LAWRENCE LIVERMORE NATIONAL LABORATORY YUCCA MOUNTAIN PROJECT
MARCH 1994 TECHNICAL HIGHLIGHTS AND STATUS REPORT

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

May 1994

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

1) **WBS 1.2.1.5, Special Studies:** LLNL has conducted a series of analyses in support of the Thermal Loading Systems Study, to evaluate an assumption of TSPA-93. The Total Systems Performance Assessment assumed that Waste Packages (Wps) re-wet at the end of the boiling period. The new calculations show that the assumption, which resulted in accelerated corrosion at the end of the boiling period for high thermal loads, is flawed. For example, areal mass loadings of 55.3 and 110.5 MTU/acre were compared. The inner half of the low thermal load repository has a relative humidity of 81% at the end of boiling (1760 yr). The same region of the high thermal load repository boils until 6130 yr, and has a much lower relative humidity (44%) at the end of boiling. It doesn't re-wet to 81% relative humidity until 29,000 yr, and the temperature at that time is only 53°C. Clearly, assumption of hot wet conditions at 6130 yr for the high thermal load repository was overly conservative. Since the same conservatism was not applied to the lower thermal load, the comparison between the two cases was not appropriate.

2) **WBS 1.2.2.3.1.1, Waste Form Testing - Spent Fuel:** There has been a suspension of radiological work in Pacific Northwest Laboratories Bldg. 325. Work conducted by the YMP was not a contributory element in the closure of this facility; however, this action has had a major impact on our work schedule. Formal documentation of the justification for closure of the building has been requested; it will be provided to LLNL and placed in the YMP records. At this time, there is no projected date for re-opening the facility; therefore, overall impact on the YMP cannot be determined. More information should become available in June.

3) **WBS 1.2.2.3.1.1, Waste Form Testing - Spent Fuel:** A comparison has been made for unsaturated (drip) tests on spent fuel fragments in a Zircaloy retainer conducted at Argonne National Laboratory and earlier saturated tests on bare spent fuel conducted at Pacific Northwest Laboratory. Both sets of tests are sponsored by Lawrence Livermore National Laboratory. Leachates from the tests were compared with regard to the amount of cesium and actinides in ionic (passes a 50A filter) and colloidal forms. Acid stripping was used to determine the amounts of the radionuclides precipitated on the vessel. There was considerable variability between the two PWR fuels (which had different variables) and between them and the bare samples. Preliminary conclusions are that the plutonium, americium and curium are not being removed congruently with the uranium matrix. These conclusions, even if upheld for the two year tests, may not hold for longer

experiment durations; that was the case when $UO_2$ tests were extended from two years out to eight years.

4) **WBS 1.2.2.3.1.2, Waste Form Testing - Glass:** Samples taken from the high level waste dissolution tests have been analyzed. The dissolution rate of lithium from the glass has been fairly constant over a period of eight years. Silicon is being removed from the liquid, but the rate is leveling off. There appear to be two competing processes: addition of silicon to the liquid due to spallation of glass layers and removal of silicon as iron silicates which form on the metal sample holders.

5) **WBS 1.2.3.11.3, Geophysics - ESF Support, Subsurface Geophysical Testing:** The LLNL/LANL Geotechnical Engineering Group took delivery of the ENVIROLOG-4 Logging Winch manufactured by AUSLOG and purchased through Weber International on May 31st. The ENVIROLOG-4 includes a depth system, housing, 100 m 4-conductor cable, cable head, winch, 12 VDC motor drive, speed control, tripod, operational software, and downhole electronics. A preliminary performance test was conducted on the ENVIROLOG-4 winch unit on May 31st. A final performance test will be conducted after delivery of the color video tool, four arm caliper and neutron tool.

6) **WBS 1.2.3.12.2, Hydrologic Properties of the Waste Package Environment:** A primary concern for repository performance is how water contacts a waste package (WP), thereby affecting its integrity and, if containment is breached, radionuclide dissolution and transport. There are two primary modes of water contact: advective liquid flow, and condensation of water vapor on the WP surface. For the first water contact mode, *liquid-phase advective flow in fractures*, the primary sources are episodic infiltration of meteoric water and repository-heat-driven condensate drainage. Drainage can be due to boiling conditions; mountain-scale, buoyant vapor flow; sub-repository-scale, buoyant vapor flow, and focused vapor flow and condensate drainage due to heterogeneity. The last three sources of condensate can occur under either sub-boiling or boiling conditions. For the second water contact mode, *condensation on WP surfaces*, the critical concerns are the relative humidity and temperature on the WP surfaces. Ambient conditions are quite humid, with a relative humidity of 98-99%. Two ways to reduce the relative humidity on the WP surfaces are to drive a large fraction of the initial water content away from the repository, and to maintain a moderate temperature gradient in the vicinity of the WP. The primary means of reducing the water content near the repository are ventilation and repository-heat-generated boiling conditions. LLNL's thermal hydrological calculations are directed to evaluating the sensitivity of water contact to site characteristics and design parameters.

7) **WBS 1.2.3.12.4, Engineered Barrier System (EBS) Field Tests (Large Block Test):** The Large Block Test excavation work started at the beginning of May and continues. A wire saw was used to trim the top of the block. The entire sawing activity took two days. The original top of the block was successfully lifted off as a single piece and provided to RSN for use at the Colorado School of Mines. A

preliminary fracture mapping was conducted on the exposed top surface of the block.

8) **WBS 1.2.3.12.5, Characterization of the Effects of Man-Made Materials on Chemical & Mineralogical Changes in the Post-Emplacement Environment:** The Diesel Exhaust study is underway. Sampling was conducted in N-tunnel, EQ 3/6 simulations have begun, and planning to add microbial effects to the study is underway. Results are required by August to support a Diesel vs. Electric decision for the ESF.

## LLNL DELIVERABLES MET

| Milestone | WBS | Planned Date | Actual Date | Description | Comment |
|---|---|---|---|---|---|
| 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 |
| MOL75 | 1.2.3.12.3 | 03-31-94 | 05-31-94 | Calibration of equip. for Scoping exp. | Delayed by procurement and requirements coordination with the LBT |
| MOL16 | 1.2.3.12.3 | 06-01-94 | 05-31-94 | Approve Activity Plan | |
| MOL77 | 1.2.3.12.4 | 01-31-94 | 04-05-94 | Submittal of SP comment responses | |

## LLNL DELIVERABLES NOT MET

| 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 |
| MOL03 | 1.2.3.10.3.1 | 03-31-94 | 07-29-94 | Report on colloid characterization | Delayed by equip.malfunction related to MOL04 and delays in hiring new staff |
| MOL04 | 1.2.3.10.3.1 | 01-12-94 | 08-15-94 | Document core flow experiment protocol | Delayed by equip.malfunction and delays in hiring new staff |
| MOL05 | 1.2.3.10.3.1 | 05-31-94 | 09-30-94 | Report on Cs and Sr static diffusion test | Delayed by equip.malfunction and delays in hiring new staff |
| MOL26 | 1.2.3.12.1 | 03-31-94 | 07-01-94 | Submit near-field geochemistry topical report | Delayed by TPR & NWTRB preparation |
| MOL15 | 1.2.3.12.4 | 03-31-94 | 07-29-94 | LBT excavation and small block delivery | Construction delays have delayed test start to Dec. 94 |
| MOL70 | 1.2.3.12.4 | 05-15-94 | 07-25-94 | LBT frame delivery | Delay by fabricator |
| MOL73 | 1.2.3.12.5 | 05-31-94 | 06-22-94 | Report on stability of organic compounds at elevated temperatures | Delayed by TPR & NWTRB preparation |
| MOL91 | 1.2.5.4.2 | 03-31-94 | 07-29-94 | Submit plan for code qualification | Individual Software Plan is currently in technical review |

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: 31-MAY-94

PARTICIPANT: LLNL PEM: SMITH WBS: 1.2.2.3.1.1

WBS TITLE: WASTE FORM TESTING - SPENT FUEL

P&S ACCOUNT: 0L2311

| FY 1994 Cumulative to Date | | | | | | | | | FY 1994 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 1189 | 1229 | 1051 | 40 | 3.4 | 103.4 | 178 | 14.5 | 116.9 | 1785 | 1785 | 0 | 0.0 | 1527 | 75.7 |

## 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 58.

**Cumulative Schedule Variance:**
Same as above. The correct schedule variance is -80.

**Variance At Complete:**

Roy B Stout June 14, 94 W. L. Clarke 6/15/94
P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: 31-MAY-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 | TCPI |
| 1778 | 1599 | 1586 | -179 | -10.1 | 89.9 | 13 | 0.8 | 101.8 | 2530 | 3064 | -534 | -21.1 | 2510 | 63.0 |

Analysis

Cumulative Cost Variance:

Cumulative Schedule Variance:
Excavation delays and frame delivery postponement has delayed block characterization activity. Do not anticipate recovery within the current fiscal year.

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. Complications with frame fabrication is requiring addition of project engineer and more design effort. Subcontractor underbid a fixed price contract and has stated that they are unable to complete frame within budget. LLNL is researching legal requirements and options to accomplish Large Block loading.

6/14/94 6/15/94

P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: 31-MAY-94

PARTICIPANT: LLNL PEM: SIMMONS WBS: 1.2.3.12.5

WBS TITLE: CHAR. OF EFFECTS OF MAN-MADE MAT. ON CHEM/MIN. CHGS.

P&S ACCOUNT: 0L3C5

| FY 1994 Cumulative to Date | | | | | | | | | FY 1994 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | ICPI |
| 180 | 146 | 190 | -34 | -18.9 | 81.1 | -44 | -30.1 | 76.8 | 248 | 438 | -190 | -76.6 | 323 | 41.1 |

## Analysis

Cumulative Cost Variance:

Cumulative Schedule Variance:

Variance At Complete:
Workscope was added for studies of diesel fuel impacts on the ESF. Additional funding has not been processed. LLNL cannot change BCWS until change has been worked through Change Control.

Dale G. Wilder 6/14/94 W. L. Clarke 6/15/94

P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: 31-MAY-94

PARTICIPANT: LLNL PEM: GIL WBS: 1.2.5.2.2

WBS TITLE: SITE CHARACTERIZATION PROGRAM

P&S ACCOUNT: 0L522

| FY 1994 Cumulative to Date | | | | | | | | | FY 1994 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 160 | 160 | 241 | 0 | 0.0 | 100.0 | -81 | -50.6 | 66.4 | 240 | 322 | -82 | -34.2 | 361 | 98.8 |

Analysis

Cumulative Cost Variance:

Cumulative Schedule Variance:

Variance At Complete:
As of May 31, 1994, all funds budgeted for this element have been depleted, ($240,000 budget; $240,333 cost). Request for additional funding will be processed through Change Control, coordinated with Element PEM.

W. L. Clarke 6/15/94 W. L. Clarke 6/15/94
P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: 31-MAY-94

PARTICIPANT: LLNL PEM: IORII WBS: 1.2.9.2.2

WBS TITLE: PARTICIPANT PROJECT CONTROL

P&S ACCOUNT: 0L922

| FY 1994 Cumulative to Date | | | | | | | | | FY 1994 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 401 | 401 | 461 | 0 | 0.0 | 100.0 | -60 | -15.0 | 87.0 | 601 | 661 | -60 | -10.0 | 691 | 100.0 |

Analysis

Cumulative Cost Variance:

Cumulative Schedule Variance:

Variance At Complete:
Increased staff by 2 full-time positions:
1.) Technical Coordinator - Interacts with Principal Investigators regarding project control activity.
2.) Assistant Resource Manager - Assists with Finance/Accounting/Reporting/Procurement functions.
Acceleration of LLNL activity in Large Block area and general ramping-up of testing activity has produced increase in project control functions. Anticipate future increases as LLNL role expands.

P&S ACCOUNT MANAGER 6/14/94 DATE TPO 6/15/94 DATE

| Participant LLNL | Yucca Mtn. Site Char. Project-Planning & Control System | 01-May-94 to 31-May-94 |
|---|---|---|
| | PACS Participant Work Station (PPWS) | Page - 1 |
| Prepared - 06/14/94:11:04:24 | 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 | 15 | 0 | -1 | 107 | 107 | 93 | 0 | 14 | 160 | 160 | 0 |
| 1.2.2 | WASTE PACKAGE | 308 | 251 | 266 | -57 | -15 | 2256 | 2360 | 2205 | 104 | 155 | 3443 | 3507 | -64 |
| 1.2.3 | SITE INVESTIGATIONS | 584 | 408 | 507 | -176 | -99 | 4426 | 4202 | 4182 | -224 | 20 | 6348 | 7213 | -865 |
| 1.2.5 | REGULATORY | 160 | 126 | 130 | -34 | -4 | 972 | 922 | 953 | -50 | -31 | 1462 | 1502 | -40 |
| 1.2.9 | PROJECT MANAGEMENT | 103 | 103 | 106 | 0 | -3 | 815 | 815 | 870 | 0 | -55 | 1222 | 1271 | -49 |
| 1.2.11 | QUALITY ASSURANCE | 54 | 54 | 31 | 0 | 23 | 433 | 433 | 347 | 0 | 86 | 650 | 650 | 0 |
| 1.2.12 | INFORMATION MANAGEMENT | 21 | 21 | 21 | 0 | 0 | 166 | 166 | 154 | 0 | 12 | 250 | 249 | 1 |
| 1.2.13 | ENVIRONMENT, SAFETY, & HEA | 2 | 2 | 5 | 0 | -3 | 17 | 17 | 8 | 0 | 9 | 25 | 25 | 0 |
| 1.2.15 | SUPPORT SERVICES | 32 | 32 | 34 | 0 | -2 | 254 | 254 | 200 | 0 | 54 | 382 | 375 | 7 |
| Total | | 1278 | 1011 | 1115 | -267 | -104 | 9446 | 9276 | 9012 | -170 | 264 | 13942 | 14952 | -1010 |

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 | 8281 | 7278 | 7559 | 7901 | 7764 | 7742 | 7988 | 7922 | 7912 | 7794 | 7746 | 7454 | 93341 |
| LABOR | 762 | 654 | 658 | 749 | 711 | 720 | 725 | 743 | 722 | 730 | 709 | 706 | 8589 |
| SUBS | 109 | 298 | 264 | 233 | 315 | 269 | 218 | 206 | 226 | 200 | 142 | 169 | 2649 |
| TRAVEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OTHER | 155 | 193 | 147 | 199 | 175 | 189 | 181 | 248 | 212 | 216 | 220 | 237 | 2372 |
| CAPITAL | 0 | 0 | 11 | 21 | 146 | 59 | 7 | 81 | 7 | 0 | 0 | 0 | 332 |
| Total BCWS | 1026 | 1145 | 1080 | 1202 | 1347 | 1237 | 1131 | 1278 | 1167 | 1146 | 1071 | 1112 | 13942 |

Participant LLNL | Yucca Mtn. Site Char. Project-Planning & Control System | 01-May-94 to 31-May-94

PACS Participant Work Station (PPWS) | Page - 2

Prepared - 06/14/94:11:04:24 | 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 | 7530 | 0 | 0 | 0 | 0 | 54400 |
| LABOR | 762 | 413 | 383 | 497 | 513 | 552 | 513 | 558 | 0 | 0 | 0 | 0 | 4191 |
| SUBS | 114 | 303 | 254 | 233 | 315 | 246 | 218 | 101 | 0 | 0 | 0 | 0 | 1784 |
| TRAVEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OTHER | 152 | 385 | 243 | 355 | 388 | 452 | 388 | 456 | 0 | 0 | 0 | 0 | 2819 |
| CAPITAL | 0 | 0 | 11 | 21 | 138 | 33 | 15 | 0 | 0 | 0 | 0 | 0 | 218 |
| Total ACWP | 1028 | 1101 | 891 | 1106 | 1354 | 1283 | 1134 | 1115 | 0 | 0 | 0 | 0 | 9012 |

Resource Distributions

| Fiscal Year 1994 | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | 1026 | 1145 | 1080 | 1202 | 1347 | 1237 | 1131 | 1278 | 1167 | 1146 | 1071 | 1112 | 13942 |
| BCWP | 1188 | 1062 | 944 | 1048 | 1810 | 1177 | 1036 | 1011 | 0 | 0 | 0 | 0 | 9276 |
| ACWP | 1028 | 1101 | 891 | 1106 | 1354 | 1283 | 1134 | 1115 | 0 | 0 | 0 | 0 | 9012 |
| ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1323 | 1534 | 1536 | 1547 | 5940 |

Fiscal Year Distribution

| | Prior | FY1994 | FY1995 | FY1996 | FY1997 | FY1998 | FY1999 | FY2000 | FY2001 | FY2002 | FY2003 | Future | At Complete |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | 11048 | 13942 | 43192 | 46455 | 35899 | 25532 | 17825 | 12021 | 8654 | 3594 | 823 | 705 | 219720 |
| BCWP | 10882 | 9276 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| ACWP | 10846 | 9012 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| ETC | 0 | 5940 | 42682 | 45613 | 34901 | 25892 | 18815 | 12262 | 9167 | 3624 | 823 | 705 | 220282 |

# YMP PLANNING AND CONTROL SYSTEM (PACS)

## MONTHLY COST/FTE REPORT

PARTICIPANT: LLNL
DATE PREPARED: 6/10/94
FISCAL MONTH/YEAR: MAY,1994

| WBS ELEMENT | CURRENT MONTH END: ACTUAL COSTS | PARTICIPANT FTES | PARTICIPANT HOURS | SUBCONTRACT HOURS | PURCHASE COMMITMENTS | SUBCONTRACT COMMITMENTS | ACCRUED COSTS# | CAP EQPT ACCURAL | FISCAL YEAR: APPROVED BUDGET | CURRENT FY94 AFP | CUMULATIVE COSTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.2.1.5 | 22,600 | 0.80 | 120 | | 0 | 0 | | | 160,000 | | 92,200 |
| SUBT 1.2.1 | 22,600 | 0.80 | 120 | 0 | 0 | 0 | 0 | 0 | 160,000 | 122,061 | 92,200 |
| | | | | | | | | | | | |
| 1.2.2.1 | 31,400 | 1.30 | 210 | | 88 | 0 | 0 | | 400,000 | | 297,300 |
| 1.2.2.3.1.1 | 8,400 | 0.30 | 40 | 378 | 119 | 250,901 | 602,500 | | 1,785,000 | | 411,20 |
| 1.2.2.3.1.2 | 3,800 | 0.20 | 32 | | 364 | 6,043 | 75,000 | | 280,000 | | 120,000 |
| 1.2.2.3.2 | 96,000 | 4.90 | 772 | | 22,875 | 821 | 63,750 | | 880,000 | | 514,700 |
| 1.2.2.3.5 | 18,400 | 1.00 | 152 | | 0 | 0 | 0 | | 100,000 | | 70,500 |
| CAPITAL EQUIP. | 1,689 | | | | 10,477 | 0 | 0 | 0 | **** | 91,000 | 133,823 |
| SUBT 1.2.2 | 159,689 | 7.70 | 1,206 | 378 | 33,923 | 257,765 | 741,250 | 0 | 3,445,000 | 7664034* | 1,547,523 |
| | | | | | | | | | | | |
| 1.2.3.12.1 | 37,400 | 1.60 | 250 | | 6,804 | 176,000 | | | 610,000 | | 413,000 |
| 1.2.3.12.2 | 68,300 | 3.30 | 630 | | 2,850 | 0 | 0 | | 861,000 | | 524,100 |
| 1.2.3.12.3 | 14,400 | 0.50 | 132 | | 4,300 | 0 | 1,800 | | 230,000 | | 124,600 |
| 1.2.3.12.4 | 207,300 | 6.70 | 1,164 | | 12,185 | 495,856 | 34,795 | | 2,530,000 | | 1,147,700 |
| 1.2.3.12.5 | 20,300 | 0.40 | 63 | | 50 | 0 | 10,774 | | 248,000 | | 177,400 |
| 1.2 3.10.3.1 | 18,200 | 0.90 | 138 | | 1,344 | 0 | 0 | | 392,000 | | 174,400 |
| 1.2.3.10.3.2 | 14,900 | 0.20 | 162 | | 2 | 0 | 0 | | 301,000 | | 112,400 |
| 1st SUBT 1.2.3* | 380,800 | 13.60 | 2,538 | 0 | 27,535 | 671,856 | 47,369 | 0 | 5,172,000 | * | 2,673,600 |
| | | | | | | | | | | | |
| 1.2.3.1 | 44,000 | 2.10 | 337 | | 0 | 0 | 0 | | 245,000 | | 183,800 |
| 1.2.3.4.2 | 28,100 | 1.10 | 254 | | 103 | 0 | 0 | | 381,000 | | 220,000 |
| 1.2.3.5.2.2 | 10,600 | 0.70 | 112 | | 0 | 0 | 0 | | 25,000 | | 57,00 |
| 1.2.3.10.1 | 0 | 0.00 | 0 | | 0 | 0 | 0 | | 75,000 | | 91,3 |
| 1.2.3.10.2 | 14,100 | 0.90 | 134 | | 0 | 0 | 0 | | 175,000 | | 161,600 |
| 1.2.3.11.3 | 2,400 | 0.10 | 20 | | 36,525 | 0 | 0 | | 180,000 | | 22,600 |
| CAPITAL EQUIP. | 0 | 0.00 | 0 | | 16,650 | 0 | 0 | | *** | 15,000 | 0 |
| 2nd SUBT 1.2.3 | 99,200 | 4.90 | 857 | 0 | 53,278 | 0 | 0 | 0 | 1,081,000 | 1,116,109 | 736,300 |
| | | | | | | | | | | | |
| 1.2.5.1 | 7,400 | 0.30 | 48 | | 0 | 0 | 0 | | 150,000 | | 88,200 |
| 1.2.5.2.2 | 22,100 | 0.70 | 105 | | 0 | 0 | 0 | | 240,000 | | 240,300 |
| 1.2.5.3.4 | 23,400 | 1.60 | 250 | | 4,652 | 0 | 0 | | 342,000 | | 180,300 |
| 1.2.5.3.5 | 3,700 | 0.20 | 36 | | 0 | 0 | 0 | | 50,000 | | 29,500 |
| 1.2.5.4.2 | 81,500 | 4.40 | 736 | | 598 | 0 | 0 | | 660,000 | | 404,700 |
| 1.2.5.5.2 | 600 | 0.00 | 0 | | 0 | 0 | 0 | | 20,000 | | 6,900 |
| CAPITAL EQUIP. | 0 | | | | 0 | 0 | | 0 | ** | 34,000 | 0 |
| SUBT 1.2.5 | 138,700 | 7.20 | 1,175 | 0 | 5,250 | 0 | 0 | 0 | 1,462,000 | 1,294,237 | 949,900 |

# YMP PLANNING AND CONTROL SYSTEM (PACS)

## MONTHLY COST/FTE REPORT

PARTICIPANT: LLNL

DATE PREPARED 6/10/94

FISCAL MONTH/YEAR: MAY,1994

| WBS ELEMENT | CURRENT MONTH END | | | | | | | | FISCAL YEAR | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ACTUAL COSTS | PARTICIPANT FTES | PARTICIPANT HOURS | SUBCONTRACT HOURS | PURCHASE COMMITMENTS | SUBCONTRACT COMMITMENTS | ACCRUED COSTS# | CAP EQPT ACCURAL | APPROVED BUDGET | CURRENT FY94 AFP | CUMULATIVE COSTS |
| 1.2.9.1.2 | 45,100 | 2.00 | 309 | | 382 | 0 | 0 | | 621,000 | | 406,900 |
| 1.2.9.2.2 | 61,200 | 5.00 | 778 | | 765 | 0 | 49 | | 601,000 | | 461,800 |
| SUBT 1.2.9 | 106,300 | 7.00 | 1,087 | 0 | 1,147 | 0 | 49 | 0 | 1,222,000 | 1,057,812 | 868,700 |
| 1.2.11.1 | 31,100 | 1.60 | 200 | | 0 | 0 | 0 | | 650,000 | | 346,3[illegible] |
| SUBT 1.2.11 | 31,100 | 1.60 | 200 | 0 | 0 | 0 | 0 | 0 | 650,000 | 609,812 | 346,300 |
| | | | | | | | | | | (FUNDED UNDER 1.2.16) | |
| 1.2.12.2.2 | 11,600 | 0.40 | 59 | | 0 | 0 | 0 | | 116,000 | | 66,200 |
| 1.2.12.2.3 | 9,700 | 0.20 | 34 | | 97 | 0 | 0 | | 134,000 | | 88,000 |
| SUBT 1.2.12 | 21,300 | 0.60 | 93 | 0 | 97 | 0 | 0 | | 250,000 | 215,606 | 154,200 |
| | | | | | | | | | | (FUNDED UNDER 1.2.17) | |
| 1.2.13.2.5 | 5,400 | 0.30 | 60 | | 0 | 0 | 0 | | 25,000 | | 8,400 |
| SUBT 1.2.13 | 5,400 | 0.30 | 60 | 0 | 0 | 0 | 0 | 0 | 25,000 | 18,750 | 8,400 |
| 1.2.15.2 | 26,400 | 2.60 | 401 | | 99 | 0 | 0 | | 290,000 | | 146,500 |
| 1.2.15.3 | 7,600 | 0.10 | 24 | | 0 | 0 | 0 | | 92,000 | | 51,200 |
| SUBT 1.2.15 | 34,000 | 2.70 | 425 | 0 | 99 | 0 | 0 | 0 | 382,000 | 300,010 | 197,700 |
| TOTAL LLNL | 999,089 | 46 | 7,761 | 378 | 121,329 | 929,621 | 788,668 | 0 | 13,849,000 | 4,734,397 | 7,574,823 |

* This work was moved to WBS 1.2.3; however, funding for this work remains in Budget and Report Category DB010202 in the AFP.

**** 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

**WBS 1.2.3.12.5:** The CSCR to provide $160k for DOE directed Man-Made Materials work in support of the August ESF Diesel vs. Electric decision was rejected by the Change Control Board Screening Group. An indication by YMSCO of how the funds will be provided to LLNL is needed.

## 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

Degradation rates for aqueous corrosion of the WPs may be significantly enhanced if the WP environment is sufficiently hot and humid. A preliminary survey of aqueous corrosion indicates temperatures above 60°C and relative humidity (RH) above 70% may result in significantly enhanced degradation rates. It is important to recognize that with the use of large multiple purpose containers (MPCs), all thermal loading options are hot for some period of time. The critical question is whether the repository system can be managed such that repository conditions are hot and dry rather than hot and humid. For "hot and dry", issue is whether we can demonstrate (through *in situ* heater testing and bounding analyses) that hot and relatively dry conditions will prevail for some period of time in the vicinity of WPs. A related question is whether (with respect to WP corrosion) the WP environment becomes relatively cool before becoming relatively humid (or wet). The answer to this question must be addressed by both the near-field environment characterization studies and the WP material characterization studies which will determine the range of temperature and relative humidity conditions that result in significantly enhanced degradation rates for the WP materials under consideration. With the use of large MPCs, there are two bounding thermal strategies:

1) minimize how long a humid repository remains hot
2) maximize how long a hot repository remains relatively dry.

The goal of the first strategy is to minimize the negative consequences of a humid repository. The goal of the second strategy is to maximize the fraction of WPs that will remain relatively dry until they have become relatively cool. Both strategies aim to minimize the likelihood and duration of hot and humid WP conditions. A primary motivation for both strategies is to avoid the most corrosive WP conditions.

T. Buscheck continued to support the thermal loading systems study by re-examining the repository-scale model calculations for AMLs of 55.3, 70, 83.4, 110.5, and 150 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 containing 40 assemblies per WP, and PWR WPs containing 21 assemblies per WP. The waste receipt schedule was supplied by John King of the M&O.

Table 1 summarizes the duration of the boiling period at various repository locations and the relative humidity attained at the end of the boiling period for a bulk permeability, $k_b$, of 280 millidarcy. These results are presented in order to improve the TSPA-93 analyses concerning the WP re-wetting time. For some of the TSPA-93 analyses, it was assumed that the WPs re-wet at the end of the boiling period. For point of comparison, the 55.3- and 110.5-MTU/acre cases (Table 1) are similar to the 57 and 114 kW/acre cases considered in TSPA-93. At the end of the boiling period for the 55.3-MTU/acre case, RH = 80.8% in the driest region of the repository (the inner half), while it never becomes drier than ambient conditions (98.4%) at the outer perimeter (outer 6%) of the repository. At the end of the boiling period, RH in the driest region of the repository (the inner half) is 81, 68, 57, 44, and 47%, for AMLs of 55.3, 70, 83.4, 110.5, and 150 MTU/acre, respectively. For all repository locations, RH at the end of the boiling period decreases with increasing AML. For the inner half of the repository, this trend of decreasing temperature with increasing AML levels off at about 110.5 MTU/acre. For the outer edge of the repository, RH decreases with AML for the entire AML range considered. The importance of AML is illustrated by noting that the outer perimeter of the 150-MTU/acre repository is drier at the end of the boiling period than the driest region of the 55.3-MTU/acre repository.

Clearly, the end of the boiling period is not a consistent indication of how wet (or humid) WP conditions are. Some of the results and conclusions of TSPA-93 were undoubtedly affected by the assumption that WP conditions have become equally wet at the end of the boiling period. To further illustrate the shortcoming of assuming that re-wetting occurs at the end of the boiling period, it is useful to compare:

1) how long it takes the driest repository location to re-wet to RH = 81% (RH attained at the end of the boiling period in the 55.3-MTU/acre case) and
2) the temperature attained when RH = 81%.

For the five listed AMLs between 55.3 and 150 MTU/acre, re-wetting to RH = 81% requires 1760, 9820, 18,690, 29,000, and 36,150 yr, respectively. The corresponding temperatures for these cases is 96, 69, 57, 53, and 50°C, respectively. In comparing the two cases (55.3 and 110.5 MTU/acre) that roughly correspond to the 57 and 114 kW/acre cases in TSPA-93, we find that it requires 1760 and 29,000 yr for the inner half of the two repositories to re-wet to RH = 81%. Because the boiling period is 6130 yr for the 110.5-MTU/acre case, the assumption of equal "wetness" at the end of the boiling period is inconsistent with the observation that it requires an additional 22,870 yr (beyond the end of the boiling period) for the 110.5-MTU/acre case to attain the value of RH (80.8%) that was present in the 55.3-MTU/acre case at the end of its boiling period. Moreover, the 110.5-MTU/acre repository has a temperature of only 53°C when RH = 81% is attained (at 29,000 yr) as compared to 96°C for the 55.3-MTU/acre case (at 1760 yr). Therefore, the 110.5-MTU/acre case re-wets to relatively humid conditions at much lower temperatures (and much later times) than the 55.3-MTU/acre case.

For further illustration, the driest region (inner 50%) of the 110.5-MTU/acre repository has cooled to 68°C when RH = 70% is attained (at 15,960 yr). By the time the driest region (inner 50%) of the 55.3-MTU/acre repository has cooled to 68°C, (at 6180 yr) it has already re-wetted to RH = 97.8%. As far as aqueous corrosive processes are concerned, the 110.5-MTU/acre case is subjected to *far less* corrosive conditions than the 55.3-MTU/acre repository.

A "surprising" conclusion of TSPA-93 was "the insensitivity of total systems performance to AML," due to "advantages of high APD in delaying WP corrosion being offset by higher corrosion rates". Artificially assuming that equally humid (wet) conditions can be imposed onto the respective AML cases at the end of the boiling period has the effect of imposing very corrosive conditions onto the high-AML case which, as noted above, does not correspond to the repository-scale thermo-hydrological calculations.

An alternative TSPA-93 assumption for when WP conditions are "wet" is when the liquid saturation, $S_l$ exceeds 8%. For the 110.5-MTU/acre case, this corresponds to a RH of approximately 41%, while RH for the 55.3-MTU/acre case never becomes drier than 66%. For the 24.2-MTU/acre case, which roughly corresponds to the low-AML case in the TSPA-93 study, RH is never less than 98.4%. This alternative TSPA-93 re-wetting assumption is effectively equivalent to saying that, for WP corrosion, there is no difference between 41 and 98% relative humidity.

Table 1 is based on the smeared-heat-source, repository-scale model. Consequently, the listed value of RH is applicable to average liquid saturation conditions. Because RH = 70% approximately corresponds to a liquid saturation 13%, it does not require very much re-wetting to attain this value of RH. Had a discrete representation of WPs 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 RH that is wetter than the local value of RH in the emplacement drift. Thermo-hydrological heterogeneity and variability in the heat output among the WPs will also cause local behavior to deviate from average behavior.

Table 1

Duration of the boiling period at various repository locations and the relative humidity attained at the end of the boiling period for 22.5-yr-old Spent Nuclear Fuel, various Areal Mass Loadings and a bulk permeability of 280 millidarcy. 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.

| Percentage of repository area enclosed (%) | Duration of the boiling period and relative humidity at the end of the boiling period for indicated AMLs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 55.3 MTU/acre | | 70 MTU/acre | | 83.4 MTU/acre | | 110.5 MTU/acre | | 150 MTU/acre | |
| 50 | 1760 yr | 80.8% | 2830 yr | 68.1% | 3870 yr | 57.2% | 6130 yr | 44.3% | 9590 yr | 46.8% |
| 75 | 1160 yr | 83.7% | 2000 yr | 70.5% | 2740 yr | 65.2% | 4290 yr | 51.4% | 7210 yr | 45.1% |
| 90 | 440 yr | 92.7% | 1090 yr | 81.0% | 1700 yr | 76.6% | 2870 yr | 67.6% | 5010 yr | 54.1% |
| 97 | 80 yr | 98.5% | 410 yr | 95.5% | 990 yr | 92.5% | 2150 yr | 86.6% | 3960 yr | 66.8% |

### 1.2.1.6 Configuration Management

No significant activity.

## 1.2.2. WASTE PACKAGE

### 1.2.2.1 Waste Package Coordination and Planning

An FY95 LLNL Metal Barriers Planning Meeting was held in Livermore on May 10, 11, and 12. W. Clarke chaired the meeting. Other LLNL staff members in attendance were J. Blink, T. Buscheck, D. Chesnut, E. Dalder, J. Farmer, J. Gansemer, B. Glass, W. Glassley, G. Gdowski, W. Halsey, R. Hamati, G. Henshall, D. Jones, G. Kaiper, A. Lamont, D. McCright, R. Monks, B. O'Connell, J. Podobnik, M. Revelli, R. Stout, R. Van Konynenburg, D. Wilder, K. Wilfinger, M. Whitbeck, B. Bryan, and M. Lewis. Other participants in the meeting were A. Simmons, D. Stucker (DOE); H. Benton, W. Cowles, L. Ramspott, R. Fish, K. McCoy, A. Roy, D. Stahl (M&O); D. Bullen (Iowa State); H. Cleary (Weston); D. Diercks, J. Park (ANL); and C. DiBella (NWTRB).

J. Blink presented "On the Benefits of an Integrated Nuclear Complex for Nevada" at the International High-Level Radioactive Waste Management Conference on May 23 in Las Vegas. Over 100 people were in the audience, and a lively discussion followed the presentation. The paper was highlighted in both Las Vegas newspapers, and several Nevada political figures and candidates have asked for a copy.

### 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

There has been a suspension of radiological work in Pacific Northwest Laboratories (PNL) Bldg. 325. Work conducted by the YMP was not a contributory element in the closure of this facility; however, this action has had a major impact on our work schedule. Formal documentation of the justification for closure of the building has been requested; it will be provided to LLNL and placed in the YMP records. At this time, there is no projected date for re-opening the facility, therefore, overall impact on the YMP cannot be determined. More information should become available in June.

Spent Fuel Dissolution

There are no activities to report for the month of May due to the total shutdown of all radiological work in Pacific Northwest Laboratories (PNL) Bldg. 325 for a safety assessment. This shutdown will further delay installation of the new liquid radioactive waste disposal holding tank for the analytical hot cells that has been discussed in previous reports.

W. Gray (PNL) presented a paper entitled "Interlaboratory Comparison of $UO_2$ Dissolution Rates" at the Fifth Annual International High-Level Radioactive Waste Management Conference in Las Vegas.

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/3.5 d; and two with a ten times higher drip rate of 0.75 mL/3.5 d. 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 ~20 months of testing at 90°C.

Aliquots of the leachate removed in April from the high drip rate tests were filtered sequentially through several filters (1, 0.1, and 0.05 µm) to determine the distribution of the colloidal material. The filters were submitted for alpha analyses. The sequential filtered samples were submitted for alpha, gamma, and cation analysis.

The data for cesium and the actinides for the first two test periods (four and five months) for the high drip-rate tests are compared to the results reported by C. Wilson for saturated tests in Tables 2 and 3, for unprecipitated fraction and maximum fraction, respectively. The unprecipitated fraction is defined for each isotope as the sum of ionic and colloidal species in the leachate. The maximum fraction is defined for each isotope as the fraction that the total amount released is of the original amount in the fuel. The total test time for Wilson was 18 months, versus 9 months for the unsaturated tests. The temperatures are comparable. The ratio of fuel weight to total volume of fluid in contact with the fuel is slightly greater for the unsaturated tests.

The major differences in the two sets of tests are these: First, a much larger fraction of the material was unprecipitated in the unsaturated tests. The one exception is cesium in the ATM-106 test. The low cesium solubility may indicate formation of a cesium uranate phase since formation of an insoluble cesium uranate phase has been noted previously.[1] Second, the maximum fraction of material released for the unsaturated tests is approximately an order of magnitude less for, uranium, plutonium, and cesium than that released in the saturated tests. However, the maximum fraction of americium and curium released in the unsaturated tests is about an order of magnitude greater than that in the saturated tests. The reason for these differences in release behavior appears to be linked to the higher unprecipitated fraction in the unsaturated tests. For longer test periods, these differences may not be observed.

$\underline{UO_2}$

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.

A Preparedness Review was held on May 12 in order to convert the experiments to Quality Affecting Activity Status. As a result of that meeting, the scientific notebook and sampling procedures used for the $UO_2$ tests were revised, and the final Preparedness Review was completed May 31.

Solution analytical results were received from the nine-year $UO_2$ drip test samples supported by Teflon stands. Uranium release rates were comparable to previous runs, with the samples releasing relatively low amounts of uranium over the last seven years, this following the rapid uranium release period that characterized the release patterns between one and two years. Fractional uranium release trends have also been examined for a limited number of samples. Uranium release was measured from three solution aliquots, including a <50Å, an unfiltered suspended solution, and an acid strip fraction. The acid strip component was derived from a 10-minute $HNO_3$ soak of the test vessel and Teflon stand, and represents the largest recovered uranium fraction from the test (80 to 98%). The <50Å component is typically the smallest fraction, representing from 1 to 6% of the total release. The suspended fraction represents all uranium suspended in solution, less the fraction passing through the 50Å filter. The suspended fraction represents from 1 to 15% of the total release, with the relatively high variability probably resulting from the resuspension of particulate material during the vessel opening and sampling processes.

Cation analyses indicate continued depletion of alkali, alkaline earths, and silicon from the EJ-13 solution after contacting the $UO_2$ pellets. Previous scanning electron microscope/energy dispersive spectroscopy (SEM/EDS) investigations have revealed that these elements are being incorporated into secondary uranyl phases on the sample surfaces, with the uranium being derived from the dissolution of the $UO_2$

[1] S. Stroes-Gascoyne, L.H. Johnson, P.A. Beeley, and D.M. Sellinger, "Dissolution of Used CANDU Fuel at Various Temperatures and Redox Conditions", Mater. Res. Soc. Symp. Proc. 50, 317-326 (1986).

pellets. Magnesium is generally depleted to the greatest extent, with leachate concentrations typically reduced to ~10% of the initial EJ-13 value. Calcium and potassium are generally depleted to ~30% of the original EJ-13 values, while Si is depleted to a level that is within 50 to 60% of the original EJ-13 value. Sodium concentrations are similar to those of the starting EJ-13 solution, a finding consistent with that of the absence of any discrete sodium uranyl phases on the $UO_2$ pellet surfaces.

Table 2. Unsaturated (High Drip Rate, 9 months, 90°C) versus Saturated (18 months, 85°C) Test Results
*Average Unprecipitated Fraction (%), the sum of the ionic and colloidal species in the leachate*

| | U | Pu | Am | Cm | Cs |
|---|---|---|---|---|---|
| ATM-103[a] | 50 | 40 | 50 | 70 | 98 |
| ATM-106[a] | 20 | 50 | 10 | 30 | 60 |
| Wilson[b] | 10 | 5 | 3 | 3 | 85 |

[a] This is the total for the first two test periods
[b] C.N. Wilson, PNL-7170 (1990), using bare fuel for three test periods at 85°C.

Table 3. Unsaturated (High Drip Rate, 9 months, 90°C) versus Saturated (18 months, 85°C) Test Results
*Maximum Fraction (ppm), the fraction released from the original fuel inventory*

| | U | Pu | Am | Cm | Cs |
|---|---|---|---|---|---|
| ATM-103 (total)[a] | 10 | 1 | 600 | 7000 | 600 |
| ATM-106 (total)[a] | 50 | 30 | 90 | 200 | 1000 |
| Wilson[b] | 100 | 100 | 200 | 40 | 10,000 |

[a] This is the total for the first two test periods
[b] C.N. Wilson, PNL-7170 (1990) 1 using bare fuel for three test periods at 85°C.

<u>D-20-53(a), Dissolution Tests with $UO_2$</u>

Approximately 20 grams of Schoepite ($UO_3 \cdot H_2O$) were prepared at LLNL via an aqueous hydrolysis of uranyl acetate, $UO_2(C_2H_3O_2)_2$, a procedure that took place over several days. This material is being analyzed and will be used in the studies just begun on the dissolution of the higher uranium oxides, $UO_3$ and $UO_8$. The initial four Schoepite dissolution experiments in the current test matrix that were begun last month are continuing. All four experiments are at room temperature and 20% oxygen. They consist of the four combinations of pH 8 and 10 as well as total carbonate concentrations of $2x10^{-4}$ and $2x10^{-2}$ mol/L. These same experiments will later be run at 75°C. Some flow problems were experienced and corrected. Very preliminary measurements that indicate uranium dissolution rates of the Schoepite at room temperature are similar to $UO_2$.

Spent Fuel Oxidation

Dry Bath Testing

The drybaths continue to operate without incident. An interim examination will be conducted for the 195°C and 255°C tests early in June. Work on the phase determinations has slowed considerably as the X-ray diffraction lab was closed with the general shutdown of Bldg. 325.

Thermogravimetric Apparatus (TGA)

May activities will be reported in a later monthly progress report. The LLNL staff has been occupied with participation in the Planned Program Approach and in preparing input for the FY95-01 PACS submission.

Materials Characterization Center (MCC) Hot Cell Activities

S. Marschman (PNL) presented a paper entitled "Rationale for Determining Spent Fuel Acquisitions for Repository Testing" at the International High-Level Radioactive Waste Management Conference in Las Vegas.

**1.2.2.3.1.2 Waste Form Testing - Glass**

The preparedness review was completed at ANL for the Unsaturated Testing of $UO_2$, and the QA grading and supporting documentation were sent to LLNL. J. Bates and P. Finn (ANL) attended the International High-Level Radioactive Waste Management Conference and presented papers on spent fuel and glass performance under unsaturated conditions.

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

The N2 dissolution tests (DWPF actinide-doped glass previously described as SRL glass) continue at ANL as scheduled. The tests have been ongoing for 100 months. Data from the December sampling have been compiled and were presented in part at the IHLRWM conference. Preliminary release data for Li and Si can be used to project the rate of glass reaction and the mode by which radionuclides are released from the glass. The last solution sampling period (411.5 weeks total) shows a fairly steady Li release rate increase if the data are averaged. The normalized release rate over the 411.5 week period for Li is -2.6 $mg/m^2 \cdot day$, while over the last sampling period the rate was 3.6 $mg/m^2 \cdot day$.

Silicon release is negative (Si was being removed from the solution) for the first 210 weeks. While there is divergence in the replicate tests, the overall trend is a slowing of the rate at which Si is being depleted from the solution. Based on the analysis of material in solution, this is due to an increase in Si going into solution due to spallation from the glass.

In Test N2#10, the Np release rate was quite constant for the first 160 weeks at 0.8 $mg/m^2 \cdot day$ and then increased to ~5 $mg/m^2 \cdot day$ between 160 and 411 weeks. The analogous Pu releases are 8 and 30 $\mu g/m^2$ day. The increase in actinide release rate is consistent with the Si release trend and spallation of reacted layer from the glass. These rates provide a lower limit for release from SRL-based glasses since the SRL 165 glass used in the N2 tests is the most durable glass SRL has developed, and is more durable than the current reference glass.

Preparation for the next 6 month sampling period for these tests has been initiated, and the sampling is scheduled for June. The solution saved from the last sampling period, which contains colloidal material, will be saved in the event that the investigation of colloids is pursued.

The N3 (West Valley ATM-10 glass) tests continue at ANL as scheduled, having completed about 77 months of testing. We are proceeding with the analysis of the cation and actinide solution data from the N3 tests. These data have been collected periodically since testing began in 1987 and stored in the records file, but have not been fully analyzed or comprehensively presented.

Results for the actinides (Np, Pu, and Am) through 345 weeks have been analyzed. These data have been obtained by alpha spectroscopy. Cation results (ICP-MS or CP-AES) for Li and Si have been analyzed and corrected for the contribution from the EJ-13 water, and thus represent release from the sample. In the case of Si, an uptake of Si from the water to be incorporated into secondary phases is observed. Release rate data will be calculated and reported next month.

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 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 shortly or the water will directly contact the glass as it collects in the test vessel. The samplings will be done in June.

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

### 1.2.2.3.2 Metal Barriers

May activities will be reported in a later monthly progress report. The LLNL staff has been occupied with participation in the Planned Program Approach and in preparing input for the FY95-01 PACS submission. A three day planning meeting for this WBS element is discussed in Section 1.2.2.1.

The report entitled "Survey of the Degradation Modes of Candidate Materials for High-Level Radioactive Waste Disposal Containers - Iron Base, Corrosion-Allowance Materials" is undergoing concurrent reviews at LLNL and YMSCO. This report is a collaborative activity between the LLNL Engineered Barrier System Staff and the Nuclear Engineering Staff at Iowa State University and represents completion of milestone MOL46.

#### 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

May activities will be reported in a later monthly progress report. The LLNL staff has been occupied with participation in the Planned Program Approach and in preparing input for the FY95-01 PACS submission. A three day planning meeting for this WBS element is discussed in Section 1.2.2.1.

### 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 re-baseline.

D. Wilder and D. Chesnut attended a YMSCO International Program Meeting held in Las Vegas on May 9.

J. Blink met with C. Johnson of the M&O on May 3 in Las Vegas to discuss LLNL's efforts on another program to develop software that couples geologic databases to simulation codes. It may be possible to share the cost of developing the software with the LLNL environmental remediation program and to customize the software for YMP needs.

### 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

May activities will be reported in a later monthly progress report. The LLNL staff has been occupied with participation in the Planned Program Approach and in preparing input for the FY95-01 PACS submission.

### 1.2.3.5 Drilling

#### 1.2.3.5.2.2 Engineering, Design, and Drilling Support

Eight logging sessions to monitor water level were conducted at UZ14 during the month of May. The runs were conducted on May 2, 4, 5, 6, 10, 11, 12, and 23.

On May 25, the 100' reference marks were re-established on truck #83361, SELSYN #SSN-1, per LLNL-YMP Technical Implementation Procedure (TIP-NV-01).

### 1.2.3.10 Altered Zone Characterization

#### 1.2.3.10.1 Characterization Techniques for the Altered Zone

May activities will be reported in a later monthly progress report. The LLNL staff has been occupied with participation in the Planned Program Approach and in preparing input for the FY95-01 PACS submission.

#### 1.2.3.10.2 Characterization of Thermal Effects on the Altered Zone Performance

The study plan for this WBS is being written.

#### 1.2.3.10.3 Integrated Testing

##### 1.2.3.10.3.1 Integrated Radionuclide Release: Tests and Models

May activities will be reported in a later monthly progress report. The LLNL staff has been occupied with participation in the Planned Program Approach and in preparing input for the FY95-01 PACS submission.

### 1.2.3.10.3.2 Thermodynamic Data Determination

May activities will be reported in a later monthly progress report. The LLNL staff has been occupied with participation in the Planned Program Approach and in preparing input for the FY95-01 PACS submission.

## 1.2.3.11 Integrated Geophysical Testing for Site Characterization

### 1.2.3.11.3 Geophysics - ESF Support, Subsurface Geophysical Testing

The LLNL/LANL Geotechnical Engineering Group took delivery of the ENVIROLOG-4 Logging Winch manufactured by AUSLOG and purchased through Weber International on May 31. The ENVIROLOG-4 includes a depth system, housing, 100 m 4-conductor cable, cable head, winch, 12 VDC motor drive, speed control, tripod, operational software, and downhole electronics. A preliminary performance test was conducted on the winch unit on May 31. A final performance test will be conducted after delivery of the color video tool, four arm caliper and neutron tool.

## 1.2.3.12 Waste Package Environment Testing

This WBS element was created from WBS element 1.2.2.2. Management, reporting and PACS are using the new WBS structure, but funding will apparently remain within the old WBS structure for the remainder of FY94.

### 1.2.3.12.1 Chemical and Mineralogical Properties of the Waste Package Environment

The revised Study Plan 8.3.4.3.4.1 for Waste Package Geochemistry and Mineralogy that was sent to YMSCO is being reformatted to meet current format guidelines specified in the NRC-DOE Agreement. Other May activities will be reported in a later monthly progress report. The LLNL staff has been occupied with participation in the Planned Program Approach and in preparing input for the FY95-01 PACS submission.

### 1.2.3.12.2 Hydrologic Properties of the Waste Package Environment

Analysis of Temperature and Relative Humidity Conditions in the Repository

A primary concern for the Near-Field/Altered Zone Hydrology Tasks is how water contacts a waste package (WP), thereby affecting its integrity and, if containment is breached, radionuclide dissolution and transport. There are two primary modes of water contact:

1) advective liquid flow, particularly as it occurs in fractures, and
2) condensation of water vapor on the WP surface.

For the first water contact mode, *liquid-phase advective flow in fractures*, the primary sources are:

1) episodic infiltration of meteoric water and
2) repository-heat-driven condensate drainage due to:
   a) boiling conditions,
   b) mountain-scale, buoyant vapor flow,
   c) sub-repository-scale, buoyant vapor flow, and
   d) focused vapor flow and condensate drainage due to heterogeneity.

The last three sources of condensate can occur under either sub-boiling or boiling conditions.

For the second water contact mode, condensation on WP surfaces, the critical concerns are the relative humidity and temperature on the WP surfaces. Ambient conditions are quite humid, with a relative humidity of 98-99%. There are two ways to reduce the relative humidity on the WP surfaces:

1) driving a large fraction of the initial water content from the vicinity of the repository, and
2) maintaining a moderate temperature gradient in the vicinity of the WP.

The primary means of reducing the water content near the repository are:

1) repository-heat-generated boiling conditions, and
2) ventilation.

As reported last month, a large reduction in the initial water content is required to significantly reduce the relative humidity, RH. For example, an 80% reduction in liquid saturation is required to reduce RH to less than 70%. An Areal Mass Load (AML, expressed in MTU/acre) that does not drive repository temperatures well above the boiling point will result in only a small reduction in RH (see Table 4).

Table 4. Minimum relative humidity and peak temperature as a function of areal mass loading.

| AML (MTU/acre) | $T_{peak}$ (°C) | RH min(%) |
|---|---|---|
| 55 | 109 | 66 |
| 70 | 128 | 36 |
| 83 | 146 | 22 |
| 110.5 | 187 | 8 |
| 150 | 250 | 2.5 |

The relative humidity calculations are based on the smeared-heat-source, disk-shaped model of the repository. Therefore, the relative humidity is based on averaged liquid saturation. Because 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 will tend to indicate values that are wetter than conditions in the emplacement drifts. As reported last month, when the WP is hotter than the emplacement drift wall, the relative humidity on the WP surface will be lower than 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.

See Section 1.2.1.5 for further discussion of thermal loading strategies and their implications.

Laboratory Experiments

LLNL continues to measure electrical impedance as a function of moisture content of Topopah Spring tuff samples from the G-4 and GU-3 holes at elevated temperatures using J-13 water as pore fluid. The wetting phase measurements at 95°C using the original set of samples were completed, and the data are being analyzed. Many samples broke during the measuring process. Additional samples are being prepared to complete the measurements at 95°C. Analysis of the existing data indicates that the frequency dependent measurements may be useful in describing the manner in which water wets rock. Several conduction mechanisms are observed that change in importance with changing saturation levels. Additional study is underway to determine the nature of each conduction mechanism. A paper describing this work, entitled "Electrical Properties of Topopah Spring Tuff as a Function of Saturation", by J.J. Roberts and W. Lin, was presented in a poster session during the High Level Radioactive Waste Management Conference. Successful completion of this work will simplify the task of measuring water distribution in thermal hydrological experiments at laboratory and field scales.

For the experiment of determining the moisture retention curve and one-dimensional imbibition using G-4 core, we continued the moisture retention experiments at high temperatures. Measurements at 95°C and about 95% relative humidity continued. There are still problems associate with the humidity sensor, and we are looking into potential solutions.

LLNL continued the experiment to determine the effect of confining pressure on fracture healing, as observed previously by Lin and Daily. A fractured Topopah Spring tuff sample from 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 - pore pressure) at room temperature has been determined. Permeability as a function of temperature, at a confining pressure of 1 MPa and pore pressure of 0.5 MPa, is being determined. We have completed the measurements at temperatures to 150°C and back down to 125°C. The water permeability at 125°C after been heated to 150°C is about 30% lower than that measured at the initial 125°C. So far, the total decrease in permeability is about 40%. No drastic fracture healing has been observed. We will test the effect of flowing steam through the sample at 125°C on the permeability. Then the temperature will be decreased to the room temperature.

The calibration of a resonant cavity for measuring suction potential as a function of moisture content in rock samples and in the field continues. A LabView driver for the network analyzer has been installed and tested. This allows the computerized collection of resonant spectra. Five cavities have been tested at room temperature and humidity conditions.

The evaluation of x-ray scan as a technique of monitoring moisture content distribution in a rock sample continues. Analysis of the preliminary x-ray scans indicates that using KI doped J-13 water as the saturating fluid can improve the resolution in the water saturation level to about 2.2%. Without doped water, the resolution decreases to about 4.4%.

Meetings and Publications

J. Blink and T. Buscheck had discussions with UNLV Prof. J. Cardle. Collaboration between LLNL and UNLV was discussed. UNLV will provide a student to assist LLNL in applications of the V-TOUGH code family for YMP studies. A contract for the remainder of FY94 is being initiated. It is anticipated that the student will be supported for several years, including a YMP-related thesis. Prof. Cardle will also provide support.

T. Buscheck presented a paper entitled "The Impact of Repository Heat on Thermo-Hydrological Performance at Yucca Mountain" on May 3 at the Thermal Loading Studies Meeting held at YMSCO and attended the Scenario A Focused ACD Assumptions Meeting held on May 4. The paper provides insight for identification of critically needed site characterization data for long term thermo-hydrological performance calculations.

T. Buscheck presented two papers at the Fifth Annual International High-Level Radioactive Waste Management Conference in Las Vegas, May 22-26, "Evaluation of Thermo-Hydrological Performance in Support of the Thermal Loading Systems Study" and "The Impact of Buoyant Gas-Phase Flow and Heterogeneity on Thermo-Hydrological Behavior at Yucca Mountain". The first report meets a milestone requirement for the thermal loading systems study and both reports provide input for the FY93 Thermal Loading Systems Study final report which has been submitted to YMSCO and is currently in review.

Several LLNL staff members attended the Peer Review Planning meeting in Las Vegas on May 27. The peer review of unsaturated zone thermal hydrology calculations requested by LLNL was delayed until after an internal YMSCO group meets to define the scope of the review. D. Chesnut was appointed as the LLNL member of the group.

**1.2.3.12.3 Mechanical Attributes of the Waste Package Environment**

The Activity Plan AP-GM-01, GM-03, GM-05 (8.3.4.2.4.3 - Mechanical Attributes of the Waste Package Environment) has been issued. This represents completion of milestone MOL16.

### 1.2.3.12.4 Engineered Barrier System (EBS) Field Tests

Revision of the draft Engineered Barrier System Field Tests (EBSFT) Study Plan was started, as a result of the comment resolution meeting (see Section 1.2.5.2.2).

J. Blink, T. Buscheck, W. Clarke, W. Halsey, W. Lin, And D. Wilder met with N. Elkins (LANL) and L. Costin (SNL) on May 25, 1994 to discuss the Phase 1 EBSFT at the North Ramp Extension.

Large Block Test (LBT)

Sample preparation for electrical impedance measurements, Hg porosimetry, and wet-dry porosity measurements using the core sections from the LBT vertical instrument holes was started. Some preliminary Hg porosimetry results indicate that the porosity in the matrix increases from about 9% near the top of the block to about 13% at about 4 m depth.

J. Blink met with senior management of the LLNL Mechanical Engineering Department on May 11 to discuss the LBT load frame design. The meeting concluded with a plan to perform 3-D structural mechanics analyses to determine in more detail the stresses in the frame due to the loads being applied to the block. Following the calculations, which are expected to be completed by mid-June, LLNL will determine and document the appropriate safety factor to be used in operating the system. Because the frame fabrication is nearly complete (delivery is scheduled for late July), modifications to increase the allowable load are expected to be made at NTS or at the DOE-Atlas Facility in North Las Vegas.

The Large Block Test excavation work started at the beginning of May and continues. A wire saw was used to trim the top of the block. The entire sawing activity took two days. The original top of the block was successfully lifted off as a single piece and provided to RSN for use at the Colorado School of Mines. A preliminary fracture mapping was conducted on the exposed top surface of the block. SNL completed two more (total) fracture flow visualization tests.

Laboratory tests 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 continues. Copper plates may be used to distribute heat from the guard heaters. Tests to evaluate the lateral temperature distribution on the surface of a copper plate opposite to the heater, was continued. Thermal conduction model calculations continue to be used in designing the guard heaters.

Procurement of instruments has started. 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 continues.

Preparation of small blocks, obtained from Fran Ridge, for scoping experiments was continued. A block assembly is ready for x-ray background measurements.

A paper entitled "The Testing of Thermal-Mechanical-Hydrological-Chemical Processes Using a Large Block", by W. Lin, D. G. Wilder, J. A. Blink, S. C. Blair, T. A. Buscheck, D. A. Chesnut, W. E. Glassley, K. Lee, And J. J. Roberts, was presented at the High Level Radioactive Waste Management Conference. This paper describes plans for the LBT and construction through December 1993.

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

New Zealand

The contract with Dr. R. Rogers, (Biodegradation Systems, Inc.) for sampling and preliminary analyses of cores obtained from cement exposed to geothermal conditions, which is essential to our determination of pH values of water in contact with cementitious materials, has now been finalized by LLNL procurement. However, because the contract involves two sampling trips to New Zealand, foreign travel approval must be obtained through DOE. We are presently completing the paper work for that approval.

Seven months of temperature data have been logged at three locations within the cooling tower near the locations of the emplaced concrete samples. The data are being transmitted every three months to LLNL.

Diesel Fuel Stability Experiments

The 200°C $H_2O$-fibercrete™ control experiment has been completed and the experiment disassembled. The 200°C $H_2O$-diesel fuel-fibercrete™ experiments are presently being conducted. In June, the 200°C $H_2O$-diesel fuel-fibercrete™-tuff experiment will be set up, tested and initiated. The results of the experiments to date are presently being prepared to be released as a report at the end of June.

Diesel Exhaust Historical Analog Study

This study has been initiated at the request of the M&O and YMSCO. A CSCR to provide 160K for this work was initiated by the M&O-ESF, but rejected by the M&O CCB group. Until that money is received at LLNL, the Man-Made Materials spending will appear to be in variance. The Man-Made materials Task is conducting this study now in order to support an ESF decision that must be made in August. Additional guidance is needed from YMSCO as to the status of the fund transfer.

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 reconnaisance survey and from 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. into 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 and replaced it 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 (Tide™).

The pipes and cables on the left side of the tunnel, and the lack of electricity and ventilation made the collection activity a challenge. Because of the limitations of the drill, we were only able to obtain two core samples. Due to the scarcity of core samples we have very limited expectations for our ability to provide what we consider to be a key piece of information: the mobility of the various diesel exhaust constituents from the surface of the tunnel into the tuff. Data regarding the mobility of diesel fuel in soils (see Table 5) suggests that the diesel constituents will move at different rates. However, we may not be able to quantify or verify this, given the few samples. Additional sampling and testing will be done at a later date in support of Study 8.3.4.2.4.5.

| Table 5. Mobility of Distillate Oil Constituents. (From Hydrocarbon Contaminated Soils. Volume 1. E. J. Calabrese P. T. Kostecki eds. (1991) p.171). | | |
|---|---|---|
| *Chemical* | *Solubility(mg/L)* | *Retardation ($R_d$[a] Coefficient* |
| *Low Mobility ($R_d$ >100)* | | |
| Fluorene | 1.9 | - |
| Phenanthene | 1.6 | 1,097 |
| Pyrene | 0.16 | - |
| Benzanthracene | 0.0057 | 24,601 |
| Benzo(a)pyrene | 0.0030 | 67,801 |
| Fluoranthene | 0.265 | - |
| *Medium Mobility (10<$R_d$<100)* | | |
| Napthalene | 31 | 87.94 |
| Dimethylbenzene, 1,3-(m-xylene) | 160 | 60.91 |
| Dimethylbenzene, 1,4-(p-xylene) | 200 | 54.39 |
| Dimethylbenzene, 1,2-(o-xylene) | 180 | 23.26 |
| Ethylbenzene | 150 | 53.92 |
| Toluene | 520 | 30.40 |
| *High Mobility ($R_d$<10)* | | |
| Benzene | 1,800 | 8.80 |
| Quinoline | 60,000 | 5.16 |
| Cresol (m-) | 26,000 | 4.78 |
| Cresol (p-) | 25,000 | 4.21 |
| Cresol (o-) | 26,000 | 2.32 |
| Phenol | 67,000 | 2.09 |

[a]The retardation coefficient represents the rate of migration of the chemical constituent in comparison to that of ground water (e.g. $R_d$ = 100 indicates that the constituent moves 100 times slower than water. The following values were used to determine $R_d$: foc = 0.01, porosity = 0.35, bulk density = 0.2 g/cm$^3$.

Our expectations for the samples of the surface coatings are much higher. An excellent suite of samples were collected using a range of substrates that will allow us to use the variety of analytical tools required to identify and quantify the organic and inorganic compounds that are expected to be present. The samples have arrived at Livermore and are presently being prepared for analysis. We would like to thank Alan Mitchell and Kevin Kinter of LANL, and Mark Owens of LLNL for their assistance during this sampling operation.

Diesel Exhaust EQ3/6 Modeling Exercise

EQ3/6 simulations are presently in preparation for the diesel exhaust work. The first modeling simulations are being prepared using simple organic-$H_2O$ systems that will ultimately be used to evaluate the exhaust component modeling exercise.

Diesel Exhaust Microbial Study

This study was initiated independently by the Man-Made Materials Task to add value to the Diesel Exhaust Studies described above. The intention is to provide a more complete answer to the long term impact of diesel exhaust than the non-biological chemical study that was requested by the M&O.

## 1.2.5 REGULATORY

### 1.2.5.1 Regulatory Coordination and Planning

LLNL staff participated in planning for the Planned Program Approach re-baseline.

### 1.2.5.2 Licensing

#### 1.2.5.2.2 Site Characterization Program

W. Lin briefed an NRC tour at the Large Block Test site on May 3.

W. Lin, J. Blink and C. Passos attended a comment resolution meeting on Study Plan 8.3.4.2.4.4 in Las Vegas on May 5. Other LLNL technical staff participated by conference call.

J. Blink and C. Passos began the process of re-working LLNL's input to Progress Report #10 based on criteria changes initiated by YMSCO and the M&O.

### 1.2.5.3 Technical Data Management

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

May activities will be reported in a later monthly progress report. The LLNL staff has been occupied with participation in the Planned Program Approach and in preparing input for the FY95-01 PACS submission.

#### 1.2.5.3.5 Technical Data Base Input

B. Bryan attended the Technical Data Working Group meeting in Las Vegas on March 23.

## 1.2.5.4 Performance Assessment

### 1.2.5.4.2 Waste Package Performance Assessment

May activities will be reported in a later monthly progress report. The LLNL staff has been occupied with participation in the Planned Program Approach and in preparing input for the FY95-01 PACS submission.

## 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

May activities will be reported in a later monthly progress report. The LLNL staff has been occupied with participation in the Planned Program Approach and in preparing input for the FY95-01 PACS submission.

## 1.2.9 PROJECT MANAGEMENT

## 1.2.9.1 Management and Coordination

### 1.2.9.1.2 Technical Project Office Management

D. Wilder, T. Buscheck, D. McCright, B. Halsey, and W. Clarke attended a Thermal Workshop and Key Assumptions meeting held by D. Stucker on May 3 and 4. J. Blink attended the M&O Thermal Loading Workshop on May 5.

An "All Hands" meeting for LLNL-YMP staff members was held by W. Clarke to discuss new direction brought about by the "Planned Program Approach".

J. Blink trained new LESSON Chemistry Instructors on May 2. J. Blink and C. Passos attended the LESSON-Nevada Committee meeting on May 13 in Las Vegas. J. Blink served as tour guide for the LESSON teacher workshop tour of the Weapons and YMP portions of the Nevada Test Site on Saturday, May 21. J. Blink (LLNL) and J. Calovini (RSN) taught the first day of Physics for the 1994 Nye/Esmeralda County LESSON workshop at NTS on May 31. J. Blink conducted a four hour teacher workshop at the Yucca Mountain Science Center on Saturday, May 7; seven teachers (grades 2-6) attended. J. Blink made an educational presentation at the UNR Math Institute on May 19 in Reno, Nevada. He also met with UNR faculty members interested in the LESSON teacher workshop. J. Blink and the two Tonopah winners of the YMP Egg Drop Contest participated in the Jim Butler Days Parade in Tonopah, Nevada on Saturday, May 28.

J. Blink visited the labs of Prof. R. Boehm at UNLV where bench scale thermal hydrological experiments are being conducted. Future collaboration between LLNL and UNLV was discussed.

### 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.

### 1.2.11 QUALITY ASSURANCE

Quality Assurance Coordination and Planning

The YMP-QA Quality Procedures (QP) are being reviewed and edited to incorporate text and procedural changes required by QARD review. Royce Monks will travel to Las Vegas during the week of June 6 to discuss changes made thus far with YMSCO personnel.

Quality Assurance Program Development

The following change notices were distributed:

- Activity Plan E-20-18(f), Rev. 1 (D. McCright) has been completed and distributed.
- Activity Plan AP-GM-01, GM-03, GM-05 (S. Blair) has been completed and distributed.
- Addendum A to Activity Plan AP-LBT-01 (W. Lin) was issued as Change Notice AP-LBT-01-0-2.

Quality Assurance Verification

Quality Assurance Verification - Audits

Audit report 94-04 was completed and distributed on May 5, 1994.

Notification of Audit 94-05 was distributed on April 26, and an entrance meeting was conducted on May 2. This audit concentrated on LLNL-YMP Near Field Environment Characterization and included the following procedures/requirements:

- 033-YMP-QP 2.6, Readiness Reviews
- 033-YMP-QP 2.8, Quality Assurance Grading
- 033-YMP-QP 2.10, Qualification of Personnel
- 033-YMP-QP 2.4, Technical Reviews
- 033-YMP-QP 3.0, Scientific Investigation Control
- 033-YMP-QP 3.2, Software Quality Assurance
- 033-YMP-QP 3.4, Scientific Notebooks

- 033-YMP-QP 5.0, Technical Implementing Procedures
- 033-YMP-QP 8.0, Identification & Control of Items, Samples & Data
- 033-YMP-QP 9.0, Control of Processes
- 033-YMP-QP 13.0, Handling, Storage and Shipping

CAR LLNL-033 was issued as a result of this audit.

Corrective action for CAR LLNL-028 was completed and verified, and the CAR was closed on May 10.

Quality Assurance Verification - Surveillance

No significant activities.

Field Quality Assurance/Quality Control

No significant activities.

Quality Assurance - Quality Engineering

No significant activities.

## 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 three revisions and no change notices. Follow up continues on previously distributed documents.

#### 1.2.12.2.3 Participant Records Management

A total of 131 items were logged into the LLNL-YMP tracking system. This includes nineteen records packages that were processed through to the CRF. Six action items were closed.

#### 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 ENVIRONMENT, SAFETY AND HEALTH

### 1.2.13.2 Safety and Occupational Health

#### 1.2.13.2.5 Occupational Safety and Health

J. Blink attended the YMP Safety Committee meeting in Las Vegas on May 5. Several ES&H surveillance reports were submitted to the FOC.

## 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 100 participants on the project who are to be trained and/or tracked. Six new participants added during the month of May and one participant left the program.

A new training database program has been written utilizing "user friendly" software compatible with the MacIntosh computer. Testing and implementation of this program will begin in late June.

R. Dalson, J. Haeberlin, and A. Russell received indoctrination from J. Blink via the revised indoctrination process.