations for the proposed cross drift. The USGS provided a short memo entitled "USGS issues/unknowns related to E-W drift and associated work." As a first step the group decided to identify a list of testing objectives for enhanced characterization of the repository block. The list that was developed is the following:

Testing Objectives for Enhanced Repository Block Characterization

1) To investigate fracture variability
2) To investigate unexposed faults
3) To investigate hydrologic properties and geotechnical properties of faults
4) To characterize the spatial distribution of moisture tension and saturation
5) To investigate the age and distribution of perched water
6) To investigate alternative conceptual models of perched water formation
7) To investigate the distribution and mineralogy of fracture fillings
8) To investigate the age and genesis of fracture filling minerals
9) To investigate the distribution of environmental isotopes from systematic and feature based samples
10) To investigate the spatial distribution of percolation flux
11) To investigate fracture matrix interactions
12) To investigate flow into openings
13) To characterize temperature gradients in the repository block
14) To investigate gas ages and flow patterns/distribution of gaseous environmental isotopes
15) To investigate infiltration and percolation in and around faults

16) To investigate gradients and flow in the SZ in and around faults
17) To investigate the changes in fracture and geotechnical characteristics in the vicinity of faults
18) To investigate flow patterns in the UZ below the repository horizon
19) To investigate the distribution and continuity of zeolitization in the Calico Hills
20) To characterize the hydrochemistry of the UZ below the repository horizon
21) To characterize the location and origin of the LHG north of the repository block
22) To investigate dilution, mixing and flux distribution in the SZ
23) To investigate the hydrochemistry of the SZ
24) To investigate the spatial distribution of thermal and geomechanical properties of the repository horizon
25) To investigate the location and continuity of stratigraphic contacts in the expanded repository block
26) To investigate the distribution of hazardous minerals in ventilation, air and the rock mass

Following the development of the agreed upon list the group reviewed the objectives paragraph of the "Draft Notes on a Process to Evaluate the Location and Scope of Enhancements to the Site Characterization Program Incorporating an East-West Drift." The following changes were recommended:

Change the first sentence to read "Develop a recommended approach for the enhanced site characterization effort incorporating a drift across the potential repository block and other investigations."

Change the last sentence to read "The extent to which enhancements in the program can confirm the data supporting the Viability Assessment also should be incorporated into the prioritization of integrated activities."

Ralph Rogers took the action to rewrite the testing objectives as criteria and distribute them to the working group memebers for review and comment.

Ralph Rogers
03/31/97 07:41 AM

To: Steven Beason@CRWMS, Bo Bodvarsson@CRWMS, Robert Craig@CRWMS, Ned Elkins@CRWMS, Ron Oliver@CRWMS, William Boyle@CRWMS, Tim Sullivan@CRWMS, Jon White@CRWMS
cc: Michael Voegele@CRWMS, Candace Lugo@CRWMS, Jim Houseworth@CRWMS, Larry Hayes@CRWMS, James Beyer@CRWMS, William Kennedy@CRWMS
Subject: Enhanced Repository Block Characterization Meeting

We have been asked to take the testing objectives/criteria that we have developed and show how they will enhance our understanding of the repository block. I have identified major products (models) and testing needs, from our customer needs list, that are supported or addressed by each testing objective/criteria. This information is included in the attahced file. Please provide comments on this tabulation by noon thursday April 3rd. If any of you do not have our compiled customer needs list it is included in this memo, below.

We need to have a meeting next week to begin discussing the actual work that will be done to enhance our understanding of the repository block. I would like to have that meeting wednesday or thursday morning, April 9th or 10th. Please let me konw which day would be better and/or impossible for you. If the PA and/or Design working groups would like to have a representative at this meeting please let me know.

If you have any questions call me at 295-5785.

FY 98 CUSTOMER-DEFINED NEEDS FROM WBS 1.2.3 IN ORDER OF IMPORTANCE

1. Long-term seepage into drifts and in-drift humidity in the post thermal phase; without perturbations due to heat but considering future climate change and permanent changes due to repsitory heat release (variable in space and time)

2. Seepage into drifts and drift humidity during thermally-perturbed state

3. Percolation flux in the unsaturated zone at the site scale, from land surface to the water table; including temporal and spatial variability, fracture/matrix interactions, and definition of fast and preferential flow pathways.

4. Environmental conditions in the drifts (pH, Eh, temperature, chemistry, relative humidity, radiation, and nutrients)

5. UZ fracture/matrix flow and advective and diffusive transport at and below the repository horizon

6. SZ flux distribution - spatial and temporal- for regional and site-scale transport models

7. SZ fracture/matrix flow and advective and diffusive transport

8. Transport characteristics of degraded EBS material and subsequent impacts on the near field and altered zones

9. UZ and SZ solubility and retardation of key radionuclides (such as Np, Pu) and colloids

10. Mechanical stability and engineering design of drifts

11. Scenario effects
    - volcanism and tectonics

EW4497

Testing Working Group

Listed below are the testing objectives/criteria for the Enhanced Characterization of the Repository Block that have been identified by the Testing Working Group. Below each objective/criteria are listed the products or customer needs that will be addressed/enhanced by meeting the objective/criteria. Customer needs are from the list that has been distributed to the IPC and are identified by number at the end of each need (in parentheses).

Criteria/Benefits/Enhancements

Are there location or layout specific considerations, including appropriate drifting, test alcoves, and subsurface boreholes, surface boreholes, and other investigations, that can enhance the scientific understanding of the site relative to:

1) fracture variability.
   Repository Design
   3-D Rock Characteristics Models
   Mechanical stability and engineering design of drifts (10)

2) unexposed faults.
   Repository Design
   3-D Geologic Model
   UZ Flow Model
   Percolation flux in the unsaturated zone at the site scale, from land surface to the water table; including temporal and spatial variability, fracture/matrix interactions, and definition of fast and preferential flow pathways. (3)

3) hydrologic properties, fracture properties and geotechnical properties in and near faults.
   Repository Design
   UZ Flow Model
   SZ Flow Model
   Percolation flux in the unsaturated zone at the site scale, from land surface to the water table; including temporal and spatial variability, fracture/matrix interactions, and definition of fast and preferential flow pathways. (3)
   Mechanical stability and engineering design of drifts (10)

4) the characterization of the spatial distribution of moisture tension and saturation.
   UZ Flow Model
   Percolation flux in the unsaturated zone at the site scale, from land surface to the water table; including temporal and spatial variability, fracture/matrix interactions, and definition of fast and preferential flow pathways. (3)

5) the age and distribution of perched water.
UZ Flow Model
Percolation flux in the unsaturated zone at the site scale, from land surface to the water table; including temporal and spatial variability, fracture/matrix interactions, and definition of fast and preferential flow pathways. (3)
UZ fracture/matrix flow and advective and diffusive transport at and below the repository horizon. (5)

6) alternative conceptual models of perched water formation.
UZ Flow Model
UZ fracture/matrix flow and advective and diffusive transport at and below the repository horizon. (5)

7) the distribution and mineralogy of fracture fillings.
UZ Flow Model
Long-term seepage into drifts and in-drift humidity in the post thermal phase; without perturbations due to heat but considering future climate change and permanent changes due to repository heat release (variable in space and time). (1)
Percolation flux in the unsaturated zone at the site scale, from land surface to the water table; including temporal and spatial variability, fracture/matrix interactions, and definition of fast and preferential flow pathways. (3)

8) the age and genesis of fracture filling minerals.
UZ Flow Model
Long-term seepage into drifts and in-drift humidity in the post thermal phase; without perturbations due to heat but considering future climate change and permanent changes due to repository heat release (variable in space and time). (1)
Percolation flux in the unsaturated zone at the site scale, from land surface to the water table; including temporal and spatial variability, fracture/matrix interactions, and definition of fast and preferential flow pathways. (3)

9) the distribution of environmental isotopes from systematic and feature based samples.
UZ Flow Model
UZ Transport Model
Long-term seepage into drifts and in-drift humidity in the post thermal phase; without perturbations due to heat but considering future climate change and permanent changes due to repository heat release (variable in space and time). (1)
Percolation flux in the unsaturated zone at the site scale, from land surface to the water table; including temporal and spatial variability, fracture/matrix interactions, and definition of fast and preferential flow pathways. (3)

10) the spatial distribution of percolation flux.
UZ Flow Model
Long-term seepage into drifts and in-drift humidity in the post thermal phase; without perturbations due to heat but considering future climate change and permanent changes due to repository heat release (variable in space and time). (1)
Percolation flux in the unsaturated zone at the site scale, from land surface to the water table; including temporal and spatial variability, fracture/matrix interactions, and definition of fast and preferential flow pathways. (3)

11) fracture and matrix components of flow.
UZ Flow Model
UZ Transport Model
Long-term seepage into drifts and in-drift humidity in the post thermal phase; without perturbations due to heat but considering future climate change and permanent changes due to repository heat release (variable in space and time). (1)
Percolation flux in the unsaturated zone at the site scale, from land surface to the water table; including temporal and spatial variability, fracture/matrix interactions, and definition of fast and preferential flow pathways. (3)

12) flow into openings.
Near Field Environment Models
Long-term seepage into drifts and in-drift humidity in the post thermal phase; without perturbations due to heat but considering future climate change and permanent changes due to repository heat release (variable in space and time). (1)
Environmental conditions in the drifts (pH, Eh, temperature, chemistry, relative humidity, radiation, and nutrients). (4)

13) temperature gradients in the repository block.
UZ Flow Model
Percolation flux in the unsaturated zone at the site scale, from land surface to the water table; including temporal and spatial variability, fracture/matrix interactions, and definition of fast and preferential flow pathways. (3)

14) gas ages and flow patterns/distribution of gaseous environmental isotopes.
UZ Flow Model
Percolation flux in the unsaturated zone at the site scale, from land surface to the water table; including temporal and spatial variability, fracture/matrix interactions, and definition of fast and preferential flow pathways. (3)

15) infiltration and percolation in and around faults.
UZ Flow Model
Percolation flux in the unsaturated zone at the site scale, from land surface to the water table; including temporal and spatial variability, fracture/matrix interactions, and definition of fast and preferential flow pathways. (3)
UZ fracture/matrix flow and advective and diffusive transport at and below the repository horizon. (5)

16) pressure and chemical gradients and flow in the SZ in and around faults.
SZ Flow Model
SZ Transport Model
SZ flux distribution - spatial and temporal - for regional and site-scale transport models. (6)
SZ fracture/matrix flow and advective and diffusive transport. (7)

17) flow patterns in the UZ below the repository horizon.
UZ Flow Model
UZ Transport Model
UZ fracture/matrix flow and advective and diffusive transport at and below the repository horizon. (5)

18) the distribution and continuity of zeolitization in the Calico Hills Tuff.
3-D Mineralogy Model
UZ Transport Model
UZ fracture/matrix flow and advective and diffusive transport at and below the repository horizon. (5)
UZ and SZ solubility and retardation of key radionuclides (such as Np, Pu) and colloids. (9)

19) the hydrochemistry of the UZ below the repository horizon.
UZ Flow Model
UZ Transport Model
UZ fracture/matrix flow and advective and diffusive transport at and below the repository horizon. (5)
UZ and SZ solubility and retardation of key radionuclides (such as Np, Pu) and colloids. (9)

20) the location and origin of the Large Hydraulic Gradient north of the repository block.
SZ Flow Model
SZ flux distribution - spatial and temporal - for regional and site-scale transport models. (6)

21) dilution, mixing and flux distribution in the SZ.
SZ Flow Model
SZ Transport Model
SZ flux distribution - spatial and temporal - for regional and site-scale transport models. (6)
SZ fracture/matrix flow and advective and diffusive transport. (7)

22) the hydrochemistry of the SZ.
SZ Flow Model
SZ Transport Model
SZ flux distribution - spatial and temporal - for regional and site-scale transport models. (6)
SZ fracture/matrix flow and advective and diffusive transport. (7)

23) the spatial distribution of thermal and geomechanical properties of the repository horizon.
3-D Rock Characteristics Models
Repository Design
3-D Mineralogy Model
Mechanical stability and engineering design of drifts. (10)

24) the location and continuity of stratigraphic contacts in the expanded repository block.
3-D Geologic Model
3-D Mineralogy Model

25) the distribution of hazardous minerals in ventilation, air and the rock mass.
ES&H
Repository Design
3-D Mineralogy Model

Testing Working Group - 4/10/97

The purpose of this note is to document the minmutes of the second meeting for the Testing Working Group of the ECRB 90-day planning effort. The meeting was held from 9:30 am to 12:30 pm on April 10th in Rm 817 of Summerlin.

The following people attended the meeting:

Ned Elkins
Steve Beason
Moo Lee
Ron Oliver
Robert Craig
Bo Bodvarsson
Russ Patterson
Michael Voegele
Drew Coleman
Ralph Rogers

The meeting began with a breif discussion of the results of recent meetings of the Integrated Planning Committee. Handouts from the IPC, outlining the remainder of the planning effort, were distributed. A discussion followed that included the question of how this planning effort related to other ongoing efforts. Specifically the question was raised about the ongoing planning for boreholes SD-6 and WT-24. Because this effort is well advanced, and seems headed for approval, the decision was made to exclude these two boreholes from further consideration in the ECRB effort.

The main part of the meeting was devoted to discussion of Preferred and Alternative sources of data to meet the criteria developed by the Testing Working Group previously, and the rationale for these choices. A lively discussion ensued and the main points of the discussion will be captured on the summary sheets that the group is developing for each criteria. A point that emerged during several of the discussions was the need to sample in the Calico Hills formation. A general configuration was suggested that includes a cross drift within the emplacement horizon of the proposed repository horizon, continuation of this drift through the Solitario Canyon Fault, a loop down through the western block of the fault, a penetration of the fault from the west, and drifting within the Calico Hills.

The group was only able to address the first eleven criteria. A meeting was set up for next Tuesday to address the remaining criteria.

Ralph Rogers
04/18/97 05:12 PM

To: James Beyer@CRWMS, Steven Beason@CRWMS, Bo Bodvarsson@CRWMS, William Boyle@CRWMS, Robert Craig@CRWMS, Ned Elkins@CRWMS, Ron Oliver@CRWMS, Tim Sullivan@CRWMS, Jon White@CRWMS
cc: Mitchell Brodsky@CRWMS, Jim Houseworth@CRWMS, William Kennedy@CRWMS, MacKaye Smith@CRWMS, Larry Hayes@CRWMS, Candace Lugo@CRWMS, Michael Voegele@CRWMS, Michaele Brady@CRWMS, Gilles Bussod@CRWMS, Dwayne Chesnut@CRWMS, Dwight Hoxie@CRWMS, Ron E. Smith@CRWMS, Russ Patterson@CRWMS, Mark Tynan@CRWMS, Mark Peters@CRWMS
Subject: Testing Working Group Input for ECRB

The purpose of this note is to document the minutes of the Testing Working Groups fourth meeting. The meeting was held in Rm 817 Summerlin, from 2:00 pm to 5:30 pm on the 17th of April. The following people were in attendance:

Clinton Lum
James Hollins
William Boyle
Mitch Brodsky
Bob Craig
Ned Elkins
Bo Bodvarsson
Mark Tynan
Ralph Rogers
Steve Beason
Paul Dixon
Russell Patterson

The first part of the meeting was devoted to reviewing the development summary sheets for the criteria developed by the testing working group and several of the criteria developed by PA and/or Design. Additions and corrections were made to the sheets as appropriate.

The second part of the meeting was devoted to a discussion of the testing program that was compatible with the information that the group has developed. Discussion of underground workings led to the identification of a preferred and alternative configuration. Discussion of surface based testing led to the identification of a set of proposed boreholes.

Preferred underground configuration:

Cross drift in the central part of the block (approximately 42+00), rather than north or south, and in the emplacement horizon, rather than above or below the horizon. The workings should cross the Solitario Canyon Fault and loop down. The Solitario Canyon Fault should be crossed again and the workings should continue in the Calico Hills Formation and cross the entire repository block within the Calico Hills.

Alternative underground configuration:

Cross drift starting from the north ramp and traversing the repository block northeast to southwest and intersecting the Solitario Canyon Fault in the central portion of the block. The drift would start above the proposed emplacement horizon and continue above it for most of the excavation but would traverse lower into the stratigraphic section in the west and intersect the Solitario Canyon Fault at the proposed emplacement horizon. The workings should cross the Solitario Canyon Fault and loop down. The Solitario Canyon Fault should be crossed again and the workings should continue in the Calico Hills Formation and cross the entire repository block within the Calico Hills.

Surface Based Testing:
Crest boreholes north and south of SD-6
Slant borehole in northern Solitario Canyon
Southern Testing Complex
Pair of WT-boreholes - central part of the Solitario Canyon Fault

A discussion followed on prioritization of configurations and testing. The preferred cross drift option supports seven criteria (1,3,9,15,17,18,19) and the alternative supports one criteria (6). Three criteria (10,11,12) are supported equally by both configurations and four criteria (2,7,8,23) would be supported by a cross drift at any location.

A prioritized list was developed for the testing. Numbers in parentheses indicate criteria supported by this test, preferred source only.

Cross drift, across Solitario Canyon Fault, with alcoves and niches (1,2,3,6,7,8,9,10,11,12,15,23)
Crest borehole north (4,5,13,14,18,24,25)
Slant borehole (3)
Crest borehole south (4,24,25)
Southern Testing Complex (21,22)
Calico Hills drifting (3,7,8,9,11,17,18,19)
WT-boreholes on Solitraio Canyon Fault (13,14,16)

Attached are the development summary sheets that have been completed by the Testing Working Group.

BENEFT

Ralph Rogers
04/30/97 07:51 AM

To: James Beyer@CRWMS, Steven Beason@CRWMS, Bo Bodvarsson@CRWMS, William Boyle@CRWMS, Robert Craig@CRWMS, Ned Elkins@CRWMS, Ron Oliver@CRWMS, Tim Sullivan@CRWMS, Jon White@CRWMS
cc: Mitchell Brodsky@CRWMS, Jim Houseworth@CRWMS, William Kennedy@CRWMS, MacKaye Smith@CRWMS, Larry Hayes@CRWMS, Candace Lugo@CRWMS, Michael Voegele@CRWMS, Michaele Brady@CRWMS, Gilles Bussod@CRWMS, Dwayne Chesnut@CRWMS, Dwight Hoxie@CRWMS, Ron E. Smith@CRWMS, Russ Patterson@CRWMS, Mark Tynan@CRWMS, Mark Peters@CRWMS
Subject: ECRB Meeting Notes

Jim Beyer

The notes that you have put together for the meetings of the working group leads have a place holder for "Key points" from each working group. The following are the key points that I have tried to make during these meetings. The other members of the testing working group can review these and let us know if there are other key points that I **should** have been making.

1> It is important to have hydrologic testing and sampling for environmental isotopes and fracture filling minerals below the zone of high surface infiltration defined by Alan Flint. Reason-this is the area where we potentially have the best input signal for our measurements, even over long time frames.

2> Displacement on the Solitario Canyon fault increases dramatically from north to south. We need to study the fault at a location where the displacement is great enough to see well developed physical characteristics of the fault zone itself and wall rock deformation associated with the fault. We also need enough displacement to allow us to access the Calico Hills without traversing the vitrophyre.

3> We have very little data on the physical properties of the rocks in the actual emplacement horizon itself. It is important to traverse as much of this horizon as possible. This point has several subpoints. The lower lithophysal zone of the Topopah will constitute at least 50% of the repository horizon and about the only data we have on it comes from a few meters in the ESF the traverse the very upper most portion of the unit. Hydrologic properties of this unit will be particularly important and could be significantly different from what we have seen in other units. This potential difference results from the observation that fracture characteristics, such as continuity, curvature, abundance, etc., are strongly influenced by the presence and abundance of lithopysae. The distribution and abundance of lithophysae in this unit could be significantly different in this unit from other units that we have encountered higher in the section. This means that it is critical to do tests like the niche studies in the lower lith under the areas of high surface infiltration. otherwise we will always be accused of trying to biase our results.

4> Fracture distributions and abundances very both from north to south and within the section between stratigraphic subunits. In part this is a subset of point 3 and makes it important to sample the entire section of the emplacement horizon if possible. This also indiocates that it is important to study the Solitario Canyon fault where it crosses the emplacement horizon because the wallrock deformation may change significantly between stratigraphic subunits.

5> Testing in the Calico Hills is crucial to our understanding of flow and transport processes below the repository horizon. We currently have virtually no data from this zone. The configuration that we have suggested would allow us to sample for environmental isotopes and other data to characterize flow and transport and to field an in-situ test to study flow and transport processes.

6> The splay coming off of the Solitario Canyon fault in the central part of the block shows decreasing displacement going upsection in outcrop. One interpretation of this data is that it is a pre-Tiva fault. If this is correct it could rpoject for significant distances into the potential repository block. This possibility should be checked by underground construction.

E.2 Performance Assessment Working Group

Jim Houseworth
03/20/97 03:41 PM

To: James Beyer@CRWMS
cc: Robert Sandifer@CRWMS, Michael Voegele@CRWMS, Robert Andrews@CRWMS, Abe VanLuik@CRWMS, Eric Smistad@CRWMS, David Sevougian@CRWMS, mlwilso@nwer.sandia.gov at PMDFPO @ YMPGATE
Subject: PA information needs from enhanced characterization

The following is a list of information needs from enhanced characterization, as identified by the PA working group. The information needs have been organized according to the expected methods that may be required to obtain this information. The correspondence between this list and criteria identified in "Draft Notes on a Process to Evaluate the Location and Scope of Enhancements to the Site Characterization Program Incorporating an East-West Drift" is noted after each item.

Boreholes and/or drifting:

Characterization of environmental tracers in the PTn to better define the extent of fast transport pathways through the PTn. Core from the PTn in the proposed borehole, SD-6, and any other boreholes that penetrate the PTn, can be used as samples for analysis of environmental tracer concentrations. a) 4

Characterization of environmental tracers (perhaps traced construction water also), hydrogeologic properties and fracture/matrix flow distribution in the CHnv (and CHnz if possible) to better define fast pathways for radionuclide movement below the repository horizon. a) 6

Characterization of the saturated zone, including chemical and isotopic composition of the water, rock samples (core) for measurements of hydrogeologic properties, and natural gradient tracer tests to better characterize the flux distribution. none

Characterization of vitric/zeolitic distributions in the southwest portion of the block to better define potential for radionuclides to bypass zeolites. a) 10

Characterization of the high water-table-gradient area, including distinguishing between perched water and the water table, and performing pump tests to better understand the hydrogeologic properties in this area. none

Chemical characterization of composition and isotopes along stratigraphic contacts where lateral diversion is suspected. This information may be used to help bound the potential for lateral diversion of water and/or radionuclide pathways in the unsaturated zone. a) 4; a) 6

Drifting:

Identification and hydrogeologic characterization of any pre-Tiva Canyon faults as potential fast pathways through nonwelded units. a) 3

Hydrogeologic characterization of Solitario Canyon Fault. Perform permeability characterization measurements in the fault. This will help define the hydrogeologic behavior of the fault in the unsaturated zone. Drill boreholes from the drift into the water table on both sides of the fault and take water samples from saturated zone to characterize chemical/isotopic variations across fault. This will help define whether or not the fault is a barrier to flow in the saturated zone. a) 14

Experimental and/or theoretical studies:

In-drift testing of water seepage into drifts. Block off main ESF or ESF enhancement tunnel and turn off ventilation to look for water seeps. Perform other measurements to characterize in-drift seepage such as proposed ESF niche studies. a) 5

Laboratory testing of transport through a perforated waste package to see if radionuclide releases from waste packages can occur through the initial pinhole perforations. none

Laboratory and/or in-drift testing of drip shields to better define the effects of such a barrier on water movement around the waste package and radionuclide release. Thermohydrologic modeling of this proposed EBS configuration is also needed. none

Analyses of the geochemical environment in the drifts to better define conditions affecting radionuclide solubilities and waste package corrosion. This includes the development of cement-phase thermochemical data. none

Laboratory testing of water and tracer movement through samples of tuff containing natural fractures to better define fracture/matrix interaction. a) 12

Geochemical analyses to better define the altered zone resulting from the effects of EBS materials and waste heat on radionuclide transport characteristics (solubilities, sorption, colloidal interactions) in the unsaturated zone. This includes the development of cement-phase thermochemical data. none

Laboratory and/or in-drift testing of cathodic protection to better define the effects on waste package corrosion. none

Jim Houseworth
03/24/97 04:47 PM

To: James Beyer@CRWMS
cc: Robert Sandifer@CRWMS, Michael Voegele@CRWMS, Robert Andrews@CRWMS, Abe VanLuik@CRWMS, Eric Smistad@CRWMS, David Sevougian@CRWMS, mlwilso@nwer.sandia.gov at PMDFPO @ YMPGATE, Ralph Rogers@CRWMS
Subject: Criteria for the enhanced characterization plan

The list of questions given below are the criteria developed for evaluating the enhanced characterization plan by the PA working group.

Are there location, layout, or test program specific considerations for enhanced characterization that can enhance the understanding of the site relative to...

water seepage into drifts to better define the mode of water contact with waste packages and the mode of potential radionuclide transport?

the distribution and concentration of environmental tracers in the PTn to better define the extent of fast transport pathways through the PTn?

the flux distribution, hydrogeologic and transport properties, and chemical and isotopic composition of the saturated zone?

the distribution and concentration of environmental tracers (perhaps traced construction water also), hydrogeologic properties, and fracture/matrix flow distribution in the CHnv (and CHnz if possible) to better define fast pathways for radionuclide movement below the repository horizon?

transport through a perforated waste package to see if radionuclide releases from waste packages can occur through the initial pinhole perforations?

in-drift water movement in the presence of a drip shield to better define the effects of such a barrier on water contact with waste packages and its potential effect on radionuclide releases?

cathodic protection to better define the effects on waste package corrosion?

the geochemical environment in the drifts (including the interaction with cement) to better define conditions affecting radionuclide solubilities and waste package corrosion?

water and tracer movement through welded and nonwelded tuff containing natural fractures to better define fracture/matrix interaction?

the geochemical and isotopic water composition along stratigraphic contacts to help bound the potential for lateral diversion of water and/or radionuclide pathways in the unsaturated zone?

the effects of EBS materials and waste heat on the geochemical environment outside the drift to better define the influence of the altered zone on radionuclide transport characteristics (solubilities, sorption, colloidal interactions) in the unsaturated zone?

the distribution of vitric/zeolitic rocks in the south and west portions of the block to better define potential for radionuclides to bypass zeolites?

the large hydraulic gradient, including distinguishing between perched water and the water table, and hydrogeologic properties in this area?

the unsaturated and saturated zone flow in and around Solitario Canyon Fault to better define the role of the fault as a potential pathway for radionuclides in the unsaturated zone and its role in the saturated zone relative to the moderate hydraulic gradient?

the identification and characterization of any pre-Tiva Canyon faults as potential fast pathways through nonwelded units?

Jim Houseworth
03/26/97 04:57 PM

To: James Beyer@CRWMS
cc: David Sevougian@CRWMS, Eric Smistad@CRWMS, Abe VanLuik@CRWMS, mlwilso@nwer.sandia.gov at PMDFPO @ YMPGATE, Robert Andrews@CRWMS, hadocke@nwer.sandia.gov at PMDFPO @ YMPGATE
Subject: Overlap of criteria between the testing and PA working groups

There is at least a partial overlap between the following criteria identified by the PA and testing working groups:

PA Criteria Number	Testing Criteria Numbers
1	12
2	9
3	21, 22
4	9, 17
9	11
10	17, 19
12	18
13	20
14	3
15	2

The degree of overlap varies and I expect there will be diverse opinions about these differences. The other PA criteria (numbers 5, 6, 7, 8, and 11) that don't correspond to any of the testing criteria are concerned with EBS/waste package environment and processes and repository-perturbed conditions external to the emplacement drifts.

Jim Houseworth
03/31/97 04:56 PM

To: James Beyer@CRWMS
cc: Robert Sandifer@CRWMS, Michael Voegele@CRWMS, Robert Andrews@CRWMS, Abe VanLuik@CRWMS, Eric Smistad@CRWMS, David Sevougian@CRWMS, mlwilso@nwer.sandia.gov at PMDFPO @ YMPGATE, Ralph Rogers@CRWMS
Subject: Comments on draft criteria

The only comment from the PA working group is that criterion 11) be modified as given below:

11) fracture and matrix components of flow and transport?

Otherwise, the PA working group is satisfied that the list of criteria given in your memo of 3/27 covers the items of concern to performance assessment.

Jim Houseworth
04/04/97 04:24 PM

To: James Beyer@CRWMS
cc: Robert Sandifer@CRWMS, Michael Voegele@CRWMS, Robert Andrews@CRWMS, Abe VanLuik@CRWMS, Eric Smistad@CRWMS, David Sevougian@CRWMS, mlwilso@nwer.sandia.gov at PMDFPO @ YMPGATE, Ralph Rogers@CRWMS
Subject: Benefits associated with ECRB criteria

The attached file contains a list of criteria considered important to PA and the perceived benefits associated with each of the criteria. I'm not certain if all of the members of the PA working group have had a chance to review the enclosed list of benefits. Therefore, we may have some changes to suggest early next week.

BNFT2.

Crit. # **Criteria Description** (corresponding number from PA criteria list)

2) unexposed faults? (15)

Benefit: Identification and characterization of potential fast pathways through nonwelded units.

3) hydrologic properties, fracture properties and geotechnical properties in and near faults? (14)

Benefit: Bound the role of faults as potential pathways for radionuclides in the unsaturated zone and their role in the saturated zone relative to abrupt changes in the hydraulic gradient.

9) the distribution of environmental isotopes from systematic and feature based samples? (2,4)

Benefit: Bound the extent of fast transport pathways through nonwelded units. Bound the potential for lateral diversion of water and/or radionuclide pathways in the unsaturated zone.

11) fracture and matrix components of flow and transport? (9)

Benefit: Bound fracture/matrix interaction for water flow and aqueous radionuclide transport.

12) flow into openings? (1)

Benefit: Bound the mode of water contact with waste packages and the mode of potential radionuclide transport through the engineered barrier system.

17) flow patterns in the unsaturated zone below the repository horizon? (10)

Benefit: Bound the potential for lateral diversion of water and/or radionuclide pathways in the unsaturated zone.

18) the distribution and continuity of zeolitization? (12)

Benefit: Bound the potential for aqueous radionuclide transport through the unsaturated zone to bypass zeolites.

19) the hydrochemistry of the unsaturated zone below the repository horizon? (10)

Benefit: Bound chemical transport parameters (e.g. adsorption and matrix diffusion) and fracture/matrix interaction.

20) the location and origin of the large hydraulic gradient north of the repository block? (13)

Benefit: Establish a conceptual model for the large hydraulic gradient.

21) dilution, mixing and flux distribution in the saturated zone? (3)

Benefit: Bound physical transport parameters, including flow rate and dispersion, for the saturated zone.

22) the hydrochemistry of the saturated zone? (3)

Benefit: Bound chemical transport parameters (e.g. adsorption and matrix diffusion) and fracture/matrix interaction for the saturated zone. Determine sources of water and flow paths throughout the saturated zone.

26) transport through a perforated waste package to see if radionuclide releases from waste packages can occur through the initial pinhole perforations? (5)

Benefit: Bound the potential for radionuclide releases from waste packages through the initial pinhole perforations.

27) in-drift water movement in the presence of a drip shield to better define the effects of such a barrier on water contact with waste packages and its potential effect on radionuclide releases? (6)

Benefit: Bound the effects of such a barrier on water contact with waste packages and its potential effect on radionuclide releases.

28) cathodic protection to better define the effects on waste package corrosion? (7)

Benefit: Bound the potential improvement for waste package corrosion.

29) the geochemical environment in the drifts (including the interaction with cement) to better define conditions affecting radionuclide solubilities and waste package corrosion? (8)

Benefit: Bound the geochemical conditions that may affect radionuclide solubilities and waste package corrosion.

30) the effects of EBS materials and waste heat on the geochemical environment outside the drift to better define the influence of the altered zone on radionuclide transport characteristics (solubilities, sorption, colloidal interactions) in the unsaturated zone?(11)

Benefit: Bound changes to radionuclide transport characteristics (solubilities, sorption, colloidal interactions) in the unsaturated zone due to repository-perturbed conditions.

Jim Houseworth
04/09/97 08:03 AM

To: James Beyer@CRWMS
cc: Robert Sandifer@CRWMS, Michael Voegele@CRWMS, Robert Andrews@CRWMS, Abe VanLuik@CRWMS, Eric Smistad@CRWMS, David Sevougian@CRWMS, mlwilso@nwer.sandia.gov at PMDFPO @ YMPGATE, Ralph Rogers@CRWMS
Subject: Revised benefits associated with ECRB criteria

The attached file contains a **revised** list of criteria considered important to PA and the perceived benefits associated with each of the criteria. The PA working group met on 4/8/97 to comment on the selected criteria and benefit statements. The revised list contains some changes in wording for the benefits from the previous list I sent you on 4/4/97 and includes benefits for five additional criteria from the consolidated criteria list that the PA working group decided to address.

During this meeting, the PA working group noted that the Working Group Criteria (the criteria cross-walk list) identified for criterion 9 on the Consolidated Criteria List should also include PA2.

BNFT3.

__Crit. #__ __Criteria Description__ (corresponding number from PA criteria list)

2) unexposed faults? (15)

__Benefit:__ Identification and characterization of potential fast pathways.

3) hydrologic properties, fracture properties and geotechnical properties in and near faults? (14)

__Benefit:__ Bound the role of faults as potential pathways for radionuclides in the unsaturated zone and their role in the saturated zone as preferential pathways or barriers to flow and transport.

5) the age and distribution of perched water?

__Benefit:__ Determine transport rate and direction through the unsaturated zone.

6) alternative conceptual models of perched water formation?

__Benefit:__ Determine if perched water bodies grow or deplete under future climate conditions and the transport characteristics for radionuclides migrating through perched water bodies.

8) the age and genesis of fracture filling materials?

__Benefit:__ Provides information on past flow paths through the unsaturated zone.

9) the distribution of environmental isotopes from systematic and feature based samples? (2,4)

__Benefit:__ Determine the extent of fast transport pathways through nonwelded units. Estimate the potential for lateral diversion of water and/or radionuclide pathways in the unsaturated zone.

10) spatial distribution of infiltration flux?

__Benefit:__ Incorporate the spatial variability of percolation flux in flow and transport modeling for performance predictions.

11) fracture and matrix components of flow and transport? (9)

Benefit: Determine fracture/matrix interaction for water flow and aqueous radionuclide transport in the unsaturated zone.

12) flow into openings? (1)

Benefit: Define the likelihood of water contact modes with waste packages and the likelihood of advective radionuclide transport through the engineered barrier system.

15) infiltration and percolation throughout the UZ in and around faults?

Benefit: Provide estimates for levels of percolation flux and radionuclide transport parameters along faults.

17) flow patterns in the unsaturated zone below the repository horizon? (10)

Benefit: Estimate the potential for lateral diversion of water and/or radionuclide pathways in the unsaturated zone.

18) the distribution and continuity of zeolitization? (12)

Benefit: Estimate the potential for aqueous radionuclide transport through the unsaturated zone to bypass zeolites.

19) the hydrochemistry of the unsaturated zone below the repository horizon? (10)

Benefit: Estimate chemical transport parameters (e.g. adsorption and matrix diffusion) and fracture/matrix interaction.

20) the location and origin of the large hydraulic gradient north of the repository block? (13)

Benefit: Distinguish between conceptual models for the large hydraulic gradient.

21) dilution, mixing and flux distribution in the saturated zone? (3)

Benefit: Estimate physical transport parameters, including flow rate, velocity, and dispersion, for the saturated zone.

22) the hydrochemistry of the saturated zone? (3)

Benefit: Estimate chemical transport parameters (e.g. adsorption and matrix diffusion), mineral distributions, and fracture/matrix interaction for the saturated zone. Determine sources of water and flow paths throughout the saturated zone.

26) transport through a perforated waste package to see if radionuclide releases from waste packages can occur through the initial pinhole perforations? (5)

Benefit: Bound the potential for radionuclide releases from waste packages through the initial pinhole perforations.

27) in-drift water movement in the presence of a drip shield to better define the effects of such a barrier on water contact with waste packages and its potential effect on radionuclide releases? (6)

Benefit: Estimate the effectiveness of such a barrier on water contact with waste packages and its potential effect on radionuclide releases.

28) cathodic protection to better define the effects on waste package corrosion? (7)

Benefit: Bound the potential improvement for waste package corrosion.

29) the geochemical environment in the drifts (including the interaction with cement) to better define conditions affecting radionuclide solubilities and waste package corrosion? (8)

Benefit: Bound the geochemical conditions that may affect radionuclide solubilities and waste package corrosion.

30) the effects of EBS materials and waste heat on the geochemical environment outside the drift to better define the influence of the altered zone on radionuclide transport characteristics (solubilities, sorption, colloidal interactions) in the unsaturated zone?(11)

Benefit: Bound changes to radionuclide transport characteristics (solubilities, sorption, colloidal interactions) in the unsaturated zone due to repository-perturbed conditions.

Jim Houseworth
04/11/97 02:41 PM

To: James Beyer@CRWMS
cc: Robert Sandifer@CRWMS, Michael Voegele@CRWMS, Robert Andrews@CRWMS, Abe VanLuik@CRWMS, Eric Smistad@CRWMS, David Sevougian@CRWMS, mlwilso@nwer.sandia.gov at PMDFPO @ YMPGATE, Ralph Rogers@CRWMS
Subject: Revised PA benefits for selected ECRB criteria

The attached file contains revised benefits statements for criteria selected as relevant to PA. The revisions primarily consist of additional statements giving a qualitative sense of the importance of each benfit to PA and brief comments concerning what has shaped our opinions on this prioritization.

The PA working group wants to add a criterion that had been left out. This criterion concerns the effects of cladding on radionuclide dissolution and mobilization. We also want to add the words "and temporal" to the criterion on the spatial distribution of percolation flux. I've included these criteria changes in the attached file below.

Our group didn't have much to say about timing of the planned activities. We believe that any new information would need to be available by the end of the fiscal year to be useful for TSPA-VA. Therefore, we are not expecting the enhanced characterization to support TSPA-VA. Data derived from enhanced characterization may be of some use as "confirmatory information". However, we don't expect anything but limited qualitative information from additional drifting to be available for VA. Borehole data may be available as confirmatory data for VA, but we were not sure of how quickly testing information could be taken and analyzed. Some of the benefits for better characterization of the EBS may also be available for as confirmatory data for VA, but we need to check this out more thoroughly. Presumably, all of the benefits are potentially available for TSPA-LA .

BNFT5 .

Crit. # **Criteria Description**

2) unexposed faults?

Benefit: Identification and characterization of potential fast pathways. This is of limited importance to PA. This is because we don't expect fault zones to be important for transporting significant quantities of radionuclides to the water table.

3) hydrologic properties, fracture properties and geotechnical properties in and near faults?

Benefit: Bound the role of faults as potential pathways for radionuclides in the unsaturated zone and their role in the saturated zone as preferential pathways or barriers to flow and transport. This is of limited importance to PA. The role of faults only becomes important if focusing of flow can divert a large portion of this percolation flux throughout the repository into fault zones. The diversion of UZ flow into fault zones is not strongly dependent on the hydrologic properties of the fault zones. The current assumption for the SZ is that fractures, including those in faults control the flow and that the SZ has a well-connected fracture system. The relative behavior of SZ transport through more highly fractured areas, such as fault zones, is more important.

5) the age and distribution of perched water?

Benefit: Determine transport rate and direction through the unsaturated zone. This is of moderate importance to PA. If properly interpreted, it may provide important information about flow distribution between fractures and matrix, transport times through the UZ, and lateral diversion.

6) alternative conceptual models of perched water formation?

Benefit: Determine if perched water bodies grow or deplete under future climate conditions and the transport characteristics for radionuclides migrating through perched water bodies. This is of moderate importance to PA. Evaluation of the conceptual models are important for interpretation of perched water data. Given a valid conceptual model, the perched water data may provide important information about flow distribution between fractures and matrix, transport times through the UZ, and lateral diversion.

8) the age and genesis of fracture filling materials?

Benefit: Provides information on past flow paths through the unsaturated zone. This is of limited importance to PA. It could potentially be useful for UZ flow and transport model calibration.

9) the distribution of environmental isotopes from systematic and feature based samples?

Benefit: Determine the extent of fast transport pathways through nonwelded units. Estimate the potential for lateral diversion of water and/or radionuclide pathways in the unsaturated zone. This is very important to PA. This data is expected to provide valuable information concerning fracture/matrix interaction for transport processes that can be used to help estimate model parameters for this important, but poorly constrained, characteristic of unsaturated zone transport.

10) spatial and temporal distribution of infiltration flux?

Benefit: Incorporate the spatial variability of percolation flux in flow and transport modeling for performance predictions. This is potentially very important to PA if the spatial or temporal variations are large enough. Percolation flux has been identified as one of the most important parameters in TSPA-95.

11) fracture and matrix components of flow and transport?

Benefit: Determine fracture/matrix interaction for water flow and aqueous radionuclide transport in the unsaturated zone. This is of moderate importance to PA. In particular, the delay in transport for strong fracture/matrix transport coupling can have a large effect on performance at 10,000 years, but is less important for performance over 1,000,000 years. Fracture/matrix coupling of flow is also important for the interaction of water with the EBS.

12) flow into openings?

Benefit: Define the likelihood of water contact modes with waste packages and the likelihood of advective radionuclide transport through the engineered barrier system. This is very important to PA. TSPA-95 and subsequent studies have shown that advective flow directly in contact with waste canisters is a serious detriment to performance. One of the questions surrounding this behavior is the extent to which water moving through the potential repository environment will drip into potential waste emplacement drifts.

15) infiltration and percolation throughout the UZ in and around faults?

Benefit: Provide estimates for levels of percolation flux and radionuclide transport parameters along faults. This is of moderate importance to PA. This is because we don't expect fault zones to be important for transporting significant quantities of radionuclides to the water table. If investigations of percolation along faults indicates that a large portion of the percolation flux is diverted to the SZ through faults, then this benefit would take on more importance.

17) flow patterns in the unsaturated zone below the repository horizon?

Benefit: Estimate the potential for lateral diversion of water and/or radionuclide pathways in the unsaturated zone. This is of moderate importance to PA. The occurrence of lateral diversion is a potentially important element of focused flow through faults in the unsaturated zone and/or mechanism for bypassing zeolites.

18) the distribution and continuity of zeolitization?

Benefit: Estimate the potential for aqueous radionuclide transport through the unsaturated zone to bypass zeolites. This is of moderate importance to PA. A portion of the radionuclide inventory is known to sorb more strongly in zeolitic rock than any other rock type. Therefore zeolites can provide an important delay function for the arrival of radionuclides at the accessible environment. The continuity and extent of zeolitization can impact the effectiveness of this natural barrier.

19) the hydrochemistry of the unsaturated zone below the repository horizon?

Benefit: Estimate chemical transport parameters (e.g. adsorption and matrix diffusion) and fracture/matrix interaction. Determine the extent of fast transport pathways through nonwelded units. Estimate the potential for lateral diversion of water and/or radionuclide pathways in the unsaturated zone. This is very important to PA. This data is expected to provide valuable information concerning fracture/matrix interaction for transport processes. Fracture/matrix interaction is a very important factor affecting the arrival time of radionuclides at the water table. Model parameters for fracture/matrix interaction are currently very poorly constrained. Information about hydrochemistry both above and below the potential repository will contribute to more defensible conceptual models of flow and transport in the unsaturated zone.

20) the location and origin of the large hydraulic gradient north of the repository block?

Benefit: Distinguish between conceptual models for the large hydraulic gradient. This is of limited importance to PA. The conceptual model of saturated zone flow that is used to describe the large hydraulic gradient could affect predictions of saturated zone flow and transport behavior, especially with climate change.

21) dilution, mixing and flux distribution in the saturated zone?

Benefit: Estimate physical transport parameters, including flow rate, velocity, and dispersion, for the saturated zone. This is very important to PA. The current characterization of the saturated zone is sparse. TSPA-95 found that performance over 1,000,000 years is very sensitive to dilution in the saturated zone.

22) the hydrochemistry of the saturated zone?

Benefit: Estimate chemical transport parameters (e.g. adsorption and matrix diffusion), mineral distributions, and fracture/matrix interaction for the saturated zone. Determine sources of water and flow paths throughout the saturated zone. This is very important to PA. In addition to the information hydrochemistry may provide concerning the dilution resulting from the mixing of different regional groundwater flows, the partitioning of radionuclide species between a mobile aqueous phase and an immobile precipitate is dependent on hydrochemistry.

26) transport through a perforated waste package to see if radionuclide releases from waste packages can occur through the initial pinhole perforations?

Benefit: Bound the potential for radionuclide releases from waste packages through the initial pinhole perforations. This is very important to PA. Performance assessment calculations have shown that the capillary characteristics of the pinhole perforations are important for determining the water contact mode with the waste. Advective water contact and radionuclide mobilization our of the waste package seriously degrade performance in comparison with diffusive-limited radionuclide mobilization. Furthermore, the effects of corrosion products in the perforations may also have an important effect on diffusion processes for radionuclide movement out of the waste package.

27) in-drift water movement in the presence of a drip shield to better define the effects of such a barrier on water contact with waste packages and its potential effect on radionuclide releases?

Benefit: Estimate the effectiveness of such a barrier on water contact with waste packages and its potential effect on radionuclide releases. This is very important to PA. The drip shield is an EBS component that is intended to prevent advective water contact with the waste package. TSPA-95 and subsequent studies have shown that advective flow directly in contact with waste canisters is a serious detriment to performance.

28) cathodic protection to better define the effects on waste package corrosion?

Benefit: Bound the potential improvement for waste package corrosion. This is very important to PA. Recent performance assessment calculations have shown that cathodic protection can significantly improve performance.

29) the geochemical environment in the drifts (including the interaction with cement) to better define conditions affecting radionuclide solubilities and waste package corrosion?

<u>Benefit:</u> Bound the geochemical conditions that may affect radionuclide solubilities and waste package corrosion. This is very important to PA. Currently, the geochemical conditions and their effects on radionuclide solubilities and waste package corrosion are poorly constrained. The drift geochemical environment could alter solubilities (and therefore, release) by several orders of magnitude.

30) the effects of EBS materials and waste heat on the geochemical environment outside the drift to better define the influence of the altered zone on radionuclide transport characteristics (solubilities, sorption, colloidal interactions) in the unsaturated zone?

<u>Benefit:</u> Bound changes to radionuclide transport characteristics (solubilities, sorption, colloidal interactions) in the unsaturated zone due to repository-perturbed conditions. This is of moderate importance to PA. The extent to which geochemical alteration can extend through the unsaturated zone affecting radionuclide transport is poorly constrained.

New) the effects of cladding on radionuclide dissolution and mobilization?

<u>Benefit:</u> Estimate the effectiveness of cladding for reduction in radionuclide dissolution and mobilization. This is very important to PA. Recent performance assessment calculations have shown that cladding may have an important role in reducing the rate of radionuclide dissolution and mobilization. However, existing data to support cladding degradation models primarily rely on results from short-term dry storage conditions which lack the environmental conditions that the cladding may encounter for longer times in the potential repository environment.

Meeting for In-Drift - April 17, 1997

Attendees
Jim Houseworth
Mitch Brodsky - DOE Design
Ralph Rogers (partial)
Mike Wilson - telephone from Sandia
Abe Van Luik - (partial)
Bob Andrews (partial)

Lin Henderson - Note taker

Jim open the meeting by reviewing material that he had put together in the Performace Assessment Development Summary.

Discussed different areas where there might be issues that could require more information from others - perched water, zeolites, drifting - borehole design, cristoblite - dust - thin layer of minolite -
could need safety protection to get through the area, health physicics problems, how many boreholes, how many through the block.

Looked at criteria to make certain that key item were covered.

Recommendation by Mitch - "that you focus on what you need." May want to discuss with testing.

Reviewed Mike's comments - Jim included them - characterization of faults, role of faults and the importance. Benefits statement for #3. Clarified in the unsaturated zone.

Number 3

Characterization of fault - which are most critical - felt Ghost Dance and Sun Dance most important - also applies to saturated zone - Jim added recommendation.

Comment on importance of data PTN - #9.

Reviewed each area one by one

Number 2. Unexposed faults - looks fine - comments
rationale - change potential repository block to potential repository horizon

Risks: May miss an important transport pathway without this data

Number 3. Source - hydrologic properties rather than geotechnologies.

Dave feels other faults that could be looked at - Mike looked at George's work - big jump in water table at fault - do pump testing around faults - Solitary Canyon closest - trying to specific preferred and alternate. Could say there are some other faults that should be investigated. Jim feels that we should be specific - Mike Solidary Canyon and Drill Hole Wash Fault - doesn't feel there is enough information further down stream. Need to look at flux in the faults rather than the surrounding regions.

Alternative sources -
added later

Jim explained his understanding that if you don't have a preference you don't have to specify.

Sources - In the UZ - drifting is the preferred method
In the Saturated Zone a borehole investigation is preferred.

Take out first sentence in the rationale.

Need to calibrate the models.

We need to understand the steep hydrologic models in the SZ to help calculate the ???? models.

Risk:

Abe comment - What does Risks mean?

Not doing anything and/or in not having any additional information.

If you do not do something to get age on drift water? What does that do?

Questioned whether there are rankings as to the risks - yes there is a number.

Risk: #3 The uncertainty in the magnitude of flux will be higher without this data.

Comment from Mitch: Intent of exercise is that the M&O can come to a meeting of the minds as to the East/West drift -

Comment from Bob - The confidence in that model is based on our understanding of Y - which means we need to have more information on Y -

Who will make the decision as to who will make the decision? - Vawter, Voegele - need to have risks that will standout to help make the decision - those of moderate and very important to PA - ask of those - if we don't get more information, what will happen?

Very High - top 3
High - 6
Med. - 5
Med. Low - 5
Low -

Comment from Mitch - need to be meshed with other groups - need to give technical reasons why most important from PA standpoint.

Comment from Mike - feels that this has been done in the benefits statements - feel that words in statement should be bolded - very important PA's.

Each has an statement as to why.

Mimic in risk particular words (the reverse). Feel should add in false positives and false negatives - perhaps others would be better to do this - Testing group.

Comment from Mitch - feels that we should identify areas where you need more data and the risk.

Decided to look at the 10 most important and focus on them first -

Skipped to number 12 -

Most important - risk is shown

Number 12

Sources - added specific "a key"

Rationale - no changes

Risks - add words "very high"

? Is this topic tied to the East/West drift - Most of high are not specific to East/West drift.

Give more emphasis to Yucca Crest - add to risk

Important to do than more than one location - Making licence application better by looking at most currently available and then repeating in a higher flux area.

Spend time on what will be beneficial to the models - the best potential benefit.

Add to Risks -

Because of the spatial variation of infiltration flux it is recommended that test be carried out in both existing drifts and in new drifts intercepting high infiltration flux.

Number 9 -

Comment Abe - pretty decent write-up - risk should be more straight forward - recommend add risk high and this data is important to the current models does not have the high calibration of transport models?

Risks - The risk is high because the confidence in these models is currently low due to of the lack of this type of calibration data.

Question as to what the outcome todays exercise will be - Jim advised have to come up with the optimum model.

Number 21

Add to Risks

High risk of not adequately characterizing dissolution and mixing in the saturated zone which could lead to unrealistic estimates of dose.

Add to

Preferred ..... Tracer Complex as planned.

Adding to Also, measurements........

Number 22

Both tied for 3 - did list and ranked and then they were split by the testing group. Kept ranking

Sources good.

Use same risk statement applies - and important to keep as three so that they don't get separated. May not make sense if separated.

Comment Dave - felt that something needs to be added to the risk statement about geochemical.

Should something be added about oxidizing ...Jim felt that it was stated.

Change to transport on both.

High risk of ....add transport characteristics in the saturated ....repeat from 21, but add

This includes the transport properties of weakly and/or strongly sorbing radionuclides whose retardation can be strongly affected by SZ hydrochemistry in various stratigraphic units such as the tuff, carbonates, and alburium.

Sources and rationale on 22 is ok.

Number 19

Some discussion as to the priority of this item being a 4 - some differences of opinion within the Labs - some think we will by pass zeolites. Not sure who is correct. One point is that there is a multiple layer of zeolite.

Not just about zeolites - it is about things moving through the matrix.

Should say.

Added .... Calico Hills and underlining units.

barriers ...are...CHn and Prow Pass

Rationale

The critical features are matrix flow in the Chnv and sorption.

Does anything need to be added to Risk?

Looking at transport characteristics of the unsaturated zone.

The risk high

Some discussion about Calico Hills - current status

Use the same statement of Number 9.

Dave proposed -

High risks of not adequately characterizing the performance of the unsaturated zone natural barrier, which could result in low confidence in the modeling of radionuclide transport to the water table.

Number 28

Risk

The risk of not having this information is that the design and manufacturing may not be adequate to assure that this process can be included and defended in the Licensing Safety case.

Number 10 - Priority 6

Discussed reason for the priority - temporal variation and climate change is important -

Take out ....probably -

Discussed Rationale - vertically distributed data - neutron holes -

Add........from boreholes drilled to the top of TSW.

Add sentence in Preferred Alternate Sources - regarding climate change - ask Jack Gauthier.

Risks:

High risk because previous TSPA's have identified percolation flux as one of the most important performance perimeters.

Number 26

EBS for next 3

Benefits -

4th sentence ....out......

Risks

High risk of not being able to take credit in the EBS model for the preventing drips from contacting the waste form.

Number 27

Stops drips on the waste package

Same for the Risks except change to...... waste package.

High risk of not being able to understand conditions that could effect the design and manufacturing of the drip shield to determine its effectiveness in preventing advective water contact with the waste package.

Source - adding

The tests would investigate the methods of manufacturing/emplacement/materials, the long term robustness, and the alternate water contact modes that may occur.

Broke for lunch:

Number 29

Made complete change to source -

add things to the drift scale heater tests.

The preferred source is an in-drift with heated cement, degraded waste package material, and pristine waste package material. This could be in combination with current drift-scale heater test or on additional test. Alternate source would be lab measurements of thermochemical data (e.g. solubilities) and flux dissolution under different water composition and heating scenarios.

Rationale

Predictions will rely on emprical tests and data, but will also need data on more fundamental parameters for theoretical chemical models.

Risk

High risk of not bounding the uncertainty on the rate of wp/degradation.

Number (new)

High risk of not being able to take credit for cladding performance.

Reviewed rest of items to see if there were any that needed to be addressed.

Question as to where perched water is covered?

Believe that perched water will be covered by testing - Bo's group.

Moved onto Optimal Configuration

We don't have any constraints at this time - could use method of prioritization.

Need to put down a configuration element , i.e., borehole - element

Concern that if just added up, may miss the really important items.

Review format for reporting the information. Discussed cross referencing to the document.

Action Items:

1. Mike will check with Jack Gauthier regarding the climate model.

2. Mitch will check with the Testing working group to obtain more information about zeolites and geophysical testing in perched water.

3. Jim will update the Development Summary and he will finalize the linking of the conclusions with the development summary.

4. Jim will set a follow-up meeting as required.

Criteria	Preferred Source	Boreholes required
12) Flow into openings	Existing drifts, new drifts in high infiltration flux zones	
9) Distribution of environmental istopes from systematic	Cored boreholes thru Ptn & Chn, including some in high infiltration flux areas	
21 &22 Saturated zone	Southern Tracer Complex as planned pump tests and introduced tracer tests in existing and new boreholes in other areas. Chemical characterization of water samples and cores at various depths, including tuffs, carbonates, and alluvium	Multiple boreholes for some of the tests
19) Hydrochem of UZ below repository.	Cored boreholes in CHn & PP down to water table	

Criteria	Preferred Source	Boreholes required
28) cathodic protection	Controlled manufacturing tests and laboratory experiments	
10) infiltration flux	Cored boreholes to top of TSw	
26) pinhole perforations	Laboratory testing	
27) drip shield	Manufacturing emplacement and materials testing. Lab tests preferred. In-situ tests for emplacement options and thermal effects (condensation)	
29) geochemical environment in drifts	In-drift heater tests with introduced materials Also lab tests of thermochemical data.	
New) cladding	Laboratory tests	

Borehole

UZ where
high infiltration flux areas
southwest block

SZ - downstream of repository block

One or two more holes in the repository block - in the western (south and west) region.

Number 11

Source

adding........Preferred source of information is through measurement of matrix hydrologic properties of cores and air permenability tests in boreholes.

Conclusion

Optimum Configuration

1. Drift closure / drip test seepage test.

2. Cored boreholes through the UZ to the W.T. in south and west portions in the rrepository block. (At least 2) (maybe SD-6 would count as one).

3. Southern Tracer Complex as planned.

   Plus 4 additional boreholes between repository and Franklin Lake Playa, going into carbonate aquifer including coring and water samples.

4. Lab tests for cathodic protection.

5. Lab tests for flow and transport perforation in waste package.

6. Lab tests manufacturing / materials for drip shield.

7. In-drift test with heat / introducted materials for geochemistry.

8. Lab tests for cladding degradation.

9. E - W drift to high flux area to measure seepage into drifts.

Jim Houseworth
04/18/97 03:33 PM

To: James Beyer@CRWMS
cc: David Sevougian@CRWMS, Eric Smistad@CRWMS, Abe VanLuik@CRWMS, mlwilso@nwer.sandia.gov at PMDFPO @ YMPGATE, jhgauth@nwer.sandia.gov at PMDFPO @ YMPGATE, gebarr@nwer.sandia.gov at PMDFPO @ YMPGATE, Robert Andrews@CRWMS, hadocke@nwer.sandia.gov at PMDFPO @ YMPGATE, Ralph Rogers@CRWMS, Robert Sandifer@CRWMS, Michael Voegele@CRWMS
Subject: Development summary and optimal configuration

The attached files contain the PA working groups development summary information (in the file config4.wpd) and our optimal configuration (in the file optcnfg.wpd). The development summary information contains new text on preferred/alternate sources, rationale, and risks. Note that statements for risk were only generated for the highest ranked criteria, primarily due to a lack of time. The optimal configuration items are listed in order of their rank (which is indicated in the configuration element column). The configuration element column also includes a correlation with the Waste Isolation Strategy hypotheses, designated as WIS #1, etc.

Some comments concerning an east-west drift and its ranking on our optimal configuration list may be of interest. Information derived from an east-west drift may provide some valuable information, although it is not the highest priority information for performance assessment. However, the fact that an east-west drift ranked last on our optimal configuration list is also due to our perception that its cost would result in not being able to do many of the other items on the list. In short, even though an east-west drift could be used to provide some useful information, the general opinion is that it is not cost-effective.

CONFIG4 OPTCNFG

2) unexposed faults?

Benefit: Identification and characterization of potential fast pathways. This is of limited importance to PA. This is because we don't expect fault zones to be important for transporting significant quantities of radionuclides to the water table.

Preferred/Alternate Sources: An east-west drift through the repository block. Alternative source is an east-west drift below the repository block.

Rationale: The fault structures generally run north/south so an east-west drift would have a greater chance of intercepting unexposed faults. The location at the potential repository block would have the most application for identifying fast aqueous radionuclide pathways to the water table. Excavations below the repository horizon would also be applicable for identifying fast aqueous radionuclide pathways.

Risks:

3) hydrologic properties, fracture properties and geotechnical properties in and near faults?

Benefit: Bound the role of faults as potential pathways for radionuclides in the unsaturated zone and their role in the saturated zone as preferential pathways or barriers to flow and transport. This is of limited importance to PA. The role of faults in the unsaturated zone only becomes important if focusing of flow can divert a large portion of this percolation flux throughout the repository into fault zones. The diversion of UZ flow into fault zones is not strongly dependent on the hydrologic properties of the fault zones. The current assumption for the SZ is that fractures, including those in faults control the flow and that the SZ has a well-connected fracture system. The relative behavior of SZ transport through more highly fractured areas, such as fault zones, is more important.

Preferred/Alternate Sources: In the unsaturated zone, the preferred sources are the Ghost Dance and Sundance Faults. The Solitario Canyon Fault is an alternate source. In the saturated zone, the Solitario Canyon Fault is the preferred source.

Rationale: The type of excavation, borehole or drift, depends on what type delivers hydrologic properties more reliably. While all of the faults mentioned above are close to potential waste emplacement, the Ghost Dance and Sundance Faults are also downdip of the primary potential repository block. The downdip location is believed to be a more likely radionuclide pathway due to the expected direction of flow diverted laterally along stratigraphic contacts. Such diversion is an essential component of substantial radionuclide movement through fault zones.

Risks:

5) the age and distribution of perched water?

Benefit: Determine transport rate and direction through the unsaturated zone. This is of moderate importance to PA. If properly interpreted, it may provide important information about flow distribution between fractures and matrix, transport times through the UZ, and lateral diversion.

Preferred/Alternate Sources: This would clearly require sampling from perched water bodies, which primarily have been found at or below the TSw/CHn interface. The preferred source is new boreholes or drifts. Existing boreholes are an alternative source. Geophysical mapping may be a useful technique to define the extent of perched water.

Rationale: New boreholes or drifts are preferred to help extend the existing spatial characterization of perched water. Further characterization of the spatial distribution and geochemical character of perched water is desired for interpretation of unsaturated zone flow and transport issues.

Risks:

6) alternative conceptual models of perched water formation?

Benefit: Determine if perched water bodies grow or deplete under future climate conditions and the transport characteristics for radionuclides migrating through perched water bodies. This is of moderate importance to PA. Evaluation of the conceptual models are important for interpretation of perched water data. Given a valid conceptual model, the perched water data may provide important information about flow distribution between fractures and matrix, transport times through the UZ, and lateral diversion.

Preferred/Alternate Sources: This requires modeling the hydrologic and geochemical evolution of perched water to see if different conceptual models can be supported or refuted based on perched water data.

Rationale: Testing of conceptual models requires theoretical predictions based on the different conceptual models to be compared with field data.

Risks:

8) the age and genesis of fracture filling materials?

Benefit: Provides information on past flow paths through the unsaturated zone. This is of limited importance to PA. It could potentially be useful for UZ flow and transport model calibration.

Preferred/Alternate Sources: This requires taking samples of fractured rock for examination of the secondary mineral deposits. Sampling from a drift is preferred, with a borehole program being an alternative method. Sampling in the western portion of the potential repository block is preferred, where limited information is currently available. Sampling from other areas and in other geologic units would be alternate sources.

Rationale: More extensive sampling and visual inspection is possible from a drift than borehole core, therefore sampling from a drift is preferred. Sampling in the potential repository block will provide information useful for conceptual models of water entering potential emplacement drifts. Very limited amounts of data have been taken from the western portion of the block and, therefore, would derive a greater benefit from enhanced characterization.

Risks:

9) the distribution of environmental isotopes from systematic and feature based samples?

Benefit: Determine the extent of fast transport pathways through nonwelded units under ambient conditions. Estimate the potential for lateral diversion of water and/or radionuclide pathways in the unsaturated zone. This is very important to PA. This data is expected to provide valuable information concerning fracture/matrix interaction for transport processes that can be used to help estimate model parameters for this important, but poorly constrained, characteristic of unsaturated zone transport.

Preferred/Alternate Sources: Measurements of environmental tracers (including chloride and various stable and radioactive isotopes) in the nonwelded layers from additional vertical boreholes. Of particular interest are data from PTn in areas identified as having high infiltration (e.g., along Yucca Crest). Sampling from the CHn and perched water zones are also important.

Rationale: Environmental tracers give important information relating to flow and transport pathways through the mountain, and thus they are needed below the repository in the Calico Hills to help define what pathways radionuclides will follow. The importance of data from PTn in high-infiltration areas is to distinguish between models of unsaturated-zone flow and transport. All chloride concentrations measured in PTn to date have been very high (in particular, much higher than the values measured for perched water). The assumption is being made in the standard UZ model that these high chloride concentrations are not representative of the PTn as a whole, and chloride concentrations should be lower where infiltration is high. This assumption needs to be tested. The results will provide information about the distribution of fast paths through PTn. Dating the ages of water found in the CHn vitric zone is also important for establishing the proper conceptual model for fracture/matrix interaction in this zone.

Risks: The risk is high because the confidence in these models is currently low due to of the lack of this type of calibration data.

10) spatial and temporal distribution of infiltration flux?

Benefit: Incorporate the spatial and temporal variability of percolation flux in flow and transport modeling for performance predictions. This is potentially very important to PA if the spatial or temporal variations are large enough. Percolation flux has been identified as one of the most important parameters in TSPA-95.

Preferred/Alternate Sources: Information that can be used to define the spatial distribution of infiltration flux requires data taken at the site surface and from boreholes drilled to the top of TSw. Better information for areas of high infiltration flux are of most interest.

Rationale: Vertically distributed data is preferred for interpreting infiltration due to the expected preferential movement of infiltration in the vertical direction. Horizontally distributed data from drifting through the TSw would be an alternate sampling plan.

Risks: High risk because previous TSPA's have identified percolation flux as one of the most important performance parameters.

11) fracture and matrix components of flow and transport?

Benefit: Determine fracture/matrix interaction for water flow and aqueous radionuclide transport in the unsaturated zone. This is of moderate importance to PA. In particular, the delay in transport for strong fracture/matrix transport coupling can have a large effect on performance at 10,000 years, but is less important for performance over 1,000,000 years. Fracture/matrix coupling of flow is also important for the interaction of water with the EBS.

Preferred/Alternate Sources: The primary areas of uncertainty regarding fracture/matrix components of flow and transport are in the PTn and CHnv. The preferred source of information is in the CHnv. This information would be obtained through measurement of matrix hydrologic properties of cores and air permeability tests in boreholes.

Rationale: The CHnv is the critical unit for radionuclide transport in the unsaturated zone where radionuclides may predominantly transport through matrix. The delay of radionuclide migration through this unit is substantial if matrix transport is dominant due to its relatively high matrix porosity.

Risks:

12) flow into openings?

Benefit: Define the likelihood of water contact modes with waste packages and the likelihood of advective radionuclide transport through the engineered barrier system. This is very important to PA. TSPA-95 and subsequent studies have shown that advective flow directly in contact with waste canisters is a serious detriment to performance. One of the questions surrounding this behavior is the extent to which water moving through the potential repository environment will drip into potential waste emplacement drifts.

Preferred/Alternate Sources: Close off sections of tunnel so that seepage (or lack thereof) can be observed without interference from ventilation. Use of existing tunnels (ESF main drift or side alcoves) would be preferred so that results could be obtained earlier. It is recommended that hundreds of meters of tunnel, in areas thought to have both high and low percolation fluxes, be observed without ventilation in order to obtain information on the variability of seepage. Data should be from the repository horizon. If performed in a new excavation, then the location of this new excavation should include some of the higher infiltration flux zones in the northwest portion of the block.

Rationale: The amount and distribution of seepage into emplacement drifts has been identified as key to repository performance in past TSPAs. We need direct information on this important quantity so that we have an experimental basis for our emplacement drift seepage models.

Risks: Very high. The greatest risk is in trying to go to licensing without this information. Even a null result (no observed seepage) would be valuable in constraining our models. There may be ways to get seepage information without actually blocking off the tunnel (e.g., sealing off sections of the wall or ceiling), but they would be riskier in that the drift ventilation would still be creating a dried-out region around the drift that might affect the seepage data. Because of the spatial variation of infiltration flux it is recommended that test be carried out in both existing drifts and in new drifts intercepting high infiltration flux.

15) infiltration and percolation throughout the UZ in and around faults?

Benefit: Provide estimates for levels of percolation flux and radionuclide transport parameters along faults. This is of moderate importance to PA. This is because we don't expect fault zones to be important for transporting significant quantities of radionuclides to the water table. If investigations of percolation along faults indicates that a large portion of the percolation flux is diverted to the SZ through faults, then this benefit would take on more importance.

Preferred/Alternate Sources: Preferred sources are the Ghost Dance and Sundance Faults. The Solitario Canyon Fault is an alternate source.

Rationale: The type of excavation, borehole or drift, depends on what type delivers hydrologic properties more reliably. While all of the faults mentioned above are close to potential waste emplacement, the Ghost Dance and Sundance Faults are also downdip of the primary potential repository block. The downdip location is believed to be a more likely radionuclide pathway due to the expected direction of flow diverted laterally along stratigraphic contacts. Such diversion is an essential component of substantial radionuclide movement through fault zones.

Risks:

17) flow patterns in the unsaturated zone below the repository horizon?

Benefit: Estimate the potential for lateral diversion of water and/or radionuclide pathways in the unsaturated zone. This is of moderate importance to PA. The occurrence of lateral diversion is a potentially important element of focused flow through faults in the unsaturated zone and/or mechanism for bypassing zeolites.

Preferred/Alternate Sources: The preferred source is regions above perched water bodies. Perched water bodies primarily have been found near or below the TSw/CHn interface. New boreholes are the preferred source, however, drifts or existing boreholes are alternative sources.

Rationale: Lateral diversion is perhaps most likely above perched water bodies. Boreholes are expected to be more useful for tracking spatial trends in geochemical composition. Information from new boreholes or drifts is preferred to help extend the existing spatial characterization of the unsaturated zone geochemical composition. Further characterization of the geochemical character of unsaturated zone water and spatial patterns associated with its geochemical identity is desired for interpretation of unsaturated zone flow and transport issues.

Risks:

18) the distribution and continuity of zeolitization?

Benefit: Estimate the potential for aqueous radionuclide transport through the unsaturated zone to bypass zeolites. This is of moderate importance to PA. A portion of the radionuclide inventory is known to sorb more strongly in zeolitic rock than any other rock type. Therefore zeolites can provide an important delay function for the arrival of radionuclides at the accessible environment. The continuity and extent of zeolitization can impact the effectiveness of this natural barrier.

Preferred/Alternate Sources: The preferred source of data is between the TSw vitrophyre and the water table in the southwestern portion of the block. Sampling from a drift is preferred. (Note that there is a comment suggesting a borehole sampling program as the preferred source. see comments below) A borehole sampling program is a potential alternate source.

Rationale: More extensive sampling and visual inspection is possible from a drift than borehole core, therefore sampling from a drift is preferred. The primary zone of zeolitization is between the TSw vitrophyre and the water table. The southwestern portion of the potential repository block is one area where zeolitization may be insufficient to affect radionuclide transport. Therefore, greater characterization in this area is of primary concern.

Risks:

19) the hydrochemistry of the unsaturated zone below the repository horizon?

Benefit: Estimate chemical transport parameters (e.g. adsorption and matrix diffusion) and fracture/matrix interaction. Determine the extent of fast transport pathways through nonwelded units. Estimate the potential for lateral diversion of water and/or radionuclide pathways in the unsaturated zone. This is very important to PA. This data is expected to provide valuable information concerning fracture/matrix interaction for transport processes. Fracture/matrix interaction is a very important factor affecting the arrival time of radionuclides at the water table. Model parameters for fracture/matrix interaction are currently very poorly constrained. Information about hydrochemistry both above and below the potential repository will contribute to more defensible conceptual models of flow and transport in the unsaturated zone.

Preferred/Alternate Sources: The preferred source is in the CHn and underlining units to the water table. The critical features are matrix flow in the CHnv and sorption. Sampling from boreholes is preferred.

Rationale: The primary barriers to radionuclide transport in the unsaturated zone are the CHn and Prow Pass, therefore, geochemical characterization in these units are most important. Sampling from boreholes will provide data along the expected vertical transport pathways.

Risks: High risks of not adequately characterizing the performance of the unsaturated zone natural barrier, which could result in low confidence in the modeling of radionuclide transport to the water table.

20) the location and origin of the large hydraulic gradient north of the repository block?

Benefit: Distinguish among conceptual models for the large hydraulic gradient. This is of limited importance to PA. The conceptual model of saturated zone flow that is used to describe the large hydraulic gradient could affect predictions of saturated zone flow and transport behavior, especially with climate change.

Preferred/Alternate Sources: Boreholes in the area of the large hydraulic gradient are the preferred source.

Rationale: The source needs to be able to provide information on the vertical profile of

hydraulic conditions in this area to help distinguish between competing conceptual models for this feature.
Risks:

21) dilution, mixing and flux distribution in the saturated zone?

Benefit: Estimate physical transport parameters, including flow rate, velocity, and dispersion, for the saturated zone. This is very important to PA. The current characterization of the saturated zone is sparse. TSPA-95 found that performance over 1,000,000 years is very sensitive to dilution in the saturated zone.

Preferred/Alternate Sources: The Southern Tracer Complex as planned. Also, measurements of hydraulic and transport characteristics in packed-off zones in existing or new deep boreholes.

Rationale: With the change to a dose-based standard for Yucca Mountain, more-detailed characterization of the saturated zone is needed. In particular, the amount of dilution in the saturated zone has been identified in past TSPAs as important to repository performance when a dose-based standard is used. The location of the Southern Tracer Complex has been defined so that it is on the primary transport pathway away from the repository, as determined by saturated-zone models.

Risks: High risk of not adequately characterizing dilution and mixing in the saturated zone which could lead to unrealistic estimates of dose.

22) the hydrochemistry of the saturated zone?

Benefit: Estimate chemical transport parameters (e.g. adsorption and matrix diffusion), mineral distributions, and fracture/matrix interaction for the saturated zone. Determine sources of water and flow paths throughout the saturated zone. This is very important to PA. In addition to the information hydrochemistry may provide concerning the dilution resulting from the mixing of different regional groundwater flows, the partitioning of radionuclide species between a mobile aqueous phase and an immobile precipitate is dependent on hydrochemistry.

Preferred/Alternate Sources: Measurement of water chemistry and environmental tracers in packed-off zones in existing or new deep boreholes. New boreholes are preferred, in which drilling and sampling disturbances to the natural geochemical condition are minimized. Analysis of the data, and comparison of data for several boreholes, will give information on flow, mixing, and matrix diffusion in the saturated zone.

Rationale: With the change to a dose-based standard for Yucca Mountain, more-detailed characterization of the saturated zone is needed. In particular, the amount of dilution in the saturated zone has been identified in past TSPAs as important to repository performance when a dose-based standard is used. The NRC staff have also recommended collecting and analyzing this type of data.

Risks: High risk of not adequately characterizing transport characteristics in the saturated zone which could lead to unrealistic estimates of dose. This includes the transport properties of weakly and/or strongly sorbing radionuclides whose retardation can be strongly affected by SZ hydrochemistry in various stratigraphic units such as the tuff, carbonates, and alluvium.

26) transport through a perforated waste package to see if radionuclide releases from waste packages can occur through the initial pinhole perforations?

Benefit: Bound the potential for radionuclide releases from waste packages through the initial pinhole perforations. This is very important to PA. Performance assessment calculations have shown that the capillary characteristics of the pinhole perforations are important for determining the water contact mode with the waste. Advective water contact and radionuclide mobilization out of the waste package seriously degrade performance in comparison with diffusive-limited radionuclide mobilization. Furthermore, the effects of corrosion products in the perforations may also have an important effect on diffusion processes for radionuclide movement out of the waste package.

Preferred/Alternate Sources: Laboratory testing is the preferred source.

Rationale: The characterization of water flow and radionuclide transport through corrosion pits can be most effectively studied in controlled experiments in a laboratory.

Risks: High risk of not being able to take credit in the EBS model for preventing drips from contacting the waste form.

27) in-drift water movement in the presence of a drip shield to better define the effects of such a barrier on water contact with waste packages and its potential effect on radionuclide releases?

Benefit: Estimate the effectiveness of such a barrier on water contact with waste packages and its potential effect on radionuclide releases. This is very important to PA. The drip shield is an EBS component that is intended to prevent advective water contact with the waste package. TSPA-95 and subsequent studies have shown that advective flow directly in contact with waste canisters is a serious detriment to performance.

Preferred/Alternate Sources: Controlled laboratory experiments are the preferred source. In-situ testing in underground drifts is an alternate source. The tests would investigate the methods of manufacturing, emplacement, and materials; the long term robustness; and the alternate water contact modes that may occur.

Rationale: The characterization of the barrier's effectiveness for long times can be most effectively studied in controlled experiments in a laboratory. An alternative source would be tests performed in an underground drift.

Risks: High risk of not being able to understand conditions that could effect the design and manufacturing of the drip shield to determine its effectiveness in preventing advective water contact with the waste package.

28) cathodic protection to better define the effects on waste package corrosion?

Benefit: Bound the potential improvement for waste package corrosion. This is very important to PA. Recent performance assessment calculations have shown that cathodic protection can significantly improve performance.

Preferred/Alternate Sources: Controlled laboratory experiments are the preferred source. In-situ testing in underground drifts is an alternate source.

Rationale: The characterization of cathodic protection for long times can be most effectively studied in controlled experiments in a laboratory. An alternative source would be tests performed in an underground drift.

Risks: The risk of not having this information is that the design and manufacturing may not be adequate to assure that this process can be included and defended in the Licensing Safety case.

29) the geochemical environment in the drifts (including the interaction with cement) to better define conditions affecting radionuclide solubilities and waste package corrosion?

Benefit: Bound the geochemical conditions that may affect radionuclide solubilities and waste package corrosion. This is very important to PA. Currently, the geochemical conditions and their effects on radionuclide solubilities and waste package corrosion are poorly constrained. The drift geochemical environment could alter solubilities (and therefore, release) by several orders of magnitude.

Preferred/Alternate Sources: The preferred source is an in-drift test with heat, cement, degraded waste package material, and pristine waste package material. This could be in combination with current drift-scale heater test or on additional test. Alternate source would be lab measurements of thermochemical data (e.g. solubilities) and dissolution rates under different water composition and heating scenarios.

Rationale: Performance assessment calculations will rely on emprical tests and data, but will also need data on more fundamental parameters for predictions using theoretical geochemical models.

Risks: High risk of not bounding the uncertainty on the rate of waste form and waste package degradation.

30) the effects of EBS materials and waste heat on the geochemical environment outside the drift to better define the influence of the altered zone on radionuclide transport characteristics (solubilities, sorption, colloidal interactions) in the unsaturated zone?

Benefit: Bound changes to radionuclide transport characteristics (solubilities, sorption, colloidal interactions) in the unsaturated zone due to repository-perturbed conditions. This is of moderate importance to PA. The extent to which geochemical alteration can extend through the unsaturated zone affecting radionuclide transport is poorly constrained.

Preferred/Alternate Sources: This topic is most readily addressed through laboratory investigations for thermochemical data.

Rationale: The expected method to address problems associated with the geochemical alteration due to repository-perturbed conditions is through geochemical models.

Risks:

New) the effects of cladding on radionuclide dissolution and mobilization?

Benefit: Estimate the effectiveness of cladding for reduction in radionuclide dissolution and mobilization. This is very important to PA. Recent performance assessment calculations have shown that cladding may have an important role in reducing the rate of radionuclide dissolution and mobilization. However, existing data to support cladding degradation models primarily rely on results from short-term dry storage conditions which lack the environmental conditions that the cladding may encounter for longer times in the potential repository environment.

Preferred/Alternate Sources: Controlled laboratory experiments are the preferred source.

Rationale: The characterization of radionuclide dissolution and mobilization through cladding can be most effectively studied in controlled experiments in a laboratory.

Risks: High risk of not being able to take credit for cladding performance.

Configuration Element	Preferred Source Cross Ref.	Alternate Source Cross Ref.	Rationale Summary
	# rank	# rank	
use of existing drifts Rank: 1 WIS #3 WIS #4	12 [1] 15 [13] 3 [19]	8 [20]	The amount and distribution of seepage into emplacement drifts has been identified as key to repository performance in past TSPAs (12). We need direct information on this important quantity so that we have an experimental basis for our emplacement drift seepage models. Other, lower ranked, benefits of existing drifts address hydrologic characterization of the Ghost Dance/Sundance Faults (3, 15) and age/genesis studies of fracture-filling materials (8). The greatest risk is in trying to go to licensing without this information. Even a null result (no observed seepage) would be valuable in constraining our models.

two cored boreholes (minimum) in the southern and western portions of repository block into the saturated zone Rank: 2 WIS #1 WIS #2 WIS #5 WIS #10 WIS #11 WIS #12	9 [2, 4] 21 [3] 22 [3] 19 [4] 10 [6] 5 [11] 11 [14] 17 [15] 9 [19]	15 [13] 18 [17]	Boreholes thorugh the repository block can provide a variety of information. The highest ranking benefits concern hydrochemistry and environmental tracers in the unsaturated zone (9, 19). Environmental tracers give important information relating to flow and transport pathways through the mountain, and thus they are needed below the repository in the Calico Hills to help define what pathways radionuclides will follow. The importance of data from PTn in high-infiltration areas is to distinguish between models of unsaturated-zone flow and transport. The risk of not having this data is high because the confidence in these models is currently low due to of the lack of this type of calibration data. Also, high-ranking benefits include characterization of the saturated zone (20,21). With the change to a dose-based standard for Yucca Mountain, more-detailed characterization of the saturated zone is needed. In particular, the amount of dilution in the saturated zone has been identified in past TSPAs as important to repository performance when a dose-based standard is used. The NRC staff have also recommended collecting and analyzing this type of data. With regard to infiltration flux (10), previous TSPA's have identified percolation flux as one of the most importan performance.

southern tracer complex plus four additional cored boreholes (minimum) between the repository block and Franklin Lake Playa that go into the carbonate aquifer Rank: 3 WIS #10 WIS #11 WIS #12	21 [3] 22 [3]		With the change to a dose-based standard for Yucca Mountain, more-detailed characterization of the saturated zone is needed. In particular, the amount of dilution in the saturated zone has been identified in past TSPAs as important to repository performance when a dose-based standard is used. The location of the Southern Tracer Complex has been defined so that it is on the primary transport pathway away from the repository, as determined by saturated-zone models. Without additional information, there is a high risk of not adequately characterizing dilution and mixing in the saturated zone and transport characteristics in the saturated zone, which could lead to unrealistic estimates of dose. This includes the transport properties of weakly and/or strongly sorbing radionuclides whose retardation can be strongly affected by SZ hydrochemistry in various stratigraphic units such as the tuff, carbonates, and alluvium.

laboratory testing (cathodic protection) Rank: 4 WIS #7 WIS #8	28 [5]		The characterization of cathodic protection for long times can be most effectively studied in controlled experiments in a laboratory. An alternative source would be tests performed in an underground drift. The risk of not having this information is that the design and manufacturing may not be adequate to assure that this process can be included and defended in the Licensing Safety case.
laboratory testing (flow and transport through waste corrosion pits in waste package) Rank: 5 WIS #10	26 [7]		The characterization of water flow and radionuclide transport through corrosion pits can be most effectively studied in controlled experiments in a laboratory. Without addtional data, there is a high risk of not being able to take credit in the EBS model for preventing drips from contacting the waste form. The difference in drips on waste form compared with drips on waste package has been shown to be very important to performance predictions.
laboratory testing (drip shield) Rank: 6 WIS #10	27 [8]		The characterization of the barrier's effectiveness for long times can be most effectively studied in controlled experiments in a laboratory. Without addtional data, there is a high risk of not being able to understand conditions that could effect the design and manufacturing of the drip shield and to determine its effectiveness in preventing advective water contact with the waste package.

in-drift testing of geochemical environment Rank: 7 WIS #7 WIS #8 WIS #9	29 [9]		Performance assessment calculations will rely on emprical tests and data of the in-drift geochemical environment. Without addtional data, there is a high risk of not bounding the uncertainty on the rate of waste form and waste package degradation.
laboratory testing (cladding) Rank: 8 WIS #9 WIS #10	--- [10]		The characterization of radionuclide dissolution and mobilization through cladding can be most effectively studied in controlled experiments in a laboratory. Without additional data, there is a high risk of not being able to take credit for cladding performance.
laboratory testing (thermochemical data (e.g. solubilities) and dissolution rates under different water composition and heating scenarios) Rank: 9 WIS #7 WIS #8 WIS #9		29 [9]	The treatment of the in-drift geochemical environnment will also need data to establish geochemical parameters for predictions using theoretical geochemical models. Without addtional data, there is a high risk of not bounding the uncertainty on the rate of waste form and waste package degradation.

east-west drift to high infiltration flux areas and Solitario Canyon Fault Rank: 10 WIS #3 WIS #4	8 [20] 2 [21]	12 [1] 10 [6]	If seepage into drifts testing is performed in a new excavation, then the location of this new excavation should include some of the higher infiltration flux zones in the northwest portion of the block. Because of the spatial variation of infiltration flux it is recommended that test be carried out in both existing drifts and in new drifts intercepting high infiltration flux.

Jim Houseworth
04/23/97 01:59 PM

To: James Beyer@CRWMS
cc:
Subject: Configuration picks for criterion 6, 10, and 11

For criterion 6, conceptual models of perched water, the configuration should be the same as for criterion 5), cored boreholes to the water table in the repository block.

For criterion 10, the preferred configuration is cored boreholes in high infiltration flux areas of the repository block to the top of the TSw.

For criterion 11, the preferred configuration is cored boreholes to the water table in the repository block.

Jim Houseworth
04/23/97 02:41 PM

To: James Beyer@CRWMS
cc:
Subject: Re: Configuration picks for criterion 6, 10, and 11

I believe the crest boreholes would be sufficient.

To: Jim Houseworth
cc:
From: James Beyer
Date: 04/23/97 02:13:01 PM
Subject: Re: Configuration picks for criterion 6, 10, and 11

Would the Northern & Southern Crest boreholes satisfy 10 & 11 or is something else needed?

To: James Beyer
cc:
From: Jim Houseworth
Date: 04/23/97 01:59:24 PM
Subject: Configuration picks for criterion 6, 10, and 11

For criterion 6, conceptual models of perched water, the configuration should be the same as for criterion 5), cored boreholes to the water table in the repository block.

For criterion 10, the preferred configuration is cored boreholes in high infiltration flux areas of the repository block to the top of the TSw.

For criterion 11, the preferred configuration is cored boreholes to the water table in the repository block.

Mitchell Brodsky
04/29/97 03:54 PM

To: James Beyer@CRWMS
cc: Daniel McKenzie@CRWMS, Ralph Rogers@CRWMS, Ned Elkins@CRWMS, BILL KENNEDY
Subject: Re: Another EW drift issue

FYI

-------------------- Forwarded by Mitchell Brodsky on 04/29/97 03:51 PM --------------------

Jim Houseworth
04/28/97 04:45 PM

To: Abe VanLuik
cc: Mitchell Brodsky, Eric Smistad, Peter Hastings
Subject: Re: Another EW drift issue

The evaluation of an enhanced characterization drift with respect to limiting adverse effects on site performance is qualitatively part of the planning process, but the actual DIE which defines specific restrictions can only be done after the planning. The reason we can't do the analyses sooner (say as part of the planning process) is that the planning process will identify the specific configuration (i.e. location for a drift), and further details of materials use will be fleshed out in the actual design. We really can't do an evaluation until we have these important details. In the case of water, we can be sure that water will be used and that some losses will occur, so the important information needed to evaluate water use is the location of the drift relative to the potential repository and geologic features. It is my understanding that the results of the DIE (including waste isolation/test interference analyses) will be considered as part of the constructor's contract.

The subject of water use has come up in our ECRB planning meetings and everyone is aware of the issue. However, differences in potential restrictions on water use (which are unknown at this time) have not played a part in defining the configuration of an enhanced characterization drift. We have begun to plan cost and schedule for DIE support of enhanced characterization activities, including the required support from PA for waste isolation analyses.

To: Jim Houseworth
cc: Mitchell Brodsky, Eric Smistad
From: Abe VanLuik
Date: 04/28/97 03:36:16 PM
Subject: Re: Another EW drift issue

Jim, I have a request for an up front, once for all determination of prudent and reasonable water use limits for the EW drift. The idea is to not impede the constructor by unnecessary limits on his modus operandi. Is this being considered as part of the planning or will this be considered as part of the constructor's contract?

Has anyone in any of your meetings considered or brought this question up? Woulkd you be so kind as to raise it at some appropriate time?

Sooner or later the DIE/WIE/TIE process has to be brought onto the scene, and it would be good to do it once, and definitively, and put it in as a constraint as part of the constructor's contract i think. We don't want to revisit the issue, and change the rules, once the constructor starts constructing the tunnel. --abe--

Jim Houseworth
04/29/97 04:16 PM

To: James Beyer@CRWMS
cc: David Sevougian@CRWMS, Eric Smistad@CRWMS, Abe VanLuik@CRWMS, mlwilso@nwer.sandia.gov at PMDFPO @ YMPGATE, jhgauth@nwer.sandia.gov at PMDFPO @ YMPGATE, gebarr@nwer.sandia.gov at PMDFPO @ YMPGATE, Robert Andrews@CRWMS, hadocke@nwer.sandia.gov at PMDFPO @ YMPGATE, Ralph Rogers@CRWMS, Robert Sandifer@CRWMS, Michael Voegele@CRWMS
Subject: Revised optimal configuration

In a memo dated 04/18/97, the PA working group identified and ranked ten different configuration elements considered for enhanced characterization. With respect to a configuration element called the east-west drift, the following comment was made:

"Some comments concerning an east-west drift and its ranking on our optimal configuration list may be of interest. Information derived from an east-west drift may provide some valuable information, although it is not the highest priority information for performance assessment. However, the fact that an east-west drift ranked last on our optimal configuration list is also due to our perception that its cost would result in not being able to do many of the other items on the list. In short, even though an east-west drift could be used to provide some useful information, the general opinion is that it is not cost-effective."

The PA working group was subsequently asked to give an opinion on the ranking of the east-west drift relative to other enhanced characterization configuration elements based entirely on the technical merit of the data that could be obtained, without regard to cost. The PA working group found that the east-west drift moved from tenth (last) to sixth on the ranked list of optimal configuration elements. This new ranked list is given in the attached file.

OPTCNFG

Configuration Element	Preferred Source Cross Ref.	Alternate Source Cross Ref.	Rationale Summary
	# rank	# rank	
use of existing drifts Rank: 1 WIS #3 WIS #4	12 [1] 15 [13] 3 [19]	8 [20]	The amount and distribution of seepage into emplacement drifts has been identified as key to repository performance in past TSPAs (12). We need direct information on this important quantity so that we have an experimental basis for our emplacement drift seepage models. Other, lower ranked, benefits of existing drifts address hydrologic characterization of the Ghost Dance/Sundance Faults (3, 15) and age/genesis studies of fracture-filling materials (8). The greatest risk is in trying to go to licensing without this information. Even a null result (no observed seepage) would be valuable in constraining our models.

two cored boreholes (minimum) in the southern and western portions of repository block into the saturated zone Rank: 2 WIS #1 WIS #2 WIS #5 WIS #10 WIS #11 WIS #12	9 [2, 4] 21 [3] 22 [3] 19 [4] 10 [6] 5 [11] 11 [14] 17 [15] 9 [19]	15 [13] 18 [17]	Boreholes thorugh the repository block can provide a variety of information. The highest ranking benefits concern hydrochemistry and environmental tracers in the unsaturated zone (9, 19). Environmental tracers give important information relating to flow and transport pathways through the mountain, and thus they are needed below the repository in the Calico Hills to help define what pathways radionuclides will follow. The importance of data from PTn in high-infiltration areas is to distinguish between models of unsaturated-zone flow and transport. The risk of not having this data is high because the confidence in these models is currently low due to of the lack of this type of calibration data. Also, high-ranking benefits include characterization of the saturated zone (20,21). With the change to a dose-based standard for Yucca Mountain, more-detailed characterization of the saturated zone is needed. In particular, the amount of dilution in the saturated zone has been identified in past TSPAs as important to repository performance when a dose-based standard is used. The NRC staff have also recommended collecting and analyzing this type of data. With regard to infiltration flux (10), previous TSPA's have identified percolation flux as one of the most importan performance.

southern tracer complex plus four additional cored boreholes (minimum) between the repository block and Franklin Lake Playa that go into the carbonate aquifer Rank: 3 WIS #10 WIS #11 WIS #12	21 [3] 22 [3]		With the change to a dose-based standard for Yucca Mountain, more-detailed characterization of the saturated zone is needed. In particular, the amount of dilution in the saturated zone has been identified in past TSPAs as important to repository performance when a dose-based standard is used. The location of the Southern Tracer Complex has been defined so that it is on the primary transport pathway away from the repository, as determined by saturated-zone models. Without additional information, there is a high risk of not adequately characterizing dilution and mixing in the saturated zone and transport characteristics in the saturated zone, which could lead to unrealistic estimates of dose. This includes the transport properties of weakly and/or strongly sorbing radionuclides whose retardation can be strongly affected by SZ hydrochemistry in various stratigraphic units such as the tuff, carbonates, and alluvium.

laboratory testing (cathodic protection) Rank: 4 WIS #7 WIS #8	28 [5]		The characterization of cathodic protection for long times can be most effectively studied in controlled experiments in a laboratory. An alternative source would be tests performed in an underground drift. The risk of not having this information is that the design and manufacturing may not be adequate to assure that this process can be included and defended in the Licensing Safety case.
laboratory testing (flow and transport through waste corrosion pits in waste package) Rank: 5 WIS #10	26 [7]		The characterization of water flow and radionuclide transport through corrosion pits can be most effectively studied in controlled experiments in a laboratory. Without addtional data, there is a high risk of not being able to take credit in the EBS model for preventing drips from contacting the waste form. The difference in drips on waste form compared with drips on waste package has been shown to be very important to performance predictions.
east-west drift to high infiltration flux areas and Solitario Canyon Fault Rank: 6 WIS #3 WIS #4	8 [20] 2 [21]	12 [1] 10 [6]	If seepage into drifts testing is performed in a new excavation, then the location of this new excavation should include some of the higher infiltration flux zones in the northwest portion of the block. Because of the spatial variation of infiltration flux it is recommended that test be carried out in both existing drifts and in new drifts intercepting high infiltration flux.

laboratory testing (drip shield) Rank: 7 WIS #10	27 [8]		The characterization of the barrier's effectiveness for long times can be most effectively studied in controlled experiments in a laboratory. Without addtional data, there is a high risk of not being able to understand conditions that could effect the design and manufacturing of the drip shield and to determine its effectiveness in preventing advective water contact with the waste package.
in-drift testing of geochemical environment Rank: 8 WIS #7 WIS #8 WIS #9	29 [9]		Performance assessment calculations will rely on emprical tests and data of the in-drift geochemical environment. Without addtional data, there is a high risk of not bounding the uncertainty on the rate of waste form and waste package degradation.
laboratory testing (cladding) Rank: 9 WIS #9 WIS #10	--- [10]		The characterization of radionuclide dissolution and mobilization through cladding can be most effectively studied in controlled experiments in a laboratory. Without additional data, there is a high risk of not being able to take credit for cladding performance.

laboratory testing (thermochemical data (e.g. solubilities) and dissolution rates under different water composition and heating scenarios) Rank: 10 WIS #7 WIS #8 WIS #9		29 [9]	The treatment of the in-drift geochemical environnment will also need data to establish geochemical parameters for predictions using theoretical geochemical models. Without addtional data, there is a high risk of not bounding the uncertainty on the rate of waste form and waste package degradation.

Jim Houseworth
04/30/97 10:59 AM

To: James Beyer@CRWMS
cc:
Subject: Re: ECRB Configuration Ranking

There are two configurations in the PA list that I don't see on your list. These are the additional boreholes outside the block that go into the carbonate aquifer, located somewhere between the repository block and Franklin Lake Playa. These boreholes were combined with the Southern Tracer Complex in the PA configuration list (our #3 configuration). We also list testing for flow into drifts in the existing ESF (our #1 configuration), which includes more than the Thermal Testing Facility and Ghost Dance Fault alcoves you have on your list.

To: Ken Ashe, Ned Elkins, Peter Hastings, Jim Houseworth, William Kennedy
cc: Ralph Rogers
From: James Beyer
Date: 04/30/97 10:38:18 AM
Subject: ECRB Configuration Ranking

Please provide any corrections that you may have to intitial configuration compilation that I did. I know Bill indicated he had some that I didn't get.

Thanks