Lawrence Livermore National Laboratory

LLYMP9405082
May 18, 1994

WBS 1.2.9
QA: N/A

Robert M. Nelson, Jr., Acting Project Manager
Yucca Mountain Site Characterization Office
Department of Energy
P.O. Box 98518
Las Vegas, Nevada 89193-8518

I-357626

SUBJECT: Yucca Mountain Project Status Report - April 1994
SCP: N/A

Attached is the April Project Status Report for LLNL's participation in the Yucca Mountain Project.

If further information is required, please contact Carol Passos at 702-794-7511 or Jim Blink at 702-794-7157.

Sincerely,

W.L. Clarke
LLNL Technical Project Officer
for YMP

WC/CP

cc: Distribution

DISCLAIMER

The LLNL Yucca Mountain Project cautions that any information is preliminary and subject to change as further analyses are performed or as an enlarged and perhaps more representative data base is accumulated. These data and interpretations should be used accordingly.

9408160215 940810
PDR WASTE
WM-11 PDR

ENCLOSURE 5

Recycled

LAWRENCE LIVERMORE NATIONAL LABORATORY
(LLNL)
YUCCA MOUNTAIN PROJECT (YMP) STATUS REPORT

April 1994

EXECUTIVE SUMMARY
(Items Proposed for Reporting in YMSCO or OGD Reports)

1) WBS 1.2.1.5, Special Studies: The temperature and relative humidity conditions at various repository locations, for an areal mass loading of 70 metric tons of uranium per acre, were examined for a youngest fuel first (10 year cutoff) receipt scenario and 21 PWR spent fuel assemblies per waste package. The calculations are based on the smeared-heat-source, repository-scale model; consequently, the relative humidity values are applicable to average liquid saturation conditions. Because 70% relative humidity approximately corresponds to a liquid saturation of 0.13, it does not require very much re-wetting to attain this value of relative humidity. Had a discrete representative of waste packages been done, the local liquid saturation conditions surrounding the emplacement drift would generally be drier than the average saturation conditions. In that regard, the repository-scale model indicates a relative humidity that is wetter than the local value of relative humidity in the emplacement drift. Thermo-hydrological heterogeneity and variability in the heat output among the waste packages will also cause local behavior to deviate from average behavior. The results indicate that 50% of the repository area will be below 70% relative humidity for over 3,000 years, but the temperature will still be 91°C when the humidity returns. For the outer edge of the repository, the relative humidity returns to 70% in 80 years when the temperature is 107°C.

2) WBS 1.2.2.3.1.1, Waste Form Testing - Spent Fuel: At a technical exchange meeting at LLNL on April 6-7 involving staff from PNL, ANL, LLNL and Canada the following three dissolution activities were scheduled to be conducted at PNL under LLNL sponsorship: 1) Flow-through tests will be started, as previously planned, on oxidized U_4O_{9+x} and unoxidized ATM-104 (PWR) spent fuel specimens after replacement of the liquid waste tank. 2) Flow-through tests on ATM-103 (PWR) spent fuel at low pH (3 to 6) will be started for comparison with results from drip tests being conducted at Argonne National Laboratory (ANL). The low pH results will also supplement results from flow-through tests that were conducted earlier with ATM-103 spent fuel at pH 8 to 10. 3) Measurements of gap inventories and grain-boundary inventories of ^{129}I will be repeated for a few spent fuel specimens using a technique that was found to be successful at Whiteshell Laboratory in Canada. The results will be compared with those summarized in last month's report. If the results obtained from using the Canadian technique are much different from the earlier test results, additional repeat measurements using the new technique may be required.

3) WBS 1.2.2.3.1.1, Waste Form Testing - Spent Fuel: Uranium release results from previous testing intervals (exclusive of the present eight to nine year old

samples) have been analyzed for the UO_2 drip tests. The majority of the tests are characterized by a period of rapid uranium release between one and two years of reaction. Uranium release rates during this interval ranged up to 14 $mg \bullet m^{-2} \bullet d^{-1}$ with most of this release being attributed to the spallation of UO_2 granules from the sample surface. The final analysis for sample PMP8U-8 indicates a normalized release of 56 $mg \bullet m^{-2} \bullet d^{-1}$, but this high value is believed to arise from the dissolution of secondary uranyl minerals during the final overnight acid strip of the test vessel components. These secondary phases appeared to be deposited on the Teflon stand throughout the duration of this test. Subsequent to the rapid release period, release rates for most tests decreased to an average of approximately 0.15 to 0.30 $mg \bullet m^{-2} \bullet d^{-1}$. This level of release has remained relatively constant throughout the duration of the remaining tests. These releases are being compared to values obtained from testing done under other reaction modes.

4) **WBS 1.2.2.3.2, Metal Barriers:** Pitting corrosion experimental techniques are being reviewed for comparison to stochastic modeling. Measurable parameters include pitting potential (by potentiostatic and potentiodynamic techniques), induction time, stochastic pit initiation, pit area, pit depth, and possible film degradation (ellipsometry and scanning tunneling microscopy, STM)

5) **WBS 1.2.2.3.5, Non-Metallic Barrier Concepts:** High quality alumina (Al_2O_3) ceramics still seem to be the most commonly available, large size technical ceramic products. There are a number of firms currently selling alumina tubing in lengths of 8-10 feet with diameters of about eight inches and a wall thickness of about 1/4". Two inches seems to be about the maximum wall thikness due to thermal transport properties during firing. Thinner is better. Other materials can be fabricated in the same size ranges, but there are significant cost disadvantages.

6) **WBS 1.2.3.12.2, Hydrologic Properties of the Waste Package Environment:** The Study Plan, 8.3.4.2.4.2 (Laboratory Determination of Hydrological Properties of the Near-field Environment has been reviewed by YMSCO. The author is resolving comments.

7) **WBS 1.2.3.12.4, Engineered Barrier System (EBS) Field Tests (Large Block Test):** A comment resolution meeting for Study Plan 8.3.4.2.4.4, (Engineered Barrier System Field Tests) is scheduled to be held on May 5, 1994.

8) **WBS 1.2.3.12.5, Characterization of the Effects of Man-Made Materials on Chemical & Mineralogical Changes in the Post-Emplacement Environment:** Study Plan 8.3.4.2.4.5 was reformatted to meet the requirements of the NRC-DOE agreement, and resubmitted to YMSCO on April 28.

9) **WBS 1.2.5.5.2, Energy Policy Act Support:** R. Van Konynenburg attended a National Academy of Sciences Committee meeting on the Technical Bases for Yucca Mountain Standards and responded to the committee's questions on carbon-14.

LLNL DELIVERABLES MET

(1994)

Milestone	WBS	Planned Date	Actual Date	Description	Comment
MOL77	1.2.3.12.4	01-31-94	04-05-94	Submittal of SP comment responses	

LLNL DELIVERABLES NOT MET

(1994)

Milestone	WBS	Planned Date	Projected Date	Description	Comment
MOL45	1.2.2.3.2	01-31-94	06-30-94	Submit updated Metal Barriers SIP	Delayed by TPR & NWTRB preparation & by Planning Workshop
MOL46	1.2.2.3.2	03-15-94	05-31-94	Submit degradation mode survey on iron-base materials to YMSCO	Draft received from subcontractor; in LLNL review
MOL03	1.2.3.10.3.1	03-31-94	05-31-94	Report on colloid characterization	Delayed by equip.malfunction related to MOL04
MOL04	1.2.3.10.3.1	01-12-94	06-30-94	Document core flow experiment protocol	Delayed by equipment malfunction
MOL26	1.2.3.12.1	03-31-94	05-27-94	Submit near-field geochemistry topical report	Delayed by TPR & NWTRB preparation
MOL75	1.2.3.12.3	03-31-94	06-30-94	Calibration of equip. for scoping exp.	Delayed by procurement and requirements coordination with the LBT
MOL91	1.2.5.4.2	03-31-94	05-31-94	Submit plan for code qualification	Individual Software Plan is currently in technical review

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: 29-APR-94

PARTICIPANT: LLNL PEM: SMITH WBS: 1.2.2.3.1.1

WBS TITLE: WASTE FORM TESTING - SPENT FUEL

P&S ACCOUNT: OL2311

FY 1994 Cumulative to Date									FY 1994 at Completion					
BCWS	BCWP	ACWP	SV	SV%	SPI	CV	CV%	CPI	BAC	EAC	VAC	VAC%	IEAC	TCPI
1036	1160	964	124	12.0	112.0	196	16.9	120.3	1785	1781	4	0.2	1484	76.5

Analysis

Cumulative Cost Variance:
The cost variance is due to two FY93 summary accounts being carried over into FY94 awaiting completion of milestones. The milestones required reports from PNL that were delayed by 30 days and as a result were not received by LLNL until mid October. These reports were immediately processed by LLNL and submitted to the Project Office for review. No actual costs were incurred but earned value was calculated upon closing of these summary accounts. These FY93 accounts were not removed during the FY93 Close-Out exercise in PACs and will continue to contribute an inaccurate $120k to both the cost and schedule variance. The correct cost variance is 76.

Cumulative Schedule Variance:
Same as above. The correct schedule variance is 4.

Variance At Complete:

Ray B. Stout May 13, '94
P&S ACCOUNT MANAGER DATE

W. L. Clarke 5/13/94
TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: 29-APR-94

PARTICIPANT: LLNL PEM: TYNAN WBS: 1.2.3.11.3

WBS TITLE: GEOPHYSICS-ESF SUPPORT SUBSURFACE GEOPHYSICAL TSTG

P&S ACCOUNT: 0L3B3

FY 1994 Cumulative to Date									FY 1994 at Completion					
BCWS	BCWP	ACWP	SV	SV%	SPI	CV	CV%	CPI	BAC	EAC	VAC	VAC%	IEAC	ICPI
142	142	42	0	0.0	100.0	100	70.4	338.1	200	100	100	50.0	59	100.0

Analysis

Cumulative Cost Variance:
Scheduled costs have not been incurred due to a delay in the procurement process ($50k). These costs are currently liens since the procurements are in progress. The remaining variance will disappear when the equipment is received, tested, and a report on capabilities is written.

Cumulative Schedule Variance:

Variance At Complete:
LLNL expects to spend all but $20k of this account (the Dep. Assistant Manager for Scienctific Programs @ YMSCO has indicated that $20k will be taken via CCB action). However, some of the funds will be used to offset a shortfall in WBS 1.2.3.5.2.2 which was onlyallocated $25k. The proper accounts will be charged; 1.2.3.11.3 will underrun and 1.2.3.5.2.2 will overrun; the total costs will be $205k, but with a different distribution than anticipated by YMSCO. These actions are by direction of the YMSCO Asst. Manager for Sci. Programs.

13 May 94 W. L. [signature] 5/13/94
P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: 29-APR-94

PARTICIPANT: LLNL PEM: SIMMONS WBS: 1.2.3.12.4

WBS TITLE: ENGINEERED BARRIER SYSTEM (EBS) FIELD TESTS

P&S ACCOUNT: 0L3C4

FY 1994 Cumulative to Date									FY 1994 at Completion					
BCWS	BCWP	ACWP	SV	SV%	SPI	CV	CV%	CPI	BAC	EAC	VAC	VAC%	IEAC	ICPI
1568	1477	1441	-91	-5.8	94.2	36	2.4	102.5	2530	2965	-435	-17.2	2468	69.1

Analysis

Cumulative Cost Variance:

Cumulative Schedule Variance:

Variance At Complete:
Variance at completion caused by current estimates for instrumentation and loading devices for the large block. The test is in a state of evolution as are the models being developed to interpret the data. Several additional channels are required in the data acquisition system. Side loading of the blocks initially was going to be accomplished by a single bladder. Complications in the fabrication of the bladder rising from the need to insert instrumentation through the bladder, forced considerations of other options. The current resolution is to achieve loading by using several bladders. This increased cost was identified and discussed during the midyear review at YMSCO.

[signature] 5/12/94 [signature] 5/13/94
P&S ACCOUNT MANAGER DATE TPO DATE

Participant LLNL	Yucca Mtn. Site Char. Project-Planning & Control System	01-Apr-94 to 30-Apr-94
	PACS Participant Work Station (PPWS)	Page - 1
Prepared - 05/12/94:07:59:05	WBS Status Sheet (WBS02)	Inc. Dollars in Thousands

WBS No.	- 1.2	WBS Manager	-
WBS Title	- YUCCA MOUNTAIN PROJECT		
Parent WBS No.	-	Parent WBS Manager	-
Parent WBS Title	-		

Statement of Work

See the current WBS Dictionary

Cost/Schedule Performance

		Current Period					FY1994 Cumulative to Date					FY1994 at Completion		
Id	Description	BCWS	BCWP	ACWP	SV	CV	BCWS	BCWP	ACWP	SV	CV	BAC	EAC	VAC
1.2.1	SYSTEMS ENGINEERING	14	14	22	0	-8	93	93	78	0	15	160	145	15
1.2.2	WASTE PACKAGE	294	292	326	-2	-34	1948	2148	1939	200	209	3445	3492	-47
1.2.3	SITE INVESTIGATIONS	499	434	489	-65	-55	3923	3840	3675	-83	165	6428	6919	-491
1.2.5	REGULATORY	118	90	87	-28	3	826	810	823	-16	-13	1482	1494	-12
1.2.9	PROJECT MANAGEMENT	100	100	116	0	-16	712	712	764	0	-52	1222	1274	-52
1.2.11	QUALITY ASSURANCE	56	56	51	0	5	379	379	316	0	63	650	635	15
1.2.12	INFORMATION MANAGEMENT	20	20	20	0	0	145	145	133	0	12	250	238	12
1.2.13	ENVIRONMENT, SAFETY, & HEA	2	2	0	0	2	15	15	3	0	12	25	13	12
1.2.15	SUPPORT SERVICES	31	31	23	0	8	222	222	166	0	56	382	374	8
Total		1134	1039	1134	-95	-95	8263	8364	7897	101	467	14044	14584	-540

Resource Distributions by Element of Cost

Fiscal Year 1994
Budgeted Cost of Work Scheduled

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
LBRHRS	8311	7436	7717	8058	7951	7801	8018	7827	8057	8029	7971	7639	94815
LABOR	765	672	676	768	732	729	728	734	732	751	729	726	8742
SUBS	109	298	264	233	315	269	218	196	241	190	132	184	2649
TRAVEL	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER	155	193	148	200	176	190	181	205	209	209	217	238	2321
CAPITAL	0	0	11	21	146	59	7	81	7	0	0	0	332
Total BCWS	1029	1163	1099	1222	1369	1247	1134	1216	1189	1150	1078	1148	14044

Participant LLNL | Yucca Mtn. Site Char. Project-Planning & Control System | 01-Apr-94 to 30-Apr-94

PACS Participant Work Station (PPWS) | Page - 2

Prepared - 05/12/94:07:59:05 | WBS Status Sheet (WBS02) | Inc. Dollars in Thousands

WBS No. - 1.2 -YUCCA MOUNTAIN PROJECT

Resource Distributions by Element of Cost

Fiscal Year 1994
Actual Cost of Work Performed

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
LBRHRS	8301	6113	5630	6247	6390	7092	7097	0	0	0	0	0	46870
LABOR	762	413	383	497	513	552	513	0	0	0	0	0	3633
SUBS	114	303	254	233	315	246	218	0	0	0	0	0	1683
TRAVEL	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER	152	385	243	355	388	452	388	0	0	0	0	0	2363
CAPITAL	0	0	11	21	138	33	15	0	0	0	0	0	218
Total ACWP	1028	1101	891	1106	1354	1283	1134	0	0	0	0	0	7897

Resource Distributions

Fiscal Year 1994	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
BCWS	1029	1163	1099	1222	1369	1247	1134	1216	1189	1150	1078	1148	14044
BCWP	1191	1081	963	1063	1838	1189	1039	0	0	0	0	0	8364
ACWP	1028	1101	891	1106	1354	1283	1134	0	0	0	0	0	7897
ETC	0	0	0	0	0	0	0	1712	1326	1292	1216	1141	6687

Fiscal Year Distribution

	Prior	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003	Future	At Complete
BCWS	11048	14044	43192	46455	35899	25532	17825	12021	8684	3594	823	705	219822
BCWP	10882	8364	0	0	0	0	0	0	0	0	0	0	
ACWP	10846	7897	0	0	0	0	0	0	0	0	0	0	
ETC	0	6687	42664	45610	34901	25892	18815	12262	9167	3624	823	705	219893

YMP PLANNING AND CONTROL SYSTEM (PACS)

MONTHLY COST/FTE REPORT

PARTICIPANT: LLNL

DATE PREPAREI 9-May-94

FISCAL MONTH/YEAR: APRIL, 1994

WBS ELEMENT	CURRENT MONTH END								FISCAL YEAR		
	ACTUAL COSTS	PARTICIPAN FTES	PARTICIPAN HOURS	SUBCONTRAC HOURS	PURCHASE COMMITMENTS	SUBCONTRACT COMMITMENTS	ACCRUED COSTS#	CAP EOP ACCURAL	APPROVED BUDGET	CURRENT FY94 AFP	CUMULATIVE COSTS
1.2.1.5	10,400	0.70	100		0	0			160,000		69,600
SUBT 1.2.1	10,400	0.70	100	0	0	0	0	0	160,000	122,061	69,600
1.2.2.1	30,900	1.30	189		68	0	0		400,000		265,900
1.2.2.2.1	62,800	2.80	437		7,499	176,000			550,000		375,600
1.2.2.2.2	82,500	2.70	590		2,292	0	0		850,000		455,700
1.2.2.2.3	24,600	0.40	77		204	0	1,800		230,000		110,200
1.2.2.2.4	121,300	5.30	937		4,183	447,119	44,900		1,650,000		940,400
1.2.2.2.5	27,700	1.40	140		20	0	11,103		248,000		157,100
1.2.2.3.1.1	453,500	0.40	44	378	1,982	250,901	641,240		1,785,000		402,800
1.2.2.3.1.2	45,400	0.20	71		330	6,043	37,500		280,000		116,200
1.2.2.3.2	72,200	4.40	677		14,370	13,704	63,750		860,000		418,700
1.2.2.3.4.1	16,600	0.90	171		1,397	0	0		390,000		156,200
1.2.2.3.4.2	21,500	0.30	57		2	0	0		300,000		97,500
1.2.2.3.5	13,500	0.70	96		0	0	0		100,000		52,200
CAPITAL EQUIP.	1,633				15,431	0		0	****	91,000	133,823
SUBT 1.2.2	974,133	20.80	3,486	378	47,778	893,767	800,293	0	7,663,000	6,217,034	3,682,323
1.2.3.1	23,000	1.00	263		0	0	0		245,000		139,700
1.2.3.4.2	32,000	1.10	273		68	0	0		381,000		191,900
1.2.3.5.2.2	17,000	0.90	12		0	0	0		25,000		46,400
1.2.3.10.1	11,200	0.40	0		0	0	0		125,000		91,300
1.2.3.10.2	9,400	0.50	104		0	0	0		125,000		147,600
1.2.3.11.3	1,200	0.10	0		36,531	0	0		200,000		20,200
CAPITAL EQUIP.	0	0.00	0		16,650	0	0		***	15,000	0
SUBT 1.2.3	93,800	4.00	652	0	53,249	0	0	0	1,101,000	933,209	637,100
1.2.5.1	16,200	0.70	142		0	0	0		150,000		80,800
1.2.5.2.2	37,700	1.80	112		0	0	0		240,000		218,200
1.2.5.3.4	22,600	1.30	199		4,608	0	0		350,000		156,900
1.2.5.3.5	4,600	0.20	27		0	0	0		50,000		25,900
1.2.5.4.2	50,300	2.80	408		1,402	0	0		660,000		323,200
1.2.5.5.2	200	0.00	8		0	0	0		20,000		6,200
CAPITAL EQUIP.	0				0	0		0	**	34,000	0
SUBT 1.2.5	131,600	6.80	896	0	6,010	0	0	0	1,470,000	1,095,437	811,200

YMP PLANNING AND CONTROL SYSTEM (PACS)

MONTHLY COST/FTE REPORT

PARTICIPANT: LLNL

DATE PREPARED: 9-May-94

FISCAL MONTH/YEAR: APRIL, 1994

WBS ELEMENT	CURRENT MONTH END: ACTUAL COSTS	PARTICIPANT FTES	PARTICIPANT HOURS	SUBCONTRACT HOURS	PURCHASE COMMITMENTS	SUBCONTRACT COMMITMENTS	ACCRUED COSTS#	CAP EQP ACCURAL	FISCAL YEAR: APPROVED BUDGET	CURRENT FY94 AFP	CUMULATIVE COSTS
1.2.9.1.2	51,200	2.90	320		176	0	0		620,000		361,800
1.2.9.2.2	54,500	3.30	767		1,058	0	49		600,000		400,600
SUBT 1.2.9	105,700	6.20	1,087	0	1,234	0	49	0	1,220,000	1,007,512	762,400
1.2.11.1	48,000	1.80	255		0	0	0		650,000		315,200
SUBT 1.2.11	48,000	1.80	255	0	0	0	0	0	650,000	609,812	315,200
										(FUNDED UNDER 1.2.16)	
1.2.12.2.2	9,100	0.20	32		0	0	0		118,000		54,600
1.2.12.2.3	12,400	0.40	20		97	0	0		134,000		78,300
SUBT 1.2.12	21,500	0.60	52	0	97	0	0		250,000	215,606	132,900
										(FUNDED UNDER 1.2.17)	
1.2.13.2.5	2,700	0.10	2		0	0	0		25,000		3,000
SUBT 1.2.13	2,700	0.10	2	0	0	0	0	0	25,000	18,750	3,000
1.2.15.2	18,200	1.90	339		99	0	0		290,000		120,100
1.2.15.3	6,700	0.10	0		0	0	0		92,000		43,600
SUBT 1.2.15	24,900	2.00	339	0	99	0	0	0	382,000	300,010	163,700
TOTAL LLNL	1,412,733	42.90	6,866	378	108,467	893,767	800,342	0	12,921,000	10,659,431	6,574,423

**** Capital equipment budgets are included in the individual WBS Elements.

Per instructions letter dated 4/27/93 V.F. Iorii to W. L. Clarke

Issues and Concerns

None at this time.

TECHNICAL SUMMARY

1.2.1. SYSTEMS ENGINEERING

1.2.1.1 Systems Engineering Coordination and Planning

No significant activities.

1.2.1.5 Special Studies

Analysis of Thermo-Hydrological Conditions in the Repository

T. Buscheck continued to support the thermal loading systems study by re-examining the repository-scale model calculations for an areal mass loadings (AML) of 70.0 MTU/acre with an emphasis on the temperature and relative humidity conditions at various locations in the repository. We assume a Youngest Fuel First SNF receipt scenario with a 10 yr cut-off for the youngest fuel (referred to as YFF 10) and account for the emplacement of BWR Waste Packages (WPs) containing 40 assemblies per WP, and PWR WPs containing 21 assemblies per WP. The waste receipt schedule was supplied by J. King of the M&O.

Table 1 summarizes the temperature and relative humidity conditions at various repository locations. The table pertains to the re-wetting period that occurs after the minimum relative humidity has been attained. The first set of columns list the time it takes to re-wet back to the indicated relative humidity and the next four columns show the temperature that occurs when the indicated relative humidity is attained. It should be emphasized that Table 1 is based on the smeared-heat-source, repository-scale model; consequently, the listed relative humidity is a value that is applicable to average liquid saturation conditions. Because 70% relative humidity approximately corresponds to a liquid saturation of 0.13, it does not require very much re-wetting to attain this value of relative humidity. Had a discrete representative of waste packages been done, we would find that the local liquid saturation conditions surrounding the emplacement drift are generally drier than the average saturation conditions. In that regard, the repository-scale model indicates a relative humidity that is wetter than the local value of relative humidity in the emplacement drift. It should also be noted that thermo-hydrological heterogeneity and variability in the heat output among the waste packages will cause local behavior to deviate from average behavior.

T. Buscheck is developing a two-drift, drift-scale model that will be able to consider the emplacement of WPs with different heat output in neighboring drifts. S. Daveler has developed a pre-processor that will allow for the explicit scheduling of WPs throughout the repository. This will enable us to look at the repository-scale consequences of emplacing WPs that may be progressively older (or younger) for each successive year of emplacement.

Table 1 Time required to attain the indicated relative humidity at various repository locations and the temperature at which that value of relative humidity is attained for 22.5-yr-old spent nuclear fuel (SNF), an AML of 70.0 MTU/acre, and bulk permeability of 280 millidarcy (1 darcy ~ $10^{-12} m^2$). The locations are identified as the percentage of the repository area enclosed, with 0 percent corresponding to the repository center, and 100 percent corresponding to the outer perimeter								
Fraction of repository area enclosed (percent)	Time required to attain the indicated relative humidity (yr)				Temperature at which the indicated relative humidity is attained (°C)			
	70%	80%	90%	95%	70%	80%	90%	95%
50	3350	8700	16,150	23,560	91	69	56	49
75	1940	4080	7630	10,450	97	77	66	61
90	630	1030	1760	2460	105	97	85	78
97	80	170	290	390	107	103	99	96

1.2.1.6 Configuration Management

Affected document notices (ADN's) were completed for CRs 94/071, 94/075, 94/077, 94/082 and 94/113. No LLNL controlled documents were affected.

1.2.2. WASTE PACKAGE

1.2.2.1 Waste Package Coordination and Planning

LLNL staff participated in planning for the Planned Program Approach (Scenario A) re-baseline.

LLNL staff participated in the Design Integration Workshop in Las Vegas on April 5.

J. Blink participated in the Focused ACD meetings in Las Vegas on April 14 and 28.

1.2.2.2 Waste Package Environment

This work is now being reported in WBS 1.2.3.12.

1.2.2.3 Waste Form and Materials Testing

1.2.2.3.1 Waste Form

1.2.2.3.1.1 Waste Form Testing - Spent Fuel

Spent Fuel Dissolution

A technical exchange meeting of PNL, ANL, LLNL, and Canadian staff members was held on April 6 and 7 in Livermore to discuss:

1) Progress for development of a spent fuel dissolution model, and

2) Overall objectives and priorities for spent fuel dissolution testing in the U.S. program.

As a result of these discussions, it was agreed that some of the future spent fuel dissolution testing at PNL should include items outlined below:

1) Flow-through tests will be started, as previously planned, on oxidized U_4O_{9+x} and unoxidized ATM-104 (PWR) spent fuel specimens after replacement of the liquid waste tank.
2) Flow-through tests on ATM-103 (PWR) spent fuel at low pH (3 to 6) will be started for comparison with results from drip tests being conducted at Argonne National Laboratory (ANL). The low pH results will also supplement results from flow-through tests that were conducted earlier with ATM-103 spent fuel at pH 8 to 10.
3) Measurements of gap inventories and grain-boundary inventories of ^{129}I will be repeated for a few spent fuel specimens using a technique that was found to be successful at Whiteshell Laboratory in Canada. The results will be compared with those summarized in last month's report. If the results obtained from using the Canadian technique are much different from the earlier test results, additional repeat measurements using the new technique may be required.

D-20-43, Unsaturated Dissolution Tests with Spent Fuel and UO_2

Spent Fuel

Tests are in progress at ANL to evaluate the long-term performance of spent fuel under unsaturated conditions at 90°C in a potential repository. These tests examine the leach and/or dissolution behavior of two types of well-characterized irradiated fuels, ATM-103 and ATM-106 (both PWR), in three types of tests: two with saturated water vapor atmospheres; two with a drip rate of 0.075 mL/3.5d; and two with a drip rate of 0.75 mL/3.5d. A control test without fuel but with a 0.075 mL/3.5d drip rate is also included. EJ-13 water for the tests came from well J-13 and was initially equilibrated with volcanic tuff for approximately 80 days at 90°C. The seven tests have undergone ~19 months of testing at 90°C.

In April, the leachate was removed from each test and the tests were restarted. Aliquots of the leachate were prepared for pH, anion, carbon, transmission electron microscope (TEM), alpha, gamma, and cation analyses. The sampling went smoothly with a step added to one of the tests to better evaluate the surface area of fuel in the test. This was accomplished by examining the pellets in one of the tests. As the data are compiled ANL will compare the ^{137}Cs release against that observed in C. Wilson's semi-static tests to get an estimate of the gap inventory that is being released.

UO_2

The objective of the tests at ANL is to evaluate the reaction of UO_2 pellets after exposure to dripping EJ-13 water at 90°C using the unsaturated test method. More specifically, these tests are designed to examine the dissolution behavior of UO_2, formation of alteration phases, release rates, and mechanisms of uranium release, and to serve as a pilot study for similar tests with spent nuclear fuel.

The UO_2 tests, using the drip test method at a drip rate of 0.075 mL/3.5d of EJ-13 water have been ongoing for about eight years. Results of these tests have been published in the past.

This program is currently being converted to quality affecting status. Efforts were expended to update the scientific notebook used to record data from these tests to a QA acceptable format. J. Bates attended discussions on spent fuel and colloids as part of the International Program meeting with the Canadians, LLNL and PNL staff.

Solution aliquots were collected for the eight to nine year UO_2 drip test samples supported by Teflon stands. A visual examination of the pellet surfaces made during the sampling process indicates that secondary uranyl phases continued to be deposited on the pellet surface. Solution pH values decreased from an initial 8.2, to values of 6.4 to 7.5 after reacting with the samples and collecting in the bottom of the stainless steel test vessels. Additional solution aliquots were collected for cation, anion, carbon, suspended uranium, and filtered uranium analysis. Results from these analyses will be presented in future reports.

Uranium release results from previous testing intervals (exclusive of the present eight to nine year samples) have been analyzed. The majority of the tests are characterized by a period of rapid uranium release between one and two years of reaction. Uranium release rates during this interval ranged up to 14 $mg \bullet m^{-2} \bullet d^{-1}$ with most of this release being attributed to the spallation of UO_2 granules from the sample surface. The final analysis for sample PMP8U-8 indicates a normalized release of 56 $mg \bullet m^{-2} \bullet d^{-1}$, but this high value is believed to arise from the dissolution of secondary uranyl minerals during the final overnight acid strip of the test vessel components. These secondary phases appeared to be deposited on the Teflon stand throughout the duration of this test. Subsequent to the rapid release period, release rates for most tests decreased to an average of approximately 0.15 to 0.30 $mg \bullet m^{-2} \bullet d^{-1}$. This level of release has remained relatively constant throughout the duration of the remaining tests. These releases are being compared to values obtained from testing done under other reaction modes.

D-20-53(a), Dissolution Tests with UO_2

Over 20 grams of U_3O_8 as NBS Standard Reference Material 950 have been obtained. This material may be used as samples in the LLNL dissolution experiments because of their direct traceability to NIST (NBS). They were prepared in the same manner that is planned to prepare it at LLNL, by heating a uranium starting material to high temperature (>800°C) in air. Equipment, safety approvals, and uranyl acetate have been acquired to prepare dehydrated schoepite, $UO_3 \bullet H_2O$. The first synthesis will begin in early May.

Laboratory equipment for the initial four $UO_3 \bullet H_2O$ dissolution experiments have been assembled and tested. They have been loaded with existing, analyzed $UO_3 \bullet H_2O$ and flow was started. There are two room temperature and two 75°C runs, the four schoepite runs in the initial eight screening runs of the test matrix. All four will be run at room temperature first, then at 75°C. This approach will double the data with minimal additional effort.

Spent Fuel Oxidation

Dry Bath Testing

The drybath spent fuel oxidation experiments continue to operate at PNL without incident. An interim examination on the 255°C and 195°C baths is scheduled for June. The longest running samples of Turkey Point PWR fuel have been at temperature (175, 130, 110°C) over 50,000 hr (almost 6 years).

In order to resolve ambiguity in the interpretation of quantitative X-ray diffractometry (XRD) results from spent fuel samples oxidized above an oxygen-to-metal (O/M) ratio of 2.4, a new series of samples were prepared using Al_2O_3 as a non-interfering standard. Samples prepared using this material appeared to have no significant preparation artifacts or physical degradation effects. Results from the initial samples indicate that the X-ray peak intensity of the $UO_{2.4}$ phase decreases systematically as the O/M increases above 2.4. X-ray peak widths increase with increasing O/M ratio, indicating a decrease in crystallite size. Preliminary analyses of the X-ray intensity results and sample O/Ms based on oxidation weight gains (assuming that the intensity loss of the $UO_{2.4}$ peaks was due to formation of a higher oxidation product) indicates that the new phase has an O/M close to 2.66. Analysis of the remaining samples in this series is temporarily on hold due to PNL's suspension of radiological operations in the Building 325 laboratories where the XRD lab is located.

Work on preparing TEM samples of the highly oxidized spent fuel samples from the drybath ovens continues slowly due to the contamination potential of spent fuel powders. Samples containing the powdered spent fuel embedded in epoxy have been prepared and are being thinned for TEM observation.

Thermogravimetric Apparatus (TGA)

A 195.63 mg fragment of ATM-105 (BWR) fuel has been running in TGA#1 at PNL at 283°C for over 475 hours. A plateau at an O/M of 2.42 was reached after ~150 hours. The initial weight gain curve compares quite well with those from samples run at 283°C in TGA#2. A sample oxidized to O/M=2.75 after 211 hours at 305°C was examined by XRD. The only phase present was U_3O_8. The samples oxidized to O/M=2.41 after 544 hours at 255°C only had the U_4O_9 phase present.

Materials Characterization Center (MCC) Hot Cell Activities

The liquid radioactive waste disposal holding tank for the PNL Building-325 analytical hot cells is being replaced. The anticipated completion date has slipped another 2 to 3 weeks to sometime in May. Only minor amounts of radioactive liquid waste can be generated at this time, which precludes operation of any flow-through tests.

1.2.2.3.1.2 Waste Form Testing - Glass

A preparedness review has been performed and open items identified for the Unsaturated Testing of UO_2 at ANL. The items are minor, and the review will be closed out shortly.

D-20-27, Unsaturated Testing of WVDP and DWPF Glass

The N2 dissolution tests (DWPF actinide-doped glass, previously described as SRL glass) continue as scheduled. The tests have been ongoing for 99 months. Test samples were taken during December and the analyses of the test solutions for colloids has been completed. Data from the December sampling are being compiled and combined with data collected previously. The data collected in the 1980's are being checked and validated for accuracy.

The N3 (West Valley ATM-10 glass) dissolution tests continue as scheduled. The tests have been ongoing for 77 months. No solution data have been reported from these tests and, as with the N2 tests, the original data sheets and analytical records are being checked and the data compiled. In particular, the rate of glass reaction in these tests which should match the normalized ^{99}Tc release results, the rate of transuranic release, and the distribution of transuranic elements between the solution, colloidal, and acid strip fractions.

D-20-70, Parametric Studies of WVDP and DWPF Glass

Sixteen parametric dissolution tests of DWPF and WVDP glass continue at ANL. Some have been in progress for up to 8 years. No sampling has been done in several years, and none is anticipated this year. The solution injections continue. Based on calculations of the free volume in the test vessel, it appears that sampling of these tests will be required in early FY95; otherwise, the water will directly contact the glass as it collects in the test vessel.

Tests on a variety of glasses exposed to 60 and 95% relative humidity (RH) at 70°C continue at ANL. No test terminations have been done for several years, and none are planned for this year. The tests will continue.

1.2.2.3.2 Metal Barriers

Task Management and Quality Assurance (PACS OL232JCD)

W. Clarke, D. McCright, and R. Van Konynenburg participated in an April 7 meeting at M&O Headquarters in Vienna, Virginia to discuss materials issues for the initial multi-purpose canister (MPC) procurement. The discussion focused on the material for the container itself and on the "basket" material used for separating the fuel assemblies. As follow-up to the meeting, D. McCright and R. Van Konynenburg, along with D. Stahl of the M&O, wrote a note on the choice of basket material for the initial procurement.

R. Van Konynenburg attended a Design Integration Workshop meeting in Las Vegas on April 5. He also received reviewer comments on the carbon-14 review paper for the journal Waste Management and has implemented the revisions.

The Metal Barrier Task is organizing a workshop to be held on May 10-12 in Pleasanton, California, to address candidate materials, test environments, and long-term test approaches. The workshop is consistent with guidance from the Planned Program Approach direction and renewed emphasis on engineered barriers along with the natural barriers. Planning for the testing activities to be performed over the next five years is one of the key agenda items. One outcome of the workshop will be identification of which tests need to be performed and in what environments. As appropriate, personnel from the near field environment, performance assessment, and waste form parts of the project have been invited. The workshop will involve participation by invited personnel cognizant of materials issues connected with the project, including YMSCO, Weston, M&O, LLNL, University of Nevada, and sub-contractors.

A. Simmons (YMSCO) and D. Stahl (M&O), visited LLNL on April 8 to discuss the technical scope, schedule and milestones of the Metal Barrier and Non-Metallic Barriers with D. McCright.

Prepare Planning Documents (PACS OL232LFF)

A draft of Revision 3 of the Metal Barrier Scientific Investigation Plan (SIP) was completed during April and an informal copy was given to the M&O to permit them to complete a milestone on the waste package design. Revision 3 followed the same general format of activities as previous versions. In view of the rapidly changing project priorities on the engineered barriers, a rather different format of the Metal Barrier activities is envisioned, and this will result in a totally rewritten SIP. This matter will be discussed at the workshop on materials and long-range testing to be held in May.

A QA grading report was completed to cover Activity Ef-20-18F, Determination of the Stress Corrosion Cracking Susceptibility of Candidate Materials Using Fracture Mechanics Test Specimens. This work is contracted to Argonne National Laboratory, and the activity plan and QA grading report cover the LLNL portion of the work.

Degradation Mode Surveys (PACS OL232LFA, Activity E-20-13)

Iron-Base, Corrosion-Allowance Materials

D. Bullen, Iowa State University, submitted a revised draft (Revision B) of the degradation mode survey on iron-base, corrosion-allowance materials on April 15. This revision contains some sections that were omitted in the first version. The revised draft is undergoing internal technical review.

Performance Tests and Model Development (PACS OL232LFB, Activity E-20-16)

G. Henshall began a review of the literature for the purpose of identifying experimental techniques in localized corrosion. Efforts this month focused on aqueous pitting corrosion. In Addition, discussions were held with J. Farmer to help in assessing some of the experiments and the ease with which they could be performed at LLNL. This review is in progress and the preliminary findings are summarized below.

Details of the Modeling

G. Henshall continued modeling the effects of the number of individual "runs" in a simulation (a measure of "sample size") on the computed pitting potential. Using the same input parameters as in previous months' calculations, predictions of the pitting potential were made with 100 runs per simulation. By comparing these results with earlier ones for 10, 20, and 50 runs, the effects of the number of runs in the simulation (NRUNS) on the curve of pitting potential E_p, as a function of "wait time" were assessed (see the February and March 1994 reports for definitions of these parameters). As NRUNS increases, E_p stays essentially constant for a given median wait time. However, increasing NRUNS increases the chance for extremes in the calculated results. One consequence is that for the maximum wait time, E_p tends to increase as NRUNS increases. As shown in Fig. 1, another consequence is that for the minimum wait time, t_{min}, E_p decreases as NRUNS increases, although there is considerable scatter. Thus, there appears to be an effect of "sample size" on the results from the stochastic model.

Further calculations were aimed at exploring the decaying birth probability option within the stochastic model. As discussed elsewhere (Ref. 1), a decay in the birth probability allows the stochastic model to better simulate some of the pit initiation data available in the literature. The form of this decay is

$$\lambda = \lambda_0 \exp [-\alpha t] \qquad (1)$$

where λ is the birth probability λ_0 and α are constants, and t is the exposure time. In previous calculations of pitting potential α was assumed to be zero so that the birth probability did not decay. All other parameters remaining the same, these calculations were repeated using α = 0.023026, corresponding to an order of magnitude decay in λ following a 100 time-step exposure. Figure 2(a) shows a comparison with the earlier calculations of E_p as a function of t_{min} for NRUNS =

20. For potentials above approximately 4 x 10^{-4} (arbitrary units) the two curves are very similar. As shown in Figure 2(b), however, below this voltage none of the 20 runs initiated a pit for $\alpha = 0.023026$. In contrast, for $\alpha = 0$ a pit occurs in every run for all of the applied potentials explored. In the case of a decaying birth probability, the lack of any runs initiating a pit below a potential of 4 x 10^{-4} (this value is expected to vary with changes in NRUNS) indicates a lower limit on E_p, or a "true" thermodynamic threshold. Such a threshold was not predicted for the case of a constant birth probability (see the March 1994 report).

References

1. G. Henshall, W. Halsey, W. Clarke, and D. McCright, University of California Lawrence Livermore National Laboratory Report, UCRL-ID-111624 (1993).

Figure 1. The variation in the E_p vs. t_{min} plot with changes in the number of runs per simulation.

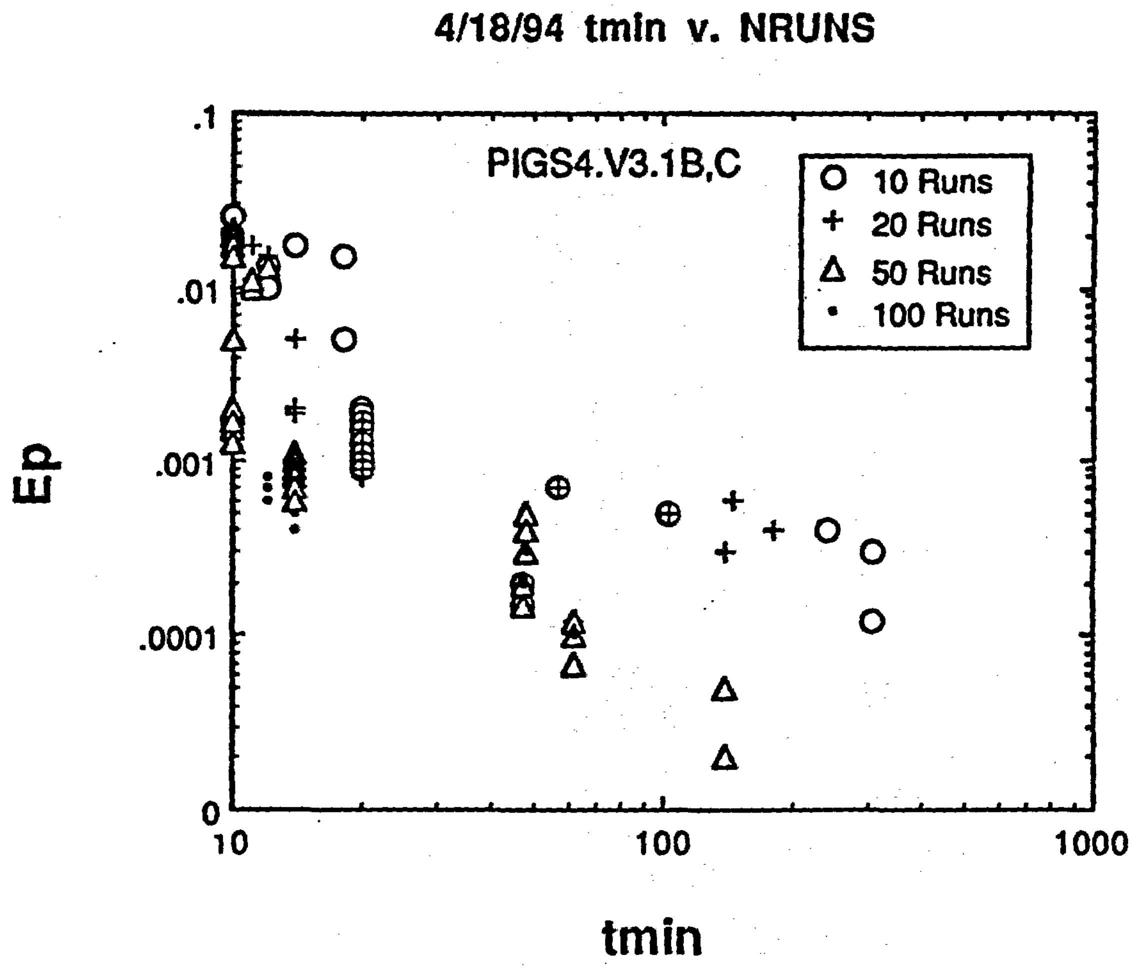
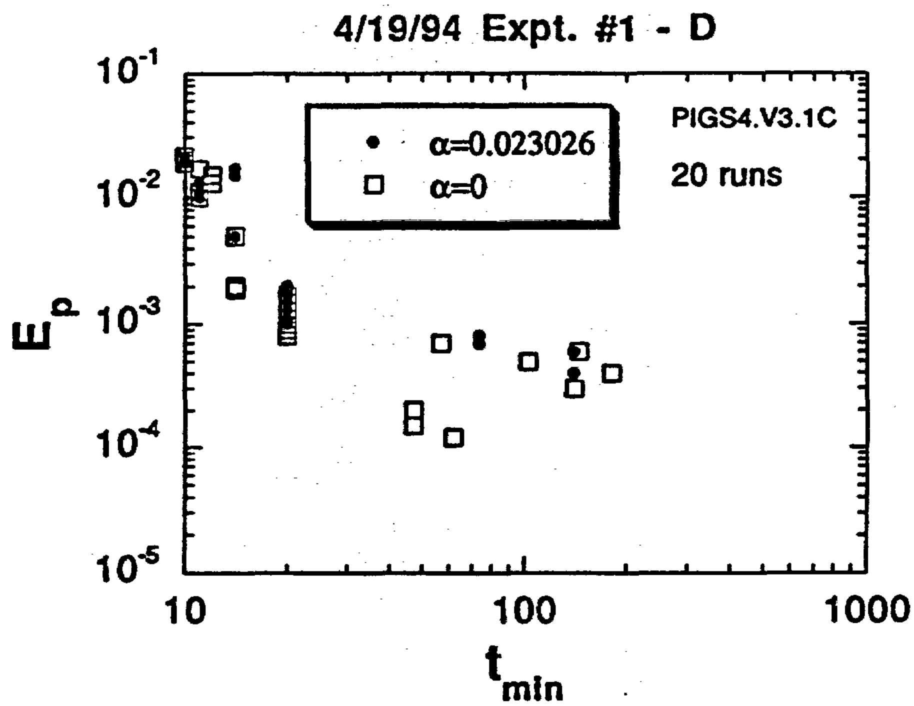
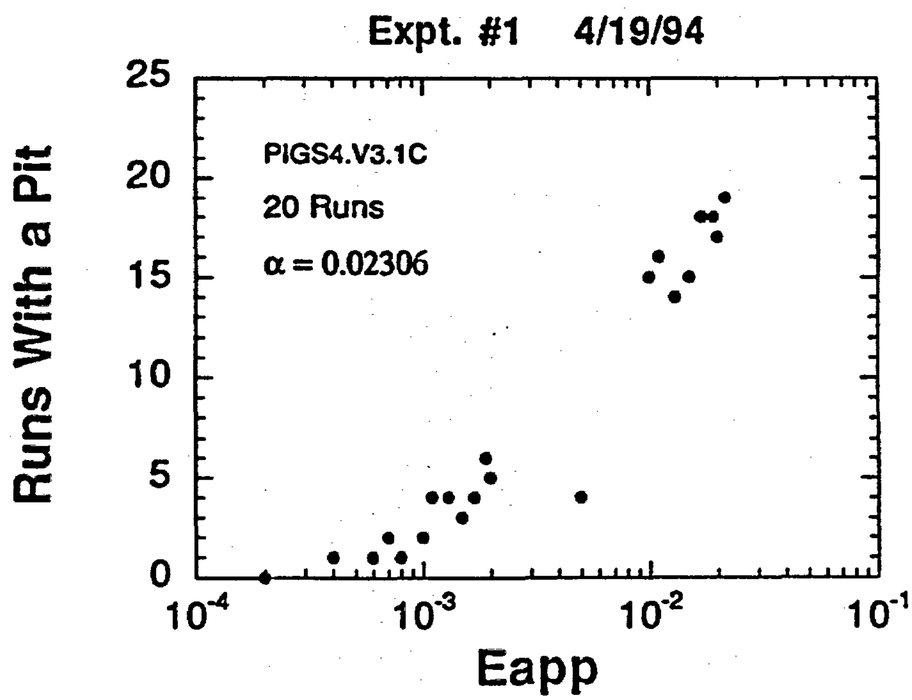


Figure 2. (a) The variation in the pitting potential as a function of the minimum wait time for two values of α. (b) The number of runs (out of 20 total) in which a pit was initiated as a function of the applied potential. The units for potential and time are arbitrary.

(a)



(b)



Experimental Determination of Critical Pitting Parameters

G. Henshall continued a review of the literature for the purpose of identifying experimental techniques iof localized corrosion. Efforts this month focused on aqueous pitting corrosion. In addition, J. Farmer collaborated in assessing some of the experiments and the ease with which they could be performed at LLNL.

Pitting Potential

The pitting corrosion experimental techniques reviewed to date are categorized based on the types of quantities they can measure.

The pitting potential can be measured by one of two basic techniques: potentiostatic and potentiodynamic. For the former, a constant potential is applied to a specimen in an electrochemical cell, and the electrical current is measured as a function of time. Theoretically, the current initially will be small and unchanging, and then will rise rapidly when pitting begins. Testing is done for a range of potentials, and the pitting potential is the least positive applied potential for which a current rise is observed within the chosen time of the experiment. The potentiodynamic technique is similar to that just described except that the potential is swept at a constant rate rather than being held constant. The sweep begins at a potential believed to be below the pitting potential and is increased until the measured current increases rapidly, indicating pit formation. The difficulty with this technique is that the measured pitting potential is a function of the sweep rate. Both techniques can be used to evaluate the effects of temperature, solution chemistry, alloying, etc., on pitting potential.

Induction Time

For a given potential and environment, the induction, or "incubation", time is defined as the exposure time required to initiate pitting. The induction time can be measured using the potentiostatic technique described earlier. Again, an abrupt increase in electrical current is used to indicate the initiation of pitting, and thus the induction time.

Stochastic Pit Initiation

The simplest stochastic pit initiation experiments are modifications of the pitting potential and induction time techniques described above. Multi-channel electronic equipment is used to record the current-time response of multiple specimens exposed to identical environments and potentials. The stochastic variations in the pitting potential and induction time are indicated by the scatter in the data from the multiple specimens. More sophisticated testing employs a similar approach to record the current-time transients during the pre-pitting stage. Sensitive instrumentation must be used to monitor the current with 0.01-0.1 µA resolution. The current-time transients can be analyzed in a number of ways, some quite complex, to provide direct measures of the pit initiation parameters needed in the stochastic model (i.e. pit embryo birth and death probabilities, and critical age). Electrolyte chemistry and other environmental variables can be altered to determine their effects on the pit initiation parameters.

Damage Function Measurement

Two methods have been identified for measuring the distribution in the size (depth or area) of pits as a function of exposure time and environment. These methods were described in the February 1994 report.

Passive Film Degradation

Two general methods have been identified for monitoring the degradation of the passive film during the pit initiation stage. The first is ellipsometry, a complex optical technique by which the thickness of the passive film is measured over a region of the metal surface as a function of exposure time. This method may be unsuitable for complex alloys. The second method employs scanning tunneling microscopy (STM), which can now be performed in aqueous solution. In this method, near-atomic-resolution imaging of the film during pit initiation potentially could provide data useful in determining the pit initiation parameters for the stochastic model.

As a preliminary assessment of experimental techniques, those experiments that provide parameters needed for the stochastic pitting models or PA models are the most critical to perform. If additional types of experiments are needed for verification of these models, then these should also be performed. It may also be useful to perform simple experiments not directly related to the modeling efforts if they provide generally useful engineering information (e.g. the pitting potential). Purely "scientific" studies, such as the ellipsometry experiments, have less value, although the STM measurements may provide input for the stochastic models and validation of the modeling method. Thus, STM measurements could be of considerable value.

Parameter Tests and Metal Degradation (PACS OL232LFC, Activity E-20-17)

Thermogravimetric Analysis

Several exploratory tests concerning the low temperature interaction of water vapor with copper were performed with the thermogravimetric analyzer (Cahn TGA 131). Test conditions were temperatures ≤110°C and air with various partial pressures of water. The objective of this initial work is to determine the apparatus operating conditions necessary to perform tests to characterize various materials with respect to the adsorption and condensation properties of water under a variety of environmental conditions. These tests are conducted by G. Gdowski (Principal Investigator) and J. Estill and S. Gordon (Technical Support).

The TGA apparatus was modified with manufacturer specified products for working with condensing gases (water vapor in the present case). However, even with the manufacturer specified modifications, inconsistent test results occurred. The problems appear to be worse when the water partial pressure is high.

Evidence indicates that water condensation in the upper part of the reactor tube is at least partly responsible for the problems. The condensed water drips on the test specimen and the thermocouple, resulting in spurious temperature and weight readings. Wide temperature swings (sometimes as large at 15°C) from the set point temperature have occurred. Extremely rapid fluctuations in the test specimen weight also occur. Evidence of enhanced corrosion due to the water dripping on the test specimen is also evident.

Changes in the test operating procedures are being incorporated in order to eliminate the water condensation problem. These include enhanced heating of the apparatus where water condensation may occur and changing of the reaction gas and purge gas flow rates.

The results of a successful test are shown in Figure 3. The test specimen (5 cm x 2.5 cm x 0.16 cm) was pure copper (CDA 102). The air was saturated with water at 70°C. The temperature was ramped in 5°C increments to 100°C and then cooled in 5°C increments to 65°C. Each temperature was held for one hour.

The weight of the specimen initially increased at 75°C. The specimen weight then decreased slowly at 80°C and more rapidly at 85 and 90°C. During the 90°C hold period, the specimen weight reached a minimum which did not change significantly during the rest of the heating period. With cooling, there was no significant change in the specimen weight until the temperature reach 75°C. At 75°C, the weight of the specimen began to increase. The weight increase occurred more rapidly at 70°C. During the hold at 65°C, there was a steep decrease in the weight followed by a rapid rise.

The results in Figure 3 indicate that on a clean copper specimen at 75°C, condensation of water occurs at a relative humidity of 80% and that at ≤80°C water condensation does not occur for relative humidities of ≤60%. The objective of further tests is to obtain a more detailed mapping of the absorption and condensation behavior of water on various materials as a function of water partial pressure and temperature.

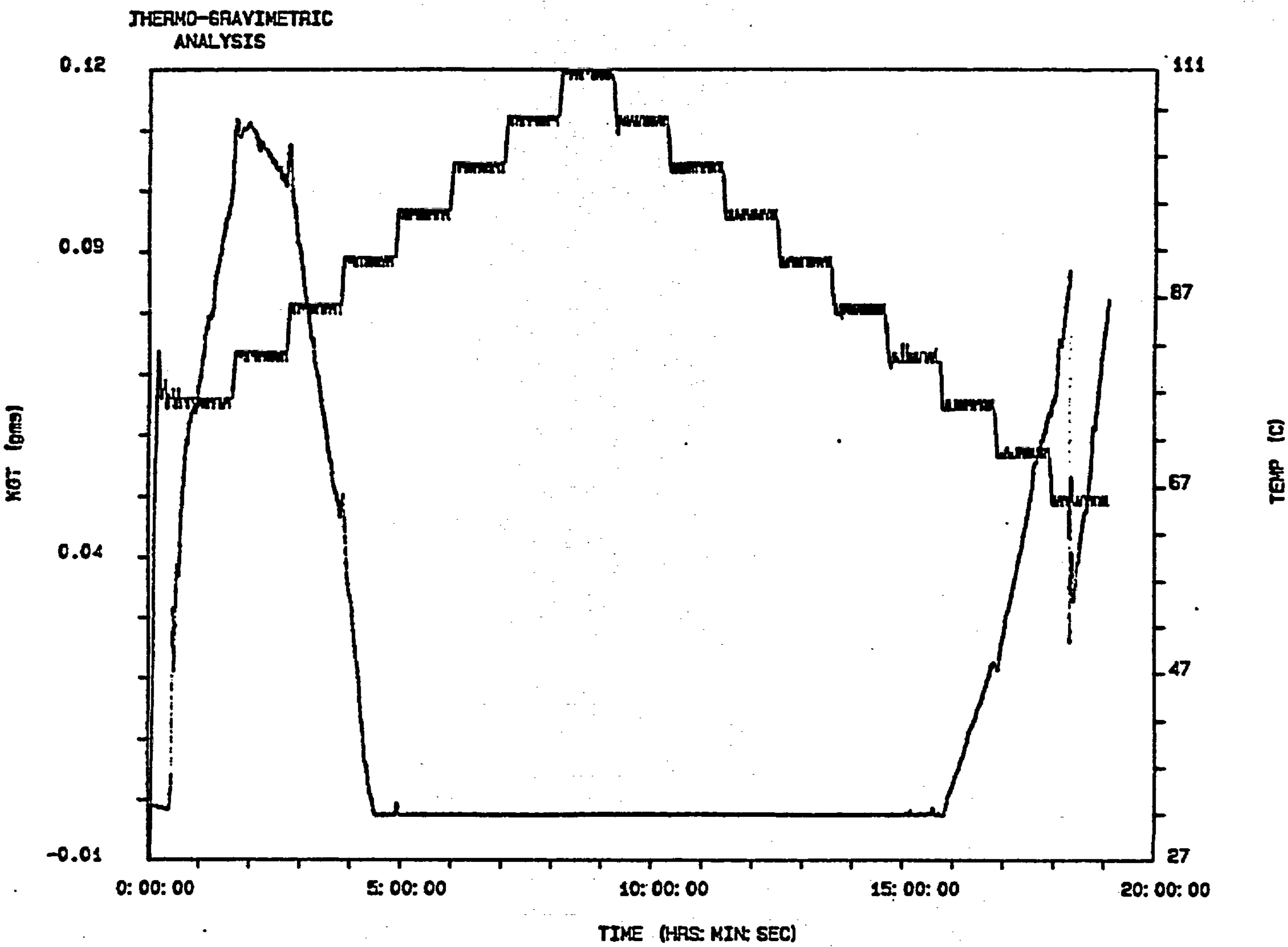
<u>Sensor Development and Support to Large Block Test</u>

M. Whitbeck and R. Glass joined the LLNL-YMP in April. They are supporting the Large Block Test (LBT) and the Metal Barrier Task. There is some overlap between these two tasks and the overlap areas are discussed below.

<u>Iridium Oxide pH Sensors</u>

Environmental/corrosion sensors are of interest to the laboratory work being performed by the Metal Barrier Task, because of the critical parameter related to the transition from "dry oxidation" to "wet corrosion". For example, the purpose of the work reported in the above section on the TGA measurements is to determine the critical humidity at which this transition occurs. While the present effort is directed toward the LBT, sensor development has a broader application.

Figure 3. Corrosion of copper in air initially saturated with water at 70°C.



A literature review was initiated to support development and characterization of pH, reference, and ion-selective electrodes to function in the environment expected for the LBT. Stability, interferences and assembly issues are being addressed.

A solid state iridium oxide pH sensor is being evaluated for application in the LBT. The chemical analysis of a sample of J-13 well water indicated the presence of chloride and other ions that might degrade the performance of this electrode (by attacking the electrochemically or sputter-deposited oxide film). A preliminary test was conducted to scope the magnitude of any such interference. A 0.3M sodium chloride solution was prepared as a stock solution and was used to add chloride to a standard pH buffer solution. The sodium chloride solution was added in increments of 10, 40 and 100 microliters to 50 ml of pH 7 phosphate buffer at 27° C resulting in Cl-ion conentrations of 2 - 32 mg/L. These levels mimic the range found in J-13 well water and a 5x-concentrated J-13 well water sample. There was no observable effect of the added sodium chloride on the response of the electrode at pH 7 in this buffer. Other pH values and the observed drift of the electrode upon first wetting (about +12.3 mV/hr) are under investigation.

Corrosion Coupons/Crevice Samples for LBT

Corrosion coupons and crevice samples for the LBT have been ordered. All the prospective container materials have been included. In the LBT, these samples will be placed in the (near) 100°C, 100% RH holes.

Corrosion Polarization Measurements

Polarization measurements are planned for selected metals as benchmarks for designing in situ electrochemical sensors. A preliminary comparison was made between two methods for making these measurements. The two methods are potentiodynamic polarization and galvanostatic polarization; both are based on the current-potential relationship for a polarized metal surface. The current-potential relationship is given by the Butler-Volmer equation:

$$i = i_0 \{ \exp[-(e-e')/b_c] - \exp[-(e-e')/b_a] \} \quad (2)$$

The parameters to be determined are i_0, e', b_c, and b_a, representing the exchange current density (corrosion current density), the equilibrium potential (corrosion potential), and the cathodic and anodic Tafel constants.

Galvanostatic data for the cathodic polarization may be determined using the PAR 173/175 potentiostat/galvanostat. Small currents are applied (i), and the resulting potential vs a Ag/AgCl reference electrode is measured. The resulting current-potential curve may be used to graphically estimate the corrosion potential and the corrosion current. Alternatively, the BAS 100 electrochemical analyzer may be used to determine the polarization data by varying the potential (e) while measuring the current (i). This has the advantage that the digitally recorded data may be used to fit the parameters in the Butler-Volmer equation using non-linear least-squares methods. While it may appear that the two methods are equivalent, there are experimental aspects that may result in non-equivalent results. The anodic polarization data are usually not determined when using galvanostatic methods. By using the galvanostatic method and manually treating the data, it was determined that a copper wire (~0.9 cm^2) in 0.3M sodium chloride solution exhibits a corrosion current of about 2 microamperes with a cathodic Tafel constant of -85 millivolt, whereas the least-squares fitting of potentiodynamic data yields a corrosion current of about 7 microamperes, a corrosion potential of about 0.8 millivolt, a cathodic Tafel constant of -100 millivolt, and an anodic Tafel constant of 24 millivolt. Both methods yield comparable corrosion rates (about 1-3 mils/year; however, the potentiodynamic method is faster, less labor-intensive, and easier to automate using computer aided measurements.

Quartz Crystal Microbalance

A quartz crystal microbalance (QCM) has been ordered for investigating corrosion under thin films of electrolyte (i.e., in humid atmosphers). Basically, these are gravimetric devices. An ac waveform is applied to an AT cut quartz crystal. The characteristic resonant frequency of vibration of the crystal is mass-dependent. Sensitive continuous measurement of corrosion is possible (ng/cm^2 sensitivity). We anticipate receiving and setting up this new measurement capability during the month of May.

Crack Growth Tests (PACS OL232LFD, Activity E-20-18F)

Sub-contract work at Argonne National laboratory (J. Park and D. Diercks, Principal Investigators), is concerned with the determination of stress corrosion crack growth rates in candidate metal barrier waste container materials. Research activities deal with fracture mechanics crack-growth-rate determinations on new heats of Types 304L and 316L stainless steels and Incoloy 825 under high stress ratios. In addition, tests will be conducted under low stress ratio conditions on Ti Grade 12, Hastelloy C-4, and the new heat of Incoloy 825.

As stated in the March monthly report, all six of the alloys to be tested have been purchased and received in product forms suitable for the fabrication of 1T compact tension specimens. The Incoloy 825, Type 304L SS, and Type 316L SS are from different heats of materials than those tested in the previous phase of this program, and the Titanium Grade 12, Hastelloy C-4, and Hastelloy C-22 are new materials for the program.

Independent chemical analyses of these six heats of material were obtained and are summarized in Tables 2 and 3. All values are within ASTM specifications except for the values from Analysis 3 that are marked with an asterisk in the tables. These out-of-specification values include iron and molybdenum in Hastelloy C-22, nickel in Type 316L SS, and molybdenum and titanium in Incoloy 825. The laboratory that performed Analysis 3 later reviewed these results and determined that technical difficulties in dilution and ignition of precipitates had been experience and that the results of this analysis were probably unreliable. A repeat analysis by the same laboratory found all samples to be within specifications, as shown in Analysis 4 of

Tables 2 and 3. Because of this finding and the results of four other independent analyses that determined all of the alloys to be within specifications, all six alloys have been accepted and will be used in the testing program.

Table 2. Chemical Composition of Testing Materials: Ti-Grade 12, Hastelloy C-4 and Hastelloy C-22 (wt.%)

Material		Si	P	Cr	Al	Fe	Mn	S	Mo	Co	N	C	Ni	Cu	Ti	O	H	V	W
Ti-Grade 12 Heat No. 65047	ASTM Specification					0.3 max			0.2-0.4		0.03 max	0.08 max	0.6-0.9		bal	0.25 max	0.0125		
	Analysis 1					0.16			0.280		0.008	0.011	0.858			0.14	0.0004		
	Analysis 3	0.06	<0.001	0.01	0.03	0.20	0.03	0.004	0.31	<0.01	0.012	0.021	0.65	<0.01					
	Analysis 4																		
	Analysis 5																		
	Analysis 6																		
Hastelloy C-4 Heat No. 245530878	ASTM Specification	0.08 max	0.04 max	14.0-18.0		3.0 max	1.0 max	0.03 max	14.0-17.0	2.0 max		0.015 max	bal		0.70 max				
	Analysis 1	0.04	0.005	15.74		0.56	0.14	0.003	15.65	<0.10		<0.002	bal		0.17				
	Analysis 3	0.05	0.008	15.57	0.16	2.14	0.15	0.002	14.51	0.13	0.015	0.012	67.02	0.02	0.05				
	Analysis 4																		
	Analysis 5																		
	Analysis 6																		
Hastelloy C-22 Heat No. 227723271	ASTM Specification	0.08 max	0.02 max	20.0-22.5		2.0-6.0	0.50 max	0.02 max	12.5-14.5	2.5 max		0.015 max	bal					0.35 max	2.5-3.5
	Analysis 1	<0.02	0.004	21.6		4.1	0.26	0.003	13.3	1.74		0.003	bal					0.16	2.8
	Analysis 3	0.06	0.006	21.37	0.12	7.75*	0.24	0.002	10.85*	1.48	0.033	0.009	56.84	0.08	0.05				
	Analysis 4	0.06	0.006	21.37	0.12	3.93	0.24	0.002	13.12	1.48	0.033	0.009	56.84	0.08	0.05				
	Analysis 5			21.8	0.19	4.25	0.28		12.7	1.87			56.4	0.09	0.02				
	Analysis 6			21.6	0.15	4.18	0.28		12.6	1.86			56.0	0.09	0.02				

Analysis 1: Vendor supplied
Analysis 2: Vendor supplied
Analysis 3: Analysis by Charles C. Kawin Co.
Analysis 4: Analysis by Charles C. Kawin Co.
Analysis 5: Analysis by Argonne National Laboratory
Analysis 6: Analysis by Argonne National Laboratory

*Value outside the range of ASTM specifications.

Table 3. Chemical Composition of Testing Materials: Type 304L SS, Type 316L ss and Incoloy 825 (wt.%)

Material		Si	P	Cr	Al	Fe	Mn	S	Mo	Co	N	C	Ni	Cu	Ti	O	H	V	W
Type 304L SS Heat No. V39545	ASTM Specification	0.75 max	0.045 max	18.0- 20.0			2.0 max	0.03 max			0.10 max	0.030 max	8.0- 12.0						
	Analysis 1	0.40	0.024	18.19			1.78	0.011	0.15	0.13	0.072	0.014	8.35	0.17					
	Analysis 2	0.41	0.023	18.14			1.78	0.012	0.15	0.13	0.072	0.016	8.33	0.19					
	Analysis 3	0.42	0.020	18.16	<0.01	69.19	1.73	0.013	0.16	0.16	0.074	0.020	8.00	0.17	<0.01				
	Analysis 4																		
	Analysis 5																		
	Analysis 6																		
Type 316L SS Heat No. 61943	ASTM Specification	0.75 max	0.045 max	16.0- 18.0			2.0 max	0.03 max	2.00- 3.00			0.030 max	10.0- 14.0						
	Analysis 1	0.43	0.021	16.44			1.20	0.004	2.10	0.18	0.046	0.012	10.29	0.33					
	Analysis 3	0.45	0.012	16.54	<0.01	67.98	1.17	0.006	2.09	0.22	0.053	0.017	9.59*	0.30	0.04				
	Analysis 4	0.45	0.012	16.54	<0.01	67.98	1.17	0.006	2.09	0.22	0.053	0.017	10.13	0.30	0.04				
	Analysis 5			16.3	<0.1	69.5	1.22		2.06	0.20			10.4	0.33	0.04				
	Analysis 6			16.2	<0.1	68.3	1.22		2.04	0.20			10.2	0.33	0.04				
Incoloy 825 Heat No. HH7344FG	ASTM Specification	0.5 max		19.5- 23.5	0.2 max	22.0 min	1.0 max	0.03 max	2.5-3.5			0.05 max	38.0- 46.0	1.5- 3.0	0.6-1.2				
	Analysis 1	0.08		23.08	0.05	30.91	0.38	0.001	3.46			0.01	39.73	1.74	0.6				
	Analysis 3	0.09	0.010	23.33	0.03	29.13	0.38	0.003	3.77*	0.23	0.009	0.014	40.56	1.75	0.52*				
	Analysis 4	0.09	0.010	23.33	0.03	29.13	0.38	0.003	3.03	0.23	0.009	0.014	40.56	1.75	0.67				
	Analysis 5			23.2	<0.1	29.9	0.40		3.39	0.26			39.9	1.74	0.57				
	Analysis 6			23.2	<0.1	29.8	0.40		3.33	0.26			39.9	1.73	0.56				

Analysis 1: Vendor supplied
Analysis 2: Vendor supplied
Analysis 3: Analysis by Charles C. Kawin Co.
Analysis 4: Analysis by Charles C. Kawin Co.
Analysis 5: Analysis by Argonne National Laboratory
Analysis 6: Analysis by Argonne National Laboratory

*Value outside the range of ASTM specification.

R. Van Konynenburg assembled a body of information on candidate materials for the waste package container (both inner and outer barriers) including NNWSI and YMP reports on this subject, references from the general technical literature, and raw material costs. E. Dalder assembled a body of information on materials performance issues related to fabrication and welding processes. As needed, this material will also be used during the May 10-12 workshop for planning long term testing.

1.2.2.3.3 Other Materials

This WBS element has not been funded in FY94.

1.2.2.3.4 Integrated Testing

This WBS element has been moved to WBS element 1.2.3.10.3; progress is reported in that element.

WBS 1.2.2.3.5 Non-Metallic Barrier Concepts

K. Wilfinger continued the survey of ceramic fabrication and joining techniques appropriate for the construction and closure of large, ceramic waste packages.

High quality alumina (Al_2O_3) ceramics still seem to be the most commonly available, large size technical ceramic products. There are a number of firms currently selling alumina tubing in lengths of 8-10 feet with diameters of about eight inches and a wall thickness of about 1/4". Two inches seems to be about the maximum wall thikness due to thermal transport properties during firing. Thinner is better. Other materials can be fabricated in the same size ranges, but there are significant cost disadvantages.

A proposal was submitted to LLNL management for the LDRD (laboratory directed R&D) competition; if funded, prototype design/construction of a ceramic waste package shell will begin.

An order was placed for the newly introduced ASTM Unified Classification Scheme for Advance Ceramics, PCN: 33-000005-09.

K. Wilfinger attended a short course on waste immobilization presented by Lou Vance, a scientist working on Synrock for ANSTO.

He also attended the 96th Annual Meeting of the American Ceramic Society in Indianapolis. Sessions were attended covering rapid prototyping, low thermal expansion ceramics, new materials and waste management.

Four significant contacts were made in the ceramics industry. One company sells boron based powders, platelets and fibers which can be used to make neutron absorbing composites. A second company manufactures refractory cements and castables. They claim to be able to make chemically bonded, cementitious seals for ceramics. The seal is reputed to support high vacuum and be impervious to penetration by moisture. A third compnay sells HIP/Pressure equipment. They are willing to bid on units large enough to accomplish joining of large ceramic parts for the YMP. They are just completing a contract with an undisclosed firm that is working in that area of research. The fourth company is a subsidiary of a manufacturer of furnace construction products including large gas-tight ceramic tubes. Although they had 8" diameter tubes 8' long on display, they were less than enthusiastic about the ability to hold tolerances on larger sizes. This is not surprising given that their products are slip cast, which often leads to some differential shrinkage during firing.

1.2.2.4 Design, Fabrication, and Prototype Testing

1.2.2.4.3 Container/Waste Package Interface Analysis

This WBS element has not been funded in FY94.

1.2.3 SITE INVESTIGATIONS

1.2.3.1 Site Investigations Coordination and Planning

LLNL staff participated in planning for the Planned Program Approach (Scenario A) re-baseline.

LLNL staff participated in the Design Integration Workshop in Las Vegas on April 5.

1.2.3.2 Geology

1.2.3.2.1.2.1 Natural Analogue of Hydrothermal Systems in Tuff

This WBS element has not been funded in FY94. Funding has been requested from the YMSCO WBS manager in order to write the Study Plan.

1.2.3.4 Geochemistry

1.2.3.4.2 Geochemical Modeling

Work is continuing on EQ3/6 Version 8.0. Other work conducted in April under this WBS will be discussed in the May report.

1.2.3.5 Drilling

1.2.3.5.2.2 Engineering, Design, and Drilling Support

Two downhole logging sessions were conducted at USW NRG-6. Hole inspections were performed on April 11 and 29. One downhole logging session was conducted at USW UZ14 on April 29 to monitor the water level.

1.2.3.10 Altered Zone Characterization

1.2.3.10.1 Characterization Techniques for the Altered Zone

Work completed in April under this WBS will be reported in May.

1.2.3.10.2 Characterization of Thermal Effects on the Altered Zone Performance

The study plan for this WBS is being written. Expected completion date is May 1994.

1.2.3.10.3 Integrated Testing

1.2.3.10.3.1 Integrated Radionuclide Release: Tests and Models

Work completed in April under this WBS will be reported in May.

1.2.3.10.3.2 Thermodynamic Data Determination

C. Palmer and R. Silva attended the Solubility Working Group Meeting held at YMSCO on April 5, 1994. A. Simmons (YMSCO), S. Nelson , D. Sassani (both of the M&O), J. Johnson (LLNL), D. Hobart (LBL), D. Clark, C. Duffy, J. Mercer-Smith, and D. Tait (all LANL) also attended. The group discussed qualification of thermodynamic and solubility data for use in modeling. In addition, future workscopes were discussed. C. Palmer presented the LLNL task workscope outlined in the new Activity Plan.

C. Palmer, R. Silva, and R. Stout met at LLNL with A. Simmons of YMSCO to discuss the task's Technical Implementation Plan. C. Palmer submitted revisions and modification to A. Simmons on April 8.

Procurement documents were completed and submitted to the LLNL TPO on April 29 for the NEA sub-contracts.

Information about YMP was given to the young women who visited the task's laboratories during "Take Our Daughters to Work Day" on April 28, 1994.

1.2.3.11 Integrated Geophysical Testing for Site Characterization

1.2.3.11.3 Geophysics - ESF Support, Subsurface Geophysical Testing

No significant activity. The work will resume when the capital and non-capital procurements have been received.

1.2.3.12 Waste Package Environment Testing

This WBS element was created from WBS element 1.2.2.2. Transfer of funding is not yet complete, but costs are now being reported to PACS using the new WBS structure.

1.2.3.12.1 Chemical and Mineralogical Properties of the Waste Package Environment

The revised Study Plan 8.3.4.3.4.1 (Waste Package Geochemistry and Mineralogy) that was sent to YMSCO is being reformatted to meet current format guidelines specified in the NRC-DOE Agreement.

Work completed in April under this WBS will be reported in May.

1.2.3.12.2 Hydrologic Properties of the Waste Package Environment

Study Plan 8.3.4.2.4.2 (Laboratory Determination of Hydrological Properties of the Near-Field Environment) has been reviewed by YMSCO. The author is resolving comments.

Analysis of Temperature and Relative Humidity Conditions in the Repository

To assist in the analysis of the temperature and relative humidity conditions in the repository, S. Daveler and J. Nitao developed a post-processor that calculates the relative humidity based on temperature, saturation, gas-phase pressure, and air mass fraction data. LLNL first reported on some of this analysis last month in WBS 1.2.1.5, but because some of the thermal loading conditions considered fall outside of those being considered by the thermal loading systems study, we continue the discussion of the analysis in this section. We assume a Youngest Fuel First SNF receipt scenario with a 10 yr cut-off for the youngest fuel (referred to as YFF(10) and account for the emplacement of BWR Waste Packages (WPs) containing 40 assemblies per WP, and PWR WPs containing 21 assemblies per WP. The waste receipt schedule was supplied by J. King of the M&O.

Because the relative humidity calculations are based on the smeared-heat-source, disk-shaped model of the repository, the relative humidity is based on averaged liquid saturation. Since it is more likely that saturation conditions will be drier in the immediate vicinity of WPs than at more distant locations (such as the centerline of the pillars separating emplacement drifts), relative humidity values based on average liquid saturation conditions tend to indicate values that are wetter than conditions in the emplacement drifts. Table 4 lists relative humidity as a function of liquid saturations S_ℓ and temperature, T, for TSw2 (the repository horizon). Note that for $S_\ell < 0.15$, relative humidity is extremely sensitive to S_ℓ. Under ambient conditions (T = 23.5°C and S_ℓ = 0.68), the relative humidity is 98.4%. Rock dry-out does not significantly reduce relative humidity unless a large percentage of the water is driven from the WP environment. A 56% reduction in S_ℓ (from 0.68 to 0.30) only reduces the relative humidity to the range of 92.8 to 95.3% (over the temperature range listed in Table 4), and 80% reduction in S_ℓ 0.68 to 0.13) is required to reduce the relative humidity to less than 70%. For 0.09< S_ℓ <0.12, relative humidity drops precipitously with S_ℓ. Therefore, if the average S_ℓ in the repository is in this range (S_ℓ < 0.2), small variations in S_ℓ can result in very large variations in relative humidity. Moreover, local saturations in the immediate vicinity of WPs need only be slightly drier than average in order for the local relative humidity to be much drier than average conditions in the repository.

Table 4
Relative Humidity as a Function of
Liquid Saturation and Temperature for TSw2

	Temperature		
Saturation	20°C	60°C	100°C
0.09	2	4	8
0.10	20	28	36
0.11	39	47	54
0.12	52	59	66
0.13	61	67	73
0.14	67	73	78
0.15	72	77	81
0.16	76	80	84
0.17	80	83	86
0.18	81	85	88
0.19	83	86	89
0.20	85	88	90
0.25	90	92	94
0.30	93	94	95
0.50	98	98	98
0.70	88	99	99
0.90	99	99.5	99.6

Another important point about WP conditions concerns differences in temperature and relative humidity conditions between the WP surface and the emplacement drift wall. It is reasonable to assume that, due to the relatively high gas-phase diffusivity, the vapor pressure will not vary substantially between the drift wall and WP surface. This is equivalent to saying that the absolute humidity will not vary substantially with radial distance from the WP surface within the drift. On the other hand, because the WP surface will be hotter than the drift wall, the relative humidity on the WP surface will be less than that on the drift wall. For the assumption of a uniform absolute humidity, the relative humidity on the WP, RH_{wp}, is given by the ratio in saturation pressure, P_{sat}:

$$RH\text{wp} = RH_{dw} \, [\, P_{sat}(T_{dw}) \,/\, P_{sat}(T_{wp}) \,] \qquad (3)$$

where RH_{dw} is the relative humidity at the drift wall and T_{dw} and T_{wp} are the drift wall and WP surface temperatures, respectively. For example, if T_{dw} and T_{wp} are 80 and 100°C, respectively, then the ratio in P_{sat} is 0.468, and if the drift wall is at ambient relative humidity (98.4%), then the WP surface would have a relative humidity of only 46%. For a better example, if T_{dw} and T_{wp} are 180 and 200°C, respectively, the relative humidity on the WP surface would be reduced by a factor of 0.645 relative to conditions on the drift wall. Because of its relatively low thermal conductivity, a granular backfill in the drift could result in a substantial, persistent temperature drop between the WP and drift wall although at the result of increased WP temperatures. Nevertheless, concepts for the Engineered Barrier System (EBS) should consider the impact of an engineered temperature drop on reducing the relative humidity on the surface of WPs.

Laboratory Experiments

During April, we continued measuring electrical resistivity at elevated temperatures as a function of moisture content of Topopah Spring tuff samples from the G-4 and GU-3 holes using J-13 water as pore fluid . The wetting phase measurements at 95°C were completed, and the data are being analyzed. Many samples broke during the measuring process. More samples will be prepared later.

We continued the experiment of determining the moisture retention curve and one-dimensional imbibition using G-4 core The data from this experiment will be used for calculating relative permeability as a function of water saturation. We continued the moisture retention experiments at high temperatures. Measurements at 95°C and about 95% relative humidity continued. The humidity sensor used to monitor the humidity level in the chamber failed, and it will be repaired.

We continued the experiment to determine the effect of confining pressure on the fracture healing, as observed previously by Lin and Daily. A fractured Topopah Spring tuff sample from the G-4 hole is being used. The sample is kept at a confining pressure of 1 MPa and a pore pressure of 0.5 MPa. Permeability as a function of effective pressure (confining pressure minus pore pressure) at room temperature was determined. Permeability as a function of temperature, at the same pressure, is being determined. The sample is at 100°C, and will be heated to about 150°C. So far, there is a slight decrease in permeability with respect to increasing temperature, but no fracture healing has been observed.

The calibration of a resonant cavity for measuring suction potential as a function of moisture content in rock samples and in the field was continued. The measurements of resonant frequency of several existing cavities, using the new network analyzer, continued. The high temperature constant humidity chamber, which will be used to calibrate the resonant cavity, has been repaired, and its performance is being monitored.

The evaluation of X-ray scan as a technique of monitoring the moisture content distribution in a rock sample continued. Using water doped with NaI as saturation fluid increased the resolution of the saturation level by a factor of two. This work will continue.

Meetings and Publications

T. Buscheck gave a presentation entitled "The Impact of Repository Heat on Thermo-Hydrological Behavior at Yucca Mountain" at the Nuclear Engineering Department's Waste Management Program at the University of California-Berkeley on April 9.

1.2.3.12.3 Mechanical Attributes of the Waste Package Environment

Work completed in April under this WBS will be reported in May.

1.2.3.12.4 Engineered Barrier System (EBS) Field Tests

A comment resolution meeting for Study Plan 8.3.4.2.4.4, (Engineered Barrier System Field Tests) is scheduled to be held on May 5, 1994.

Large Block Test (LBT)

The preparations for placing the large block in vertical compression are nearly complete. Compressing the block will protect it from vibrations induced by the surrounding excavation activities. The anchors to be used for the tie-down were not available; therefore, grouted rock bolts with couplers will be used instead. The rock bolts were grouted. The preparations for supporting the sides of the block also continued. REECo is purchasing straps to support the sides of the block during the early phase (the top few feet) of the excavation. The excavation work will start at the beginning of next month. The excavation has been delayed by over one month because of the procurement delays and delays in initiating the new REECo workorder.

LLNL worked with SNL staff to determine the cost to complete the sawing of the large block. A wire saw may be more cost effective in cutting the top off than constructing a new saw frame for the SNL saw and using the 19 foot bar from the commercial saw. A contractor in Beatty, NV has the capability to cut off the block top with a wire saw. A decision will be made in early May as to which option will be used.

A temperature control unit has been ordered for the heat exchange system which will be installed on the top of the block. The design of the heat exchange system is based on thermal conduction model calculations. A potential manufacturer for the bladders has been selected. A meeting will be scheduled with the representative of the manufacturer to discuss detailed design criteria for the bladders. The engineering design of the bladder support/housing devices was started.

The load-retaining frame fabrication continued. The delivery schedule of the frame was revised to the middle of July. RSN was instructed to provide 24 bolts for the frame manufacturer to test the assembling of the sections of the frame. The pull tests to evaluate the design of anchoring the frame were completed. RSN will use the results to design the anchor system. An engineering design review was initiated at LLNL on the LBT frame and fastener design in response to a comment by RSN regarding the safety factor used in the fastener design.

Laboratory tests continued on the performance of the Kapton heaters (to be used as guard heaters for the large block and as heaters for the small block experiments) and the potential insulation materials under a 5 MPa stress. Copper plates may be used to distribute heat from the guard heaters. Tests were started to evaluate the lateral temperature distribution on the surface of a copper plate, opposite to the heater. Thermal conduction model calculations continued to help design the guard heaters.

A Technical Implementation Procedure for the LBT has been written: Neutron Moisture Logging and Gamma Density Logging Procedures. The field sampling procedures for small blocks are being added to the LBT Activity Plan. Requirements of QPs 8.0 and 13.0 not covered in the Activity Plan will be documented in scientific notebooks.

LLNL staff met with representatives of the ESF Test Coordination Office, RSN, and REECo in Las Vegas on April 5 to do detailed planning for the execution of the second Job Package for the LBT.

Core sections from the vertical instrument holes were received at LLNL for determining porosity, density, pore size distribution, and mineralogy. These determinations will be begin next month. Preparation also continued of small blocks which were obtained from Fran Ridge for scoping experiments.

See WBS 1.2.2.3.2, Metal Barriers (Parameter Tests and Metal Degradation, Activity E-20-17), for information on sensor work performed in support of the LBT.

1.2.3.12.5 Characterization of the Effects of Man-Made Materials on Chemical & Mineralogical Changes in the Post-Emplacement Environment

Study Plan 8.3.4.2.4.5 was reformatted to meet the requirements of the NRC-DOE agreement. It was resubmitted to YMSCO on April 28.

<u>Diesel Exhaust Historical Analog Study</u>

This study has been initiated at the request of the M&O and is being conducted with the understanding that an additional $160k will be provided for this work before the end of FY94. The man-made materials task is conducting this study now in order to support a decision regarding hauling that must be made in August. Until the funding is received; man-made materials work effort for this study will appear as a variance.

Sample locations in N-tunnel were selected for their potential to show the greatest accumulated diesel deposits. The sites were selected as a result of an earlier reconnaissance survey and discussions with miners regarding diesel powered haulage systems and the timing of tunnel modifications. The rock wall near the floor and from the floor adjacent to the left rib at 1900 ft. in N-tunnel displays a clay-rich deposit that appears to have a component of soot. A number of factors lead us to believe that this deposit may contain accumulations from diesel exhaust. First, this location is well into the tunnel and therefore had less chance to ventilate than areas closer to the tunnel entrance. Second, the engines supposedly stopped at this point for loading and unloading. Third, the early hauling systems were not scrubbed and were exhausted low and to the left. Later mucking operations have removed the contaminated ground from the middle of the tunnel floor; this was replaced with a thick layer of gravel. Near the wall, however, we hope to have obtained floor samples from the original 1963 tunnel that were later contaminated by the exhaust scrubbing solution (TideTM).

Other work completed in March and April under this WBS element will be reported in May.

1.2.5 REGULATORY

1.2.5.1 Regulatory Coordination and Planning

LLNL staff participated in planning for the Planned Program Approach (Scenario A) re-baseline.

LLNL staff participated in the Design Integration Workshop in Las Vegas on April 5.

1.2.5.2 Licensing

1.2.5.2.2 Site Characterization Program

LLNL worked with the WBS Manager and M&O Integrators to accomplish the split of WBS 1.2.5.2.2 into a 1.2.3 part associated with study plans and a remainder with the existing WBS number. Because this area was under funded during FY94 planning, additional funds will be required in both WBS elements. Detailed justification is being provided to the M&O Integrator in support of CSCR preparation.

LLNL staff worked with the M&O seismic team to review the seismic design criteria for the ESF. This work was a follow-up to the LLNL participation in the FY93 seismic study led by the M&O.

J. Blink met with several NRC staff members at the Large Block Test site on April 13 and 19. Following the meetings, he arranged for controlled distribution of the LBT Activity Plan (Activity Plan-LBT-01) to John Gilray, the NRC on-site representative.

1.2.5.3 Technical Data Management

1.2.5.3.4 Geologic and Engineering Materials Bibliography of Chemical Species (GEMBOCHS)

In the JEWEL code development, several routines were revised, and GEMBOCHS datafiles based on bulk composition (e.g., element catalogs) now contain only that subset of basis and auxiliary basis species which appear in the dependent dissociation reactions for aqueous species, minerals, and gases. An improved algorithm was developed and incorporated for selecting and printing literature references associated with various user-defined datafiles.

FACET code development incorporated routines that permit users to add new literature references; these routines also ensure that all requisite information pertaining to such additional references is obtained from the user.

LLNL staff worked with INGRES technical support to develop and implement a "work-around" that effectively circumvented an INGRES software bug which had ultimately caused our local installation to crash, following several days of odd behavior.

J. Johnson presented an overview of the GEMBOCHS database and software library at the YMP-SOLWOG (Radionuclide Solubility Working Group) meeting in Las Vegas.

1.2.5.3.5 Technical Data Base Input

LLNL-YMP reorganized its process for TDB input. B. Bryan will obtain data-containing reports from LLNL authors. J. Blink will extract data for author review, and C. Passos will prepare the TDIFs.

1.2.5.4 Performance Assessment

1.2.5.4.2 Waste Package Performance Assessment

LLNL staff participated in a meeting called by R. Deklever, of the M&O, in Las Vegas on April 15. The meeting objective was to coordinate efforts on Source Term definition being conducted at LLNL EBS PA, M&O-PA, and in Determination-of-Importance evaluations.

1.2.5.5. Special Projects

1.2.5.5.1 Integrated Test Evaluation (ITE)

This activity has not been funded in FY94.

1.2.5.5.2 Energy Policy Act Support

R. Van Konynenburg attended a National Academy of Sciences Committee meeting on the Technical Bases for Yucca Mountain Standards and responded to the committee's questions on carbon-14.

1.2.9 PROJECT MANAGEMENT

1.2.9.1 Management and Coordination

1.2.9.1.2 Technical Project Office Management

LLNL staff participated in planning for the Planned Program Approach (Scenario A) re-baseline.

W. Clarke, D. McCright, and R. Van Konynenburg participated in an April 7 meeting at M&O Headquarters in Vienna, Virginia to discuss materials issues for the initial multi-purpose canister (MPC) procurement. See WBS 1.2.2.3.2 for further discussion.

J. Blink participated in the Infrastructure Reduction Assessment Team meeting in Las Vegas on April 21. At that meeting, the IRAT resolved comments on the proposed consolidated procedure to replace Test Planning Packages and Job Packages with a streamlined process. He also participated in the Quality Integration Group meeting in Las Vegas on April 28. J. Blink provided information to the M&O in support of the April 22 meeting of the Cost Reduction Steering Committee Group.

S. Lundeen attended the YMP-SAG (Software Advisory Group) meeting in Albuquerque, NM.

J. Blink met with D. Keller of the NTS Contractors Organization on April 21 to discuss the paper entitled "On the Benefits of an Integrated Nuclear Complex for Nevada" which will be presented at the International High Level Radioactive Waste Management Conference in May. He also met with Paul Christensen, Clark County Commissioner, on May 29 to discuss the paper and the LESSON Teacher Workshop Program.

J. Blink presented a hands-on science class to about 20 elementary school teachers at the Of Science and Mountains workshop in Las Vegas on April 5. He also developed and presented a critical thinking class to about 15 middle school teachers in a YMP sponsored workshop in Las Vegas on April 11. He presented a "Gee-Whiz" hands-on science class to 50 middle and high school students in Indian Springs, NV and to about 150 fourth and fifth graders at Tomiyasu Elementary School in Las Vegas on April 12. On April 22, J. Blink participated in a meeting of the Clark County School District curriculum committee; this committee involves local business people in CCSD planning. On April 22, Carol Passos and Jim Blink helped conduct the Second Annual Egg Drop Contest for about 400 elementary school students. Portions of the event were televised by KLAS-TV8. The event was organized by J. Blink, J. Brandt (YMP-SAIC), and Mark Pfister of Channel 8. Over 150 egg protection devices were dropped from a 100 foot high hook-and-ladder truck. About one-fourth of the creative projects protected the raw egg successfully. This event was an adaptation of a lesson in the OCRWM Science Curriculum.

1.2.9.2 Project Control

1.2.9.2.2 Participant Project Control

Actual schedule progress and costs were submitted to the PACS reporting system via the PACS workstation. Variance analysis explanations were developed.

The FY95 planning process for WBS Elements 1.2.2 and 1.2.3 has been delayed because of the ongoing shift in the DOE strategic plan for the Yucca Mountain Site Characterization Project. It is anticipated that the planning process will resume in May.

1.2.11 QUALITY ASSURANCE

Quality Assurance Coordination and Planning

No significant activity.

Quality Assurance Program Development

S. Lundeen provided a formal review of the proposed software QP revisions.

Quality Assurance Verification

Quality Assurance Verification - Audits

Notification of Audit 94-04 was distributed on March 24, 1994 and an entrance meeting was conducted on April 1, 1994. This audit will concentrate on LLNL-YMP Training and Qualifications of Personnel/Review of Technical Publications and included the following procedures/requirements:

1) 033-YMP-QP 2.9, Indoctrination and Training
2) 033-YMP-QP 2.10, Qualification of Personnel
3) 033-YMP-QP 3.3, Review of Technical Publications and Data

Corrective action for CARs LLNL-029 and LLNL-030 were completed and verified. Both CARs were closed on April 11, 1994.

Quality Assurance Verification - Surveillance

No surveillances occurred during the month of April.

Field Quality Assurance/Quality Control

No significant activities.

Quality Assurance - Quality Engineering

The QA office provided assistance to the Waste Form Characterization technical area, in the area of records submittal to the Local Records Center of Scientific Notebooks and back-up data.

1.2.12 INFORMATION MANAGEMENT

1.2.12.2 Records Management

1.2.12.2.2 Local Records Center Operations (LRC)

LLNL-YMP Document Control issued one revision and two change notices. Follow up continues on previously distributed documents.

1.2.12.2.3 Participant Records Management

A total of 200 items were logged into the LLNL-YMP tracking system. This includes forty-two records/records packages that were processed through to the CRF. Ten action items were closed.

April was designated as Records Awareness Month for LLNL-YMP. A Records Awareness brochure was created and distributed to each individual.

1.2.12.2.5 Document Control

LLNL received no funding under this WBS element for FY94. Work performed to complete LLNL's obligation in this WBS element is funded under WBS 1.2.12.2.2.

1.2.13.2 SAFETY AND OCCUPATIONAL HEALTH

1.2.13.2.5 Occupational Safety and Health

J. Blink met with W. Dixon, the YMSCO AMESH, to discuss LLNL-YMP ES&H activities in FY94 and FY95. Subsequent to the meeting, he provided a draft copy of an Oakland Operations Office management assessment of LLNL to W. Dixon. The assessment rated LLNL-YMP "excellent" and provided details on ES&H performance by LLNL-YMP personnel at the LLNL site.

1.2.15 SUPPORT SERVICES

1.2.15.2 Administrative Support

No significant activities.

1.2.15.3 Yucca Mountain Site Characterization Project (YMP) Support for the Training Mission

Currently there are ninety-eight participants on the project who are to be trained and/or tracked.

Both R. Glass and M. Whitbeck received indoctrination via the revised indoctrination process.

Programming has been completed on a new training database using software which will be "user friendly" and compatible with the MacIntosh computer. Scheduling of the testing phase and actual implementation have been put on hold temporarily.

LLNL PROJECT STATUS REPORT DISTRIBUTION

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Nelson, S-Tiss
Dixon
Dyer

5/31/94

May 20, 1994

LA-EES-13-05-94-008

I-357638

5-30-94

Mr. Robert M. Nelson, Acting Project Manager
Yucca Mountain Site Characterization Office
US Department of Energy
P.O. Box 98608
Las Vegas, NV 89193-8608

Dear Mr. Nelson:

Los Alamos Monthly Activity Report for April 1994; Highlights of Activity, Variance Analysis Report, and PACS Monthly Cost/FTE Report (SCPB: N/A)

Attached is the Los Alamos monthly activity report for April 1994, which includes the Highlights of the Monthly Activity Report, Variance Analysis Report, and PACS Monthly Cost/FTE Report.

The Highlights of the Monthly Activity Report is an internal document describing our technical work; however, it has not received formal technical or policy review by Los Alamos or the YMP. Data presented in this document constitute predecisional information, should not be referenced, and are not intended for release from the U.S. Department of Energy as referenceable information.

The Variance Analysis Report identifies cost and/or schedule variances, analyzes those variances as to cause, and establishes any corrective action necessary.

The PACS Monthly Cost/FTE Report presents a monthly summary of Los Alamos' effort on the YMP. This report provides monthly totals of cost, labor person-hours, subcontractor person-hours, outstanding commitments, and accruals, all at the third level of the WBS. In addition, updated annual budget, approved funds, and annual cost values are provided.

If you have changes to our distribution list, please call Susan Klein at (505) 667-0916.

Sincerely,

Julie A. Canepa

Julie A. Canepa

SHK/elm

Attachment: a/s

ENCLOSURE 6

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LA-EES-13 File, MS J521

Los Alamos Highlights for April 1994

WBS 1.2.3.1.1 Site Management. Janet Mercer Smith, Clarence Duffy, David Clark, and C. Drew Tait participated in the Solubility Working Group meeting in Las Vegas during the week of April 4.

Clarence Duffy, Ines Triay, Janet Mercer-Smith participated in the Geochemistry Integration Team meeting in Las Vegas on April 13. Topics discussed included the upcoming workshop on Validation of Geochemical Models for Performance Assessment; revisions of the Geochemistry White Paper; and outyear planning, taking into consideration Scenario A.

During the week of April 11, Los Alamos staff hosted Professor Claude Degueldre of the University of Geneva, who presented a seminar titled "A New Model to Describe Groundwater Colloid Properties." Degueldre also participated in discussions with staff on radionuclide transport at natural and anthropogenic analogs.

Los Alamos Technical Coordinators David Bish and Clarence Duffy; Principal Investigators David Vaniman, Ines Triay, and George Zyvoloski; and Los Alamos Project Leader for Site and Regulatory Investigations Janet Mercer-Smith hosted a meeting on April 24 with Ardyth Simmons (DOE) and Steve Nelson (Intera) at which they discussed planning for a Scenario A. They determined the major activities and milestones for FY 1995-1997 geochemistry and mineralogy/petrology activities. Findings from these activities will be inputted into DOE's 1998 decision on Yucca Mountain site suitability. The meeting was continued by teleconference on April 28.

WBS 1.2.3.2.1.1.1 Transport Pathways. Thick sections of calcite vein materials were prepared for joint USGS-Los Alamos studies of calcite precipitation. These sections will provide material for microsampling at the USGS to obtain stable-isotope data to compare with LANL mineral-chemical data. The sections will be used in integrated studies of fracture-lining calcites by the USGS and LANL to evaluate the role of calcite precipitates as markers of paleotransport and as possible participants in future waste-mineral interactions.

XRD data were regressed by S. Chipera to produce quantitative mineral abundances for 83 Sorption-task samples (WBS 1.2.3.4.1.2.1). Twenty-one additional Sorption-task samples were submitted for quantitative XRD analysis and are currently undergoing sample preparation. Results from these samples will be published as a letter report to be included in the May 1994 Los Alamos monthly report. For the fracture mineralogy task, eight samples from drill holes USW GU-3 and USW G-4 were analyzed by XRD. The GU-3 samples are from the shallower portion of the drill hole (108–210m), and once again they confirmed the presence of significant amounts of sepiolite and palygorskite in fractures of this drill hole.

B. Carlos discussed with interested project geologists the erionite occurrence in USW UZ-14. The core was put on display for all to examine (with a minimum of handling) using the binocular microscope.

WBS 1.2.3.2.1.1.2 Alteration History. A journal article titled "The mineralogy and temporal relations of coexisting authigenic minerals in altered tuffs and the utility of alkali zeolites as potential low-temperature dateable minerals" (G. WoldeGabriel, D. Broxton, and F. Byers) was transmitted to the Los Alamos TPO for programmatic and quality assurance review. A journal article on the petrography, mineralogy, and chemistry of calcite-silica deposits at Exile Hill in comparison with local spring deposits (D. Vaniman, D. Bish, and S. Chipera) was completed and is in technical review. Staff completed their responses to a set of comments from the State of Nevada on the Alteration History study plan. Most of the comments dealt with the conditions under which their long-term heating experiments were run. In their responses, the staff reiterated the position that their experimental priorities represented a reasonable use of time and resources. Other comments included many requests for information or research that are contained in other study plans, and the staff identified the relevant study plans or program elements.

WBS 1.2.3.2.5 Volcanism. Staff met in Las Vegas with George Thompson and representatives of the DOE to discuss the results of the ongoing review of research methods in the geophysics program for Volcanism studies. Meeting participants selected a group of experiments to assess the detectability of basalt intrusions through a combination of acquisition of aeromagnetic and ground magnetic data for the southern Half Pint range. They also determined that no assessment of the presence of magma bodies in the Yucca Mountain region will be attempted until the seismic reflection/refraction experiment across Crater Flat is completed and higher quality teleseismic data through the upgraded seismic net is available.

Frank Perry chaired a special session titled "Basalts of New Mexico: ages, eruptive, history, petrology, and petrogenesis" at the 1994 New Mexico Geological Society Spring Meeting in Socorro, NM. This session dealt extensively with dating of young basalts, an important issue for Volcanism studies at Yucca Mountain.

Bruce Crowe, Frank Perry, and Greg Valentine presented results of volcanic characterization studies, probabilistic volcanic risk assessment, and magmatic effects studies to the Nuclear Regulatory Commission's Advisory Committee on Nuclear Waste in Bethesda, Maryland, on April 20.

WBS 1.2.3.4.1.3 Speciation. Staff spent a great deal of effort relocating the 250 MHz NMR spectrometer to a more appropriate location in Los Alamos, and David Clark spent approximately two weeks bringing the spectrometer up to field. While the spectrometer was being moved and brought up to field, staff prepared oxygen-17-labeled samples of Np(V), Np(VI), Pu(V), and Pu(VI) for NMR study, which were examined using oxygen-17 NMR on a 500 MHz spectrometer. Staff reproduced their original observation of the Np(VI) resonance at 2899 ppm and also observed the Pu(V) resonance at 2400 ppm. Since observation will take a great deal of instrument time, the samples were shipped to another Los Alamos location so that they can be examined using the 300 MHz instrument located there. Unfortunately, because of a stand-down at this new facility, staff was forced to halt their experiments and leave the samples inside the facility. Following this, staff prepared a sample of oxygen-17-enriched Pu(IV) colloid to determine if NMR will aid in the difficult task of colloid characterization. Clark also spent a great deal of time gathering relevant thermodynamic data on the actinides of relevance to YMP for comparison with the values currently used in GEMBOCHS. He has found some significant inconsistencies, and these will be brought up at the next Solubility Working Group meeting in June.

To continue work on Np(V) hydrolysis and its temperature dependence, staff ordered parts so that they could use an autotitrator to control the pH of two thermostatted air-tight cells, one for the sample and the other for the background. In conjunction with the Sorption task, they collected near infra-red spectra for saturated Np solutions in carbonate solutions equivalent to J-13 and UE-25 p#1 waters. These spectra confirmed a mixed NpO_2^+ / $NpO_2(CO_3)^-$ mixture for the former solution and essentially only $NpO_2(CO_3)^-$ for the latter solution. Such information served as a sanity check for EXAFS experiments done previously, in which significant differences in the EXAFS spectra were not seen.

Staff also began a spectroscopic determination of the oxidation state distribution of a Pu sample (2 ml of 48 nM Pu at pH = 6) submitted by LBL. (This sample is not ideal for a first determination because of its low concentration.) Pu(IV) and Pu(VI) have strong, distinct absorption bands, and their strategy was to look for them. Pu(V) does not have such distinct bands, so its contribution in very dilute solutions to the oxidation state distribution will be found by difference. The sample showed no Pu(IV) or Pu(VI) absorption peaks in spectral regions where they might be expected; therefore, they tentatively concurred with the LBL solvent extraction finding that Pu(V) is the predominate oxidation state.

Papers, abstracts, and milestones approved by YMPO
Milestone 3356, Fabryka-Martin et al., "Distribution of Chlorine-36 in the Unsaturated Zone at Yucca Mountain: An Indicator of Fast Transport Paths"

Kung and Triay, "Effect of Natural Organics on Cd and Np Sorption"

Poths et al, "Helium Surface Exposure Ages at the Lathrop Wells, NV, Volcanic Center"

Valentine et al., "Use of Natural Analog and Modeling studies to Constrain the Effects of Magmatic Activity on Long-term Geologic Repositories"

Papers, abstracts, and milestones completed and forwarded to YMPO
Conca, "Selenite Transport in Unsaturated tuff from Yucca Mountain"

Gable et al., "Site Scale Modeling of Radionuclide Transport at Yucca Mountain, Nevada: Grid Generation and Reactive Tracers"

Milestone 3347, Hawley and Rogers, "AFM Studies of Natural Mineral Surfaces I: Goethite Surface Microtopography and Reactions"

YMP PLANNING AND CONTROL SYSTEM (PACS)

Participant:	LANL		MONTHLY COST/FTE REPORT					Fiscal Month/Year Apr FY1994	
Date Prepared:	12-May-94							Page 1	
								Fiscal Year 1994	
WBS Element	Actual Costs	Participant Hours	Subcon Hours	Purchase Commitments	Subcon Commitments	Accrued Costs*	Approved Budget	Approved Funds	Cumulative Costs
1.2.1	0.0	0.0	0.0		0.0		40.0	32.8	1.6
1.2.3	868.0	3,914.4	2,265.6		930.6		9,353.0	7,025.5	5,019.7
1.2.5	65.2	211.7	298.7		77.8		725.0	660.4	372.9
1.2.6	129.4	940.8	511.2		134.5		2,120.0	1,738.7	999.4
1.2.9	93.3	687.1	505.9		72.9		1,220.0	921.1	593.6
1.2.11	153.5	322.6	1,272.6		149.7		1,200.0	918.9	700.0
1.2.12	43.8	31.9	504.7		219.0		500.0	447.9	247.1
1.2.13	5.0	16.8	45.2		72.8		100.0	75.0	30.9
1.2.15	52.0	80.6	252.0		78.3		538.0	422.3	309.3
Totals	1,410.2	6,205.9	5,655.9		1,735.6	0.0	15,796.0	12,242.6	8,274.5

Robert Spiro
8-702-794-1983

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: April 30, 1994

PARTICIPANT: LANL PEM: D. Williams WBS: 1.2.3.1

WBS TITLE: Site Investigations, Coordination & Planning

P&S ACCOUNT: 0A31

FY 1994 Cumulative to Date									FY 1994 at Completion					
BCWS	BCWP	ACWP	SV	SV%	SPI	CV	CV%	CPI	BAC	EAC	VAC	VAC%	IEAC	TCPI
438	438	577	0	0.0	100.0	-139	-31.7	75.9	806	891	-85	-10.5	1062	117.2

Analysis

Cumulative Cost Variance:

The negative $139k cost variance is directly attributable to incorrect costing of effort to this account by another Los Alamos participant group. This error will be recitified in time for upload of the May, 1994 status.

Cumulative Schedule Variance:

(Not reportable.)

Variance At Complete:

As discussed in the "Cumulative Cost Variance" section above, the costing error causing this variance will be corrected before the next upload.

PARTICIPANT: LANL   PEM: Ardyth Simmons   WBS: 1.2.3.4.1.4.1

WBS TITLE: Dynamic Transport Column Experiments

P&S ACCOUNT: 0A34141

FY 1994 Cumulative to Date									FY 1994 at Completion					
BCWS	BCWP	ACWP	SV	SV%	SPI	CV	CV%	CPI	BAC	EAC	VAC	VAC%	IEAC	TCPI
451	456	649	5	1.1	101.1	-193	-42.3	70.3	834	909	-75	-9.0	1186	145.4

Analysis

Cumulative Cost Variance:

The variance shown this month for this P&S account is due to the continuing presence of a component summary account (Liquid Scintillation Counter), showing cost with no budget (as previously discussed, this item was budgeted in FY 93, and apparently cannot be removed from PACS even though it was costed in FY 94); the variance is also due to greater than anticipated spending in another component summary account, during the first six months of the fiscal year. The ETC's for that account have been adjusted to reflect a more realistic spending pattern.

Cumulative Schedule Variance:

(Not reportable.)

Variance At Complete:

(Not reportable.)

PARTICIPANT: LANL PEM: Ardyth Simmons WBS: 1.2.3.9.7

WBS TITLE: Special Studies: ESF Test Coordination

P&S ACCOUNT: 0A397

FY 1994 Cumulative to Date									FY 1994 at Completion					
BCWS	BCWP	ACWP	SV	SV%	SPI	CV	CV%	CPI	BAC	EAC	VAC	VAC%	IEAC	TCPI
559	559	424	0	0.0	100.0	135	24.2	131.8	986	936	50	5.1	748	83.4

Analysis

Cumulative Cost Variance:

The cumulative cost variance for this account is--as noted in last month's VAR for this account--attributed to a delay in implementing double-shifts for Los Alamos personnel at the ESF, due to delays in deployment of the TBM (originally planned to begin in March, 1994). This double-shift staffing is still anticipated to occur in the second half of FY94, prior to TBM delivery, as site preparation work increases; costing of that increased effort is expected to partially offset this variance. A possible true underrun of approximately $100k is still possible in this account.

Cumulative Schedule Variance:

(Not reportable.)

Variance At Complete:

(Not reportable.)

PARTICIPANT: LANL PEM: M. Brodsky WBS: 1.2.6.1.6

WBS TITLE: Explor. Stud. Faci. (ESF) Test Management

P&S ACCOUNT: 0A616

FY 1994 Cumulative to Date									FY 1994 at Completion					
BCWS	BCWP	ACWP	SV	SV%	SPI	CV	CV%	CPI	BAC	EAC	VAC	VAC%	IEAC	TCPI
563	563	369	0	0.0	100.0	194	34.5	152.6	1000	885	115	11.5	655	84.7

Analysis

Cumulative Cost Variance:

Erroneous costing corrections are underway but not yet complete for this account, resulting in the variance seen here and discussed in the March 1994 variance for 0A616. Completion of these corrective actions is still expected to reduce this variance to within threshold levels within the next two reporting periods.

Cumulative Schedule Variance:

(Not reportable.)

Variance At Complete:

The explanation for this variance is directly linked to that discussed above under "Cumulative Cost Variance"; analysis of this account does, however, suggest the possibility of a true underrun at-completion. This will become clearer at the next reporting period.

Julie A. Canepa 5/16/94
P&S ACCOUNT MANAGER DATE

Julie A. Canepa 5/16/94
TPO DATE

WBS: 1.2.9.1
QA: N/A

Los Alamos

NATIONAL LABORATORY
Earth and Environmental Sciences Division

EES-13—Nuclear Waste Management R&D
Mail Stop J521, Los Alamos, NM 87545
Phone (505) 667-9768, Fax (505) 667-1934

June 16, 1994

LA-EES-13-06-94-001

Mr. Robert M. Nelson, Acting Project Manager
Yucca Mountain Site Characterization Office
US Department of Energy
P.O. Box 98608
Las Vegas, NV 89193-8608

I-358699

Dear Mr. Nelson:

Los Alamos Monthly Activity Report for May 1994; Highlights of Activity,Variance Analysis Report, and PACS Monthly Cost/FTE Report (SCPB: N/A)

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Sincerely,

Julie A. Canepa

Julie A. Canepa

SHK/afa

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6/24/94

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J.A. Mercer-Smith, EES-13, MS J521
M.D. Voegele, SAIC, Las Vegas, NV
RPC File (2), MS M321
LA-EES-13 File, MS J521

Los Alamos Highlights for May 1994

WBS 1.2.3.1.1 Site Management. Staff met with R. Patterson and J. D'Lugosz for a Scenario A planning session on hydrology activities. Staff also attended a Scenario A planning meeting at SNL on 16 May.

J. Mercer-Smith met with A. Simmons to discuss proposed colloid transport studies at the Nevada Test Site. If funded, those studies would be conducted in collaboration with a NTS drill-back of a past nuclear weapons test and would investigate whether radionuclide migration has occurred (and if it has occurred, by what mechanism) in the unsaturated zone.

Staff attended the Solubility Working Group meeting in Las Vegas.

WBS 1.2.3.2.1.1.1 Transport Pathways. Staff addressed comments on "Mineralogic Variation in Drill Core UE-25 UZ-16, Yucca Mountain, Nevada" (Milestone 3372). The revisions will be completed by early June.

Quantitative XRD and scanning-electron microscopy studies were largely completed this month for the report on silica leaching along fractures (Milestone 4031). This letter report will be completed during June.

Quantitative XRD analyses were completed for 25 samples used in Sorption task (WBS 1.2.3.4.1.2.1) research. Results of these studies were presented in "Letter Report: Quantitative X-ray Diffraction Results for Samples used for the Sorption Task" (Milestone 4045), which will be included in the detailed Los Alamos May monthly report. A total of 128 quantitative XRD determinations were summarized, plus an additional 49 XRD analyses of "pure" mineral specimens used in sorption studies. (The samples used are mostly pure, but include some materials with a range of other intermixed constituents.) Their results indicate no significant differences in mineralogy between various aliquots that received differing treatments prior to sorption studies. High Np sorption by surface calcretes appeared not to be attributable to sorption by sepiolite because pure-mineral tests with sepiolite indicated no enhancement of sorption. Other factors will have to be evaluated to determine the cause of high Np sorption by calcretes.

Calcite separations and sample preparation were underway on calcite-bearing fractures from the lower portion of drill core UZ-16. The separated calcites will be used in studies to evaluate the role that calcite may play in defining transport pathways and in possible waste interactions.

Thirty-three samples of core from UZ-14 between 414 and 433 m depth have been received from the SMF; these samples will be studied to evaluate the potential occurrence of erionite in this interval. Erionite is a potential inhalation health hazard and previous studies have indicated that it occurs only in restricted locations or in very low abundances at Yucca Mountain.

Staff attended the International High-Level Radioactive Waste Management Conference in Las Vegas, 22-26 May. D. Vaniman presented a paper titled "Inferences of Paleoenvironment from Petrographic, Chemical and Stable-Isotope Studies of Calcretes and Fracture Calcites," which was co-authored with J. Whelan of the USGS. This paper defines a unique interval of isotopically light carbon in calcite precipitated at the interface between B and K soil horizons at Yucca Mountain; the uniqueness of this horizon should be taken into account in sampling for paleoenvironmental studies.

WBS 1.2.3.2.1.1.2 Alteration History. S. Levy attended a meeting in Las Vegas on 3 May on the status of research relevant to repository thermal effects issues. She made a brief presentation on mineralogy-petrology research pertinent to thermal effects, which included references to D. Vaniman's studies of Topopah Spring vitrophyre glass dehydration and rehydration, W. Carey's studies of zeolite and clay dehydration and rehydration, long-term steam heating experiments by S. Chipera and D. Bish, and Yucca Mountain natural analog studies by Levy and Bish.

An abstract titled "Hydration Energetics of Zeolites" by W. Carey and D. Bish was prepared for the upcoming Clay Minerals Society annual meeting. New data for the hydration energetics of Na, K, Ca, and Mg end-member clinoptilolite obtained from thermogravimetric equilibration studies were used to develop a model of the hydration energetics in zeolites. Another abstract submitted to the same meeting is titled "The Nature of Interlayer Water in Smectite" by S. Chipera, W. Carey, and D. Bish. The abstract discusses the results of recent experiments on the interactions of water in the smectite structure during hydration and dehydration under variable water vapor pressures. A journal article on the petrography, mineralogy, and chemistry of calcite-silica deposits at Exile Hill in comparison with local spring deposits (D. Vaniman, D. Bish, and S. Chipera) was undergoing technical review.

Staff attended a scoping meeting in Albuquerque for the U.S. Nuclear Waste Technical Review Board meeting to be held 12-13 July. Within the technical theme of radionuclide mobilization and movement, the Board has specified an interest in the origin, movement, and retardation of colloids. Levy will make a presentation on natural analog studies at Yucca Mountain pertinent to colloid transport under repository hydrothermal conditions.

WBS 1.2.3.2.1.2 Stability of Minerals and Glasses. D. Bish and L. Wichman traveled to Penn State and Yale Universities to perform a Quality Assurance survey and to conduct training. Personnel orientations were conducted, position descriptions were finalized, and M&TE calibrations were formalized. A contract to Penn State University was let this month. Researchers at both Penn State and Yale are now working in earnest on zeolite preparation and measurement of dissolution and precipitation kinetics.

Penn State completed efforts to purify a large amount of clinoptilolite from Castle Creek, Idaho, and they also concluded Na cation-exchange experiments on the purified material.

Yale continued their efforts to determine the effect of Al, Si, and the degree of saturation on analcime dissolution at 80°C, and they began preliminary experiments on the effect of pH and temperature on the dissolution rate of analcime.

During April three new flow-through experiments were started, two at 80°C and one at 25°C. Several stages with high-input concentrations of Al and Si were started in order to measure dissolution rates under conditions near equilibrium; these experiments should be completed shortly. Yale also began to examine the pH effect on the dissolution rate of analcime under alkaline conditions.

WBS 1.2.3.2.5 Volcanism. "Status of Volcanic Hazard Studies for the Yucca Mountain Site Characterization Project" (Milestone 3422) was completed and submitted to DOE for policy review. This 450+ page report documents over 10 years of Los Alamos volcanism studies, particularly those studies completed in the last 5 years. The report also fulfills Milestones 3396, "Revised Geologic Map of the Lathrop Wells Volcanic Center," Milestone T055, "Revised Probability Calculations," and Milestone 3238, "Frequency of the Occurrence of Quaternary Basalt in the Central Great Basin by Structural Setting."

A paper titled "Dikes vs. Sills at the Paiute Ridge Intrusive Complex, Southern Nevada" by G. A. Valentine, F. V. Perry, and B. M. Crowe was prepared for submission to the journal *Science*. This paper fulfills Milestone 4022, "Letter Report on Magma System Dynamics."

WBS 1.2.3.4.1.1 Groundwater Chemistry Model. Staff evaluated the compositional data available for the chemistry of unsaturated zone waters at Yucca Mountain. Data on the chemistry of precipitation (i.e., rain and snow) at Yucca Mountain and at two sites north of the Nevada Test Site were also evaluated. Based on the initial evaluation, it appeared that the chemistry of precipitation and chemical processes in the soil zone have a dominant influence on the chemistry of unsaturated zone waters at Yucca Mountain. There is no evidence for substantial water-rock interaction in samples from non-zeolitic units. In zeolitic units, calcium and magnesium are exchanged for sodium, leading to depletion of calcium and magnesium in the waters and enrichment of sodium in the waters. The chemical evolution of groundwater at Yucca mountain appeared to be different from the evolution of unsaturated zone groundwaters at Rainier Mesa, northeast of Yucca Mountain. At Rainier Mesa, evidence for rock-water interactions was found in the chemistry of fracture waters collected in the tunnels beneath the mesa. The chemistry of these waters showed effects of the attack of carbonic acid on the tuffaceous rocks above the tunnels.

Estimates of net infiltration rates in the unsaturated zone in Yucca Mountain at UZ-4, UZ-5, and UZ-16 were derived, based on a chloride-balance calculation. The estimates range from approximately 0.2 to 0.9 mm/yr, depending on the depth from which the waters were sampled. These calculations assumed winter precipitation compositions most closely reflect the compositions of infiltration at the surface. Further details of this calculation were provided in a letter to the Los Alamos TPO, which is included in the detailed May 1994 monthly report.

WBS 1.2.3.4.1.2 Sorption and WBS 1.2.3.4.1.4 Dynamic Transport. Using natural fractures coated with zeolites and oxide minerals, staff began transport experiments involving fractured-tuff columns. Batch sorption coefficients were measured in the pure mineral separates coating the fractures. The column experiments will validate the use of sorption parameters to quantify radionuclide retardation through fractures. Non-sorbing radionuclides were being used to determine the hydrological parameters of the fractures. Sorbing radionuclides (such as Cs-137 and Np-237) will be used to study radionuclide reatardation through the fractured columns.

WBS 1.2.3.4.1.3 Speciation/Solubility. ***Speciation.*** As discussed last month, staff decided to ship their Np(V) and Pu(IV) colloid samples to the Los Alamos Plutonium Facility in order to use the 300 MHz instrument located there. Because of a self-imposed stand down at that facility, they have been unable to use the instruments there or ship the samples back to another instrument. They then prepared to ship their remaining samples to another Los Alamos facility for study on a high-field 500 MHz instrument. That instrument was scheduled for a computer upgrade, which arrived at about the same time as the samples, so these samples could not be examined either. Because these two instruments were not available, the staff was not able to acquire very important high-field NMR data on Pu(IV) colloid and Np(V) carbonate samples. The Np data are very important to determine the speciation for the extreme ends of the carbonate system; this data will be used to help fit the thermodynamic constants for the Np(V) system studied by Tait and Eckberg by conventional UV-VIS-NIR spectroscopy.

D. Clark and D. Palmer were assaying all the Pu and Np stock solutions in preparation for the upcoming 15 June nuclear materials inventory, which is a shut-down, clean-out audit; no samples will be permitted to be shipped until the Nuclear Material Balance Area is released by the DOE. Clark and Palmer will prepare and ship fresh Np(V) NMR samples in the first week of June in an attempt to continue work during the audit, with the assumption that the new preamp housing for the NMR will be available. Pu(IV) colloid scoping experiments will be put on hold until instrument repairs are complete.

D. Clark gathered additional thermodynamic data on the actinides relevant to YMP for comparison with the values currently used in GEMBOCHS. He also examined the thermodynamic data for technetium and found some rather distressing inconsistencies that will be brought up at the Solubility Working Group meeting in Las Vegas. J. Johnson at LLNL will perform some scoping modeling calculations using thermodynamic parameters supplied by Clark.

Staff also worked on PAS spectroscopic determination of oxidation-state distribution on a Pu sample sent by D. Hobart at LBL. They found that the percentage of Pu(IV) in the sample was < 30%, while that of Pu(VI) was < 50%. The remainder is assumed to be Pu(V), so the percentage of Pu(V) is at least 20% and probably significantly higher. Therefore, they noted the oxidation of the initially Pu(IV) sample, which is in agreement with the solvent extraction technique and suggests that most of the sample is in the Pu(V) state. This unscheduled work has reduced the time that would have been devoted to Np-hydrolysis work and may contribute to a delay in meeting the corresponding milestone.

Solubility. Staff completed both the Np and Pu oversaturation experiments in 0.1 M $NaClO_4$, and they are currently analyzing the solids isolated from these solutions.

Staff also completed the Am/Nd pH 8.5 experiment but continued the Am/Nd at pH 6 and 7. They assayed these solutions once since then and found that the pH 7 Am/Nd solution was at steady-state. They will assay this solution once more, perform the oxidation state determination, and then stop this solution. They will isolate the solid from this solution and attempt to identify it using XRD. With regard to the pH 6 Am/Nd solution, the staff will continue to monitor this solution over the next month. We currently have no explanation for the sharp decrease in Am/Nd concentration seen in this solution.

Staff disposed of excess solids from earlier J-13 and UE-25p #1 experiments and are continuing their efforts, in collaboration with LBL's ES&H department, to dispose of the 4000+ counting samples from the aforementioned experiments.

At Los Alamos, W. Efurd conducted experiments to assess the thermal stability of the reaction vessel-heating block assembly at 90°C. This assembly performed satisfactorily (ranged within ±1°C of 90°C with no leaks) at this temperature.

WBS 1.2.3.9.7 ESF Testing. Staff provided day-shift field coordination and PI support for ESF Test Alcove #1. Planning on the Phase 3 (Ramps & Main) ESF tests continued, including support for the CRWMS M&O test-to-test, test-to-construction, and waste isolation evaluations. Staff continued to finalize the planning packages for the radial borehole test.

A status report was issued on the second deployment of the laser-induced breakdown spectroscopy (LIBS). Work was under way to evolve the LIBS system for measurements to accommodate testing needs in conjunction with TBM operations. A report on this subject will appear in the detailed May 1994 monthly report.

Work continued on assembling files in the Field Document Records Center for activities conducted in the starter tunnel and the starter tunnel alcove. This effort includes the maintenance of an administrative database that identifies sample locations and their corresponding photo identifiers.

WBS 1.2.6.1.6 ESF Test Management. Staff prepared and initiated revisions of documents for the second phase of test facility construction of the LLNL large block experiment. This program is being implemented under the control of a series of job package records and a test planning record. The site preparation portion of the work at Fran Ridge was completed. The test construction phase of the large block experiment was proceeding as planned.

Publications

Boak, D. et al., "Exploratory Studies Facility Test Implementation and Integration with Construction and Design," High Level Radioactive Waste Management, Proc. 5th Annual International Conference, Las Vegas, Nevada (Amer. Nuc. Soc. and Amer. Soc. Civil. Eng.). pp. 1770-1774.

Conca, J. and I. Triay, "Selenite Transport in Unsaturated Tuff from Yucca Mountain," High Level Radioactive Waste Management, Proc. 5th Annual International Conference, Las Vegas, Nevada (Amer. Nuc. Soc. and Amer. Soc. Civil. Eng.). pp. 2175-2182.

Curtis, D. et al., "Radionuclide Release Rates from Natural Analogues of Spent Fuel," High Level Radioactive Waste Management, Proc. 5th Annual International Conference, Las Vegas, Nevada (Amer. Nuc. Soc. and Amer. Soc. Civil. Eng.). pp. 2228-2236.

Fabryka-Martin, J. et al., "Distribution of Chlorine-36 in the Unsaturated Zone at Yucca Mountain: An Indicator of Fast Transport Paths," *Proceedings of the Topical Meeting on Site Characterization and Model Validation (FOCUS '93)*, American Nuclear Society, Las Vegas, Nevada, September 26-29,1993, 58-68.

Levy, S., and G. Valentine, "Natural Alteration in the Cooling Topopah Spring Tuff, Yucca Mountain, Nevada, as an Analog to a Waste-Repository Hydrothermal Regime," *Proceedings of the Topical Meeting on Site Characterization and Model Validation (FOCUS '93)*, American Nuclear Society, Las Vegas, Nevada, September 26-29,1993,145-149 (Milestone 3381).

Meijer, A., "Far-field Transport of Carbon Dioxide: Retardation Mechanisms and Possible Validation Experiments," *Proceedings of the Topical Meeting on Site Characterization and Model Validation (FOCUS '93)*, American Nuclear Society, Las Vegas, Nevada, September 26-29,1993,110-112.

Vaniman, D. and J. Whelan, "Inferences of Paleoenvironment from Petrographic, Chemical and Stable-Isotope Studies of Calcretes and Fracture Calcites". High Level Radioactive Waste Management, Proc. 5th Annual International Conference, Las Vegas, Nevada (Amer. Nuc. Soc. and Amer. Soc. Civil. Eng.), pp. 2730-2737.

Papers, abstracts, and milestones approved by YMSCO

Bolivar et al., "The transition to a revised quality assurance standard"

Carlos, B., "Field Guide to Fracture Lining Minerals"

Gable et al., "Site Scale Modeling of Radionuclide Transport at Yucca Mountain, Nevada: Grid Generation and Reactive Tracers"

Hawley, M. and P. Rogers, "Iron Oxide Mineral-Water Interface Reactions Studied by AFM"

P. Reimus et al, "Simultaneous Transport of Synthetic Colloids and a Nonsorbing Solute through single Saturated Natural Fractures"

Rogers, P. and S. Chipera, "Sorption Characteristics of Yucca Mountain Tuffs as a Function of Particle Size, Surface Area, and Water Composition"

Papers, abstracts, and milestones completed and forwarded to YMSCO

Carey, W., "Hydration Energetics of Zeolites"

Crowe et al., "Volcanism Status Report"

Kohler et al, "Neptunium(V) Sorption on Hematite in Aqueous Suspension: Effects of Carbonate and EDTA"

YMP PLANNING AND CONTROL SYSTEM (PACS)

Participant:	LANL		MONTHLY COST/FTE REPORT					Fiscal Month/Year May FY1994	
Date Prepared:	13-Jun-94							Page 1	
								Fiscal Year 1994	
WBS Element	Actual Costs	Participant Hours	Subcon Hours	Purchase Commitments	Subcon Commitments	Accrued Costs*	Approved Budget	Approved Funds	Cumulative Costs
1.2.1	0.0	0.0	0.0		0.0		40.0	36.0	1.6
1.2.3	650.4	4,999.7	1,078.5		786.7		9,353.0	8,239.3	5,670.1
1.2.5	59.8	305.8	267.3		63.5		725.0	660.4	432.6
1.2.6	256.3	1,068.5	1,878.4		129.5		2,120.0	1,908.0	1,255.8
1.2.9	143.9	702.2	663.4		59.2		1,220.0	1,098.0	737.5
1.2.11	117.7	263.8	816.8		121.7		1,200.0	1,080.0	817.7
1.2.12	52.5	122.6	411.0		176.2		500.0	450.0	299.6
1.2.13	5.9	16.8	52.4		58.6		100.0	90.0	36.8
1.2.15	57.3	87.4	302.5		69.6		538.0	484.2	366.6
Totals	1,343.8	7,566.7	5,470.3		1,465.0	0.0	15,796.0	14,045.9	9,618.3

Robert Spiro
8-702-794-1983

PARTICIPANT: LANL   PEM: Ardyth Simmons   WBS: 1.2.3.2.5.5.1

WBS TITLE: Characterization of Volcanic Features

P&S ACCOUNT: 0A32551

FY 1994 Cumulative to Date									FY 1994 at Completion					
BCWS	BCWP	ACWP	SV	SV%	SPI	CV	CV%	CPI	BAC	EAC	VAC	VAC%	IEAC	TCPI
376	310	344	-66	-17.6	82.4	-34	-11.0	90.1	572	485	87	15.2	635	185.8

Analysis

Cumulative Cost Variance:

(Not Reportable.)

Cumulative Schedule Variance:

(Not reportable.)

Variance At Complete:

The EAC calculated for this account is erroneous data input by Los Alamos Project Control staff, which was not corrected until after this data was uploaded on 6/13/94. The data should reflect the correct situation in this account in the next upload.

PARTICIPANT: LANL   PEM: Ardyth Simmons   WBS: 1.2.3.4.1.4.1

WBS TITLE: Dynamic Transport Column Experiments

P&S ACCOUNT: 0A34141

FY 1994 Cumulative to Date									FY 1994 at Completion					
BCWS	BCWP	ACWP	SV	SV%	SPI	CV	CV%	CPI	BAC	EAC	VAC	VAC%	IEAC	TCPI
531	535	717	4	0.8	100.8	-182	-34.0	74.6	834	904	-70	-8.4	1118	159.9

Analysis

Cumulative Cost Variance:

The variance shown this month for this P&S account is due to the continuing presence of a component summary account (Liquid Scintillation Counter), showing cost with no budget (as previously discussed, this item was budgeted in FY 93, and apparently cannot be removed from PACS even though it was costed in FY 94); the variance is also due to greater than anticipated spending in another component summary account, during the first seven months of the fiscal year. Los Alamos Project Control staff are working with the principal investigator in question to control the overrun.

Cumulative Schedule Variance:

(Not reportable.)

Variance At Complete:

(Not reportable.)

PARTICIPANT: LANL   PEM: Ardyth Simmons   WBS: 1.2.3.9.7

WBS TITLE: Special Studies: ESF Test Coordination

P&S ACCOUNT: 0A397

FY 1994 Cumulative to Date									FY 1994 at Completion					
BCWS	BCWP	ACWP	SV	SV%	SPI	CV	CV%	CPI	BAC	EAC	VAC	VAC%	IEAC	TCPI
640	640	428	0	0.0	100.0	212	33.1	149.5	886	845	41	4.6	593	59.0

Analysis

Cumulative Cost Variance:

New staff, discussed in April, 1994 VAR for this account, have been hired and the ETC's adjusted accordingly. Additionally, the Project Office has reduced the BAC in this account by $100k, pursuant to C/SCR No. 94/187

Cumulative Schedule Variance:

(Not reportable.)

Variance At Complete:

(Not reportable.)

PARTICIPANT: LANL PEM: M. Brodsky WBS: 1.2.6.1.6

WBS TITLE: Explor. Stud. Faci. (ESF) Test Management

P&S ACCOUNT: 0A616

FY 1994 Cumulative to Date									FY 1994 at Completion					
BCWS	BCWP	ACWP	SV	SV%	SPI	CV	CV%	CPI	BAC	EAC	VAC	VAC%	IEAC	TCPI
657	657	474	0	0.0	100.0	183	27.9	138.6	1000	989	11	1.1	722	66.6

Analysis

Cumulative Cost Variance:

Erroneous costing corrections are underway but not yet complete for this account, resulting in the variance seen here and discussed in the March 1994 variance for 0A616. Completion of these corrective actions is still expected to reduce this variance to within threshold levels within the next two reporting periods. In addition, ETC's have been adjusted to reflected newly hired staff in this effort.

Cumulative Schedule Variance:

(Not reportable.)

Variance At Complete:

(Not reportable.)

jc 6/16/94

Julie A. Canepa 6/16/94
P&S ACCOUNT MANAGER DATE

Julie A. Canepa 6/16/94
TPO DATE