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OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

QUALITY ASSURANCE AUDIT REPORT

FOR

AUDIT LLNL/LBNL-ARP-97-16

OF THE

CIVILIAN RADIOACTIVE WASTE MANAGEMENT SYSTEM MANAGEMENT AND OPERATING CONTRACTOR

AT

LAWRENCE LIVERMORE NATIONAL LABORATORIES LIVERMORE, CALIFORNIA and LAWRENCE BERKELEY NATIONAL LABORATORIES BERKELEY, CALIFORNIA

MAY 12 THROUGH 16, 1997

Prepared by: _____ **Date:** 6/20/97
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1.0 EXECUTIVE SUMMARY

As a result of the performance based Quality Assurance (QA) Audit LLNL/LBNL-ARP-97-16, the audit team determined that the Civilian Radioactive Waste Management System Management and Operating Contractor (CRWMS M&O) at Lawrence Livermore National Laboratory (LLNL) and Lawrence Berkeley National Laboratories (LBNL) is satisfactorily implementing an effective QA program and process controls for the Exploratory Studies Facility (ESF) Thermal Tests being conducted on the Yucca Mountain Project. These conclusions were based on the scientific investigations and reporting of data described in the CRWMS M&O deliverable, "Single Heater Test Interim Report" (BABEAF000-01717-6900-00001, Revision 00) and through evaluations of the scientific investigations, activities, processes and planning for the Drift Scale Tests at LLNL and LBNL. This audit is a "follow-on" evaluation to the performance based audit SNL-ARP-97-14 conducted in April 1997 at Sandia National Laboratories (SNL) in Albuquerque, New Mexico, in the continuing evaluation of the ESF Thermal Tests being conducted at Yucca Mountain.

The audit team identified one deficiency that resulted in the issuance of a Deficiency Report (DR) and one deficiency that was evaluated and closed during the course of the audit at LBNL. DR YM-97-D-048 documents that LBNL procedural controls and the Office of Civilian Radioactive Waste Management (OCRWM) QA program requirements are not being followed for the control of scientific notebooks. The deficiency corrected during the audit concerned the LBNL procurement of instrumentation that lacked appropriate documentation. The audit team also identified a deficiency that resulted in the issuance of a DR at LLNL. DR YM-97-D-047 documents that a quality affecting procurement was made from a supplier not on the Qualified Suppliers List (QSL); and additionally, a procurement that should have been processed as quality affecting was processed as non-quality affecting. Details of these issues are described in Section 5.5. Some additional management attention is apparently necessary relative to procurement issues. There were no other deficiencies identified by the audit team. It was determined that a DR issued previous to the audit relative to the use of study plans (YM-97-D-032) had direct relevance to the planning of activities at both laboratories. Additionally, there were six process improvement recommendations resulting from this audit which are detailed in Section 6.0 of this report.

The audit team determined that LBNL and LLNL personnel were competent, qualified professionals that developed good data resulting in sound scientific interpretations despite the deficiencies cited. The team based these observations on its evaluation of the controls and processes examined relative to test planning, procurements and scientific investigation activities for the Drift Scale Test (DST) and reviews of Single Element Heater Test (SHT) reports examined during the audit at LLNL and LBNL.

2.0 SCOPE

The audit was conducted to evaluate the adequacy and effectiveness of LLNL and LBNL controls for selected processes and activities related to scientific studies of ESF Thermal Tests that are being conducted and are going to be conducted in the Thermal Test Facility at Yucca Mountain. The audit was intended to determine that controls for test planning, procurements and scientific investigation activities for the DST and SHT comprising the ESF Thermal Tests are adequate and being effectively implemented at LLNL and LBNL in accordance with program requirements. The degree to which the ESF Thermal Tests and test planning activities met critical process steps and management commitments and expectations was also an element of the scope of this audit.

The processes/activities and end-products for the ESF Thermal Tests were evaluated during the audit, in accordance with the audit plan.

PROCESS/ACTIVITY/END-PRODUCT

The following deliverables were evaluated during the audit:

CRWMS M&O, "Single Heater Test Interim Report", BABEAF000-01717-6900-0001, Revision 00, February, 1997, (Work Breakdown Structure 1.2.3.14.2).

The activities evaluated included OCRWM QARD Supplement III, "Control of Scientific Investigations" (DOE/RW-0333P, Revision 5) requirements as well as procurement, planning and resource management activities.

The performance based evaluation of process effectiveness and product acceptability was based on:

1. Satisfactory implementation of the critical process steps;
2. Use of trained and qualified personnel working effectively;
3. Documentation that substantiates the quality of the products; and
4. Acceptable results and adequate end products.

TECHNICAL AREAS

The audit included a technical evaluation of process effectiveness and product acceptability. Details of the technical evaluation are included in Section 5.4.

3.0 AUDIT TEAM AND OBSERVERS

The following is a list of audit team members and their assigned area of responsibility and observers:

Name/Title/Organization	QA Program Requirements/ Processes or Products
Kenneth O. Gilkerson, Audit Team Leader (ATL) OQA	Supplement III, Critical Process Steps, Management Objectives
William J. Glasser, Auditor, OQA	Supplement III, Critical Process Steps, Procurement, Work Planning
John R. Doyle, Auditor, OQA	Supplement III, Critical Process Steps, M&O Interim Report
Jefferson McCleary, Technical Specialist, Woodward Clyde Consultants	Supplement III, Planning, Critical Process Steps, M&O Interim Report

4.0 AUDIT MEETINGS AND PERSONNEL CONTACTED

Pre-audit meetings were held at the LBNL facilities in Berkeley, California, on May 12, 1997; and at LLNL facilities in Livermore, California, on May 15, 1997. A daily debriefing and coordination meeting was held with laboratory management and staff to discuss issues and potential deficiencies as appropriate. A daily audit team meeting was also held each evening to coordinate the pace of the audit and to discuss issues, process recommendations and potential deficiencies. The audit was concluded with post-audit meetings held at LBNL in Berkeley, California, on May 14, 1997; and at LLNL in Livermore, California, on May 16,1997. Personnel contacted during the audit are listed in Attachment 1. The list includes those who attended the pre-audit and post-audit meetings.

5.0 SUMMARY OF AUDIT RESULTS

5.1 Program Effectiveness

The audit team determined that in general, with the exception of areas identified in the deficiencies cited, process controls are being effectively implemented by LLNL and LBNL for the First ESF Thermal Tests, specifically the SHT and DST preparations. The audit assessed process activities relative to the DST and CRWMS M&O deliverable, "Single Heater Test Interim Report" (BABEAF000-01717-6900-00001, Revision 00). This report was prepared by the CRWMS M&O based on ESF Thermal Test results and reports from LLNL, LBNL and SNL. The audit team determined that LLNL and LBNL Principal Investigators and Technical

Staff acquired data resulting in sound scientific interpretations, and are conducting adequate scientific investigations relative to the conduct of the DST. SNL was evaluated during audit SNL-ARP-97-14. It should be noted that all of these laboratories initially relied on project study plans as their basis of planning. Each of these participants expressed concern over conflicting project direction relative to the use of study plans. See Section 5.5.3 for further detail.

The evaluations of these studies in real time allows the process recommendations made by the audit team to be useful in providing acceptable quality products to OCRWM.

5.2 Stop Work or Immediate Corrective Actions Taken

There were no Stop Work Orders, immediate corrective actions, or related additional items resulting from this audit.

5.3 QA Program Audit Activities

A summary table of audit results is provided in Attachment 2. The details of the audit evaluation, along with the objective evidence reviewed, are contained within the audit checklists. The checklists are kept and maintained as QA Records.

5.4 Technical Audit Activities

The thermal tests in the ESF are complex multi-disciplinary tests and the implementation of these tests involves a number of organizations on the Yucca Mountain Project. In order for the current ongoing SHT and the under construction DST to be successfully completed, a high degree of interaction, cooperation, and integration among the various test participants is necessary. Therefore, the technical objectives of the audit of LLNL and LBNL activities on the SHT and DST included an assessment of how the organizations were integrated to achieve the goals of the tests, an assessment of the technical quality of the work that each lab was performing, and an assessment of how the currently ongoing and planned thermal tests will contribute to the projects thermal goals and an improved understanding of thermally driven processes. Technical checklist questions were developed in the following categories: Data collection and management; Identification of data needs/modeling approach; Design requirements testing; Testing strategy; and SHT lessons learned. Source documents for the checklist questions included 1) "Thermal Loading Study For FY 1996" (B00000000-01717-5705-00044 Rev 01); 2) "Single Heater Test Interim Report" (BABEAF000-01717-6900-00001 Rev 00); 3) "U.S. Department Of Energy

Determination of the use of the Results of the Peer Review Report on the Thermohydrologic Modeling And Testing Program; and 4) A consultant report by Roger W. Staehle titled, "Corrosion Performance Of Carbon Steel Containers For Containing Radioactive Waste." While a few questions were specific to only one laboratory (questions on canister corrosion were only applicable to LLNL for example), by and large the same questions were asked to scientific or principal investigators at both laboratories. While it was not anticipated that the answers to the technical questions would be the same for each participant, it was anticipated that the answers would be compatible and that the investigators at one lab would be cognizant of what was being done at the other lab in all areas where there was a collaborative effort by LLNL and LBNL. It was gratifying to see that this was the case. Answers to the same checklist questions by the two organizations demonstrated that there was good communication, and that concepts, ideas, and data were being exchanged in a collaborative effort to understand and explain the processes (chemical, hydrologic, mechanical) that are occurring as a result of heating the SHT block. It is anticipated that this same collaborative exchange will occur on a larger scale with the heating of the DST drift.

The key element in assessing the technical quality of the work of LLNL and LBNL was the scientific notebooks used to document their investigations. Much of the work being conducted is new and innovative and the use of scientific notebooks is certainly appropriate. In accordance with the importance of the notebooks, a considerable amount of time was devoted to examining scientific notebooks and the controlling scientific notebook procedures at both labs. In all, about twenty notebooks were examined. As discussed in Section 5.5 of this audit report, some deficiencies were identified at LBNL relative to the development, maintenance and content of scientific notebooks. It should be emphasized, however, that most of the notebooks examined at LBNL were of good quality and a few were excellent in terms of compliance with the procedure and the ability of a reviewer to retrace the investigation without recourse to the investigator. At LLNL all of the notebooks were at least adequate, most were of good quality and several were excellent. In examining the scientific notebook procedures for the two organizations there is only one significant difference. The LLNL procedure requires periodic review while the LBNL procedure only requires a review after the conclusions of a scientific investigation have been finalized. It is recognized that requiring a periodic review can be restrictive in that missing a periodic review date by a few days is a procedural non-conformance with little or no impact on quality. However, the uniform high quality that periodic reviews brings to the scientific notebook process more than outweighs any potential disadvantage. See Section 6.0, recommendation number one, regarding the initiation of periodic reviews of scientific notebooks.

In view of the importance of scientific notebooks, a number of suggestions to authors of notebooks are provided in Section 6.0, recommendation number two. It is emphasized that given the innovative type of work being conducted by LLNL and LBNL, the only way to assess the technical quality of work in progress is through the scientific notebooks. Overall, it is apparent that high quality work is being performed by the audited organizations.

In terms of how the currently ongoing and planned thermal tests will contribute to the project's thermal goals and an improved understanding of thermally driven processes, several observations were made. First, it is noted that the evolution of the design of the thermal tests has out paced the formal planning process. The project is in the process of revising the overall planning process and at this time it is not clear what the final process will be. For purposes of this report, it is assumed that an approved plan that meets OCRWM program requirements will be in place prior to the start of the DST. Characterization of the fracture network in the DST test area is ongoing, primarily by fracture mapping, air permeability and tracer testing in boreholes in the test area. Observations to date suggest that roughly ten percent of the fractures present have significant conductivity; however, the locations of conductive fracture intersections with the heated drift wall appears to be unknown at present. Discussions with several investigators indicated that knowing the locations where conductive fractures intersect the drift wall would be valuable information for instrument placement, interpretation of instrument readings, modeling studies, and for locating post-test mine out areas for evaluating mineralogic changes in the fractures. One possible mechanism for locating conductive fractures with equipment on hand would be to warm the drift, after the bulkhead is in place, until the first few millimeters of the drift wall reach a temperature of approximately 32^0 C (90^0 F); then draw a vacuum on the drift using the ventilation system. Rock gasses at the current ambient temperature of approximately 24^0 C will be drawn into the drift through conductive fractures and IR imaging of the strong thermal contrast will document the locations of conductive fractures. It is recommended that the feasibility of using this technique to document the locations of conductive fracture intersections with the heated drift wall be evaluated. See Section 6.0, recommendation number three.

The project currently has several thermal goals, including one of not raising the surface temperature above the repository (and presumably above test areas) by more than 2^0 C. However, it is not clear if the goal is 2^0 C at the interface with the atmosphere, 2^0 C below the level of diurnal changes, 2^0 C below the level of seasonal changes, 2^0 C at a specific feature such as a conductive fracture, or 2^0 C averaged over some specified area. Further, it appears that no baseline data is being collected either as a benchmark to measure change against or as input to

boundary conditions for thermal modeling studies. This thermal goal should be revisited. If it is determined that it is a valid goal, then it should be better defined and a schedule established for conducting baseline monitoring. See Section 6.0 recommendation number four. Relative to other thermal goals, discussions with several investigators indicated that the 350^0 C cladding temperature goal will not be addressed by the DST because of the use of electric heaters, the 200^0 C drift wall temperature goal will be directly addressed by the DST, and the 90^0 C temperature goal at the top of the zeolites will be indirectly addressed by the DST by better calibrating the models used to predict temperature.

The formation of heat pipes is a process that is being actively investigated at LLNL and LBNL by modeling studies, laboratory experiments, and natural analog studies. Discussions with investigators indicate that relative to the DST, heat pipes are unlikely to form due to the probable short duration and relatively low temperature of the test. However these same discussions also indicated that the temperature and duration of the test are a matter of considerable debate. A majority of investigators favored a hot test so that a condensate zone would form more quickly and the processes most important to performance could be better evaluated in the relatively short time available for the test. The push for a cooler test that would more closely simulate repository loading appears to come from the U.S. Nuclear Regulatory Commission, and some investigators felt that this approach would require a longer duration for the test to be meaningful. There was a general consensus that the hotter the test and the longer it was run, the greater the likelihood that heat pipes would form. Given these uncertainties, it is recommended that a planning link be established between the length and temperature of the test, the probability of heat pipe development, and the potential need for monitoring vapor loss at the surface. See Section 6.0, recommendation number five.

How the perturbing effects of the excavation itself and the monitoring boreholes on the test results are going to be assessed is a significant issue for the ESF thermal tests. Modeling results indicate that unsealed boreholes in the test area can cause major perturbations in the thermal field. Metallic components in the SHT block have made the ERT results difficult to interpret, and the water that collected in zone 4 of hole 16 in the SHT block would have continued migrating had it not been trapped in the packed zone of the borehole. It appears that sufficient effort is being devoted to this problem and it is recommended that these efforts continue. See Section 6.0, recommendation number six.

It was noted that some investigators have come to view the thermal tests as an end in themselves rather than a part of a larger project. This is understandable, and perhaps even necessary in some cases, and no recommendation results from this observation. Nevertheless, investigators are encouraged to periodically step back and get a perspective on where the thermal tests fit, both physically within the mountain and in the context of the overall project.

The technical audit activities covered numerous topics in addition to those discussed above and are detailed in the performance based audit checklist LLNL/LBNL-ARP-97-016. However, the discussions with investigators and examinations of documents on other topics did not result in other recommendations. Overall, it is apparent that the technical work being conducted by LLNL and LBNL relative to the thermal tests in the ESF is effective in improving the understanding of thermally driven processes that would occur in response to a repository at Yucca Mountain.

5.5 Summary of Deficiencies

The audit team identified three deficiencies during the audit for which two Deficiency Reports (DR) have been issued.

A synopsis of the deficiencies documented are detailed below. The DRs generated during this audit have been transmitted under separate letter.

5.5.1 DR

As a result of the audit, the following DRs were issued:

YM-97-D-047

A quality related procurement for the calibration of mass weights was let by LLNL to a supplier no longer on the QSL. Also, a procurement for instrumentation that should have been processed as a quality related procurement was processed as "non-quality" related, resulting in the appropriate quality and technical requirements not being imposed as required. The instruments in question have been installed for use in the test alcove.

YM-97-D-048

The OCRWM program requirements and LBNL procedural requirements

for the development, maintenance, and content of scientific notebooks are not being implemented for some notebooks that were reviewed.

5.5.2 Deficiencies Corrected During the Audit

As part of the evaluation for procurement of calibrated items for use on the DST, a review was conducted of LBNL initiated purchase requisitions 1838-36 and 1838-38, for pressure transducers and a mass flow controller, respectively. This review identified that the acceptance inspection reports for both items, prepared on the same day by the same individual, were not fully completed. Further, it was not clear from the documentation what criteria was used to evaluate the acceptability of the calibration services. As a result of this observation, LBNL initiated the following actions for both reports:

- Reviewed the acceptability of calibration reports from Setra for pressure transducers, and from Sierra Instruments for a mass flow controller.
- Obtained from the suppliers additional information to meet requirements for procurement of calibration services.
- Completed acceptance inspection reports and attached LBNL "Attachment to Requisition Request for Calibration Services". A note was added to the attachment to clarify that calibration certificates, along with additional information provided by the manufacturer, is again being signed in Block IV (acceptance statement) of the Acceptance Inspection Report with the current date.
- Corrected statement on requisitions signed by the Principal Investigator after initial acceptance of items.
- Prepared a memo to file to explain the need for these "Corrected During the Audit" actions.

Since the observed discrepancies were created on the same day by the same individual, the activity is considered isolated requiring only remedial actions. Prior to completion of this audit, the documentation changes noted above were reviewed by the auditor and confirmed to have been corrected as stated.

corrected as stated.

5.5.3 Follow-up of Previously Identified CARs, DRs and PRs

There were two previously issued DRs that were determined to be applicable to the scope of this audit. DR YM-97-D-025 was issued prior to this audit (re: Surveillance # YMP-SR-97-002) regarding the installation of instruments and equipment that were not procured and calibrated in accordance with program requirements. Although a response has been accepted with proposed remedial and corrective actions, the condition is still unresolved. A similar problem was identified at LBNL relative to the procurement of test instruments. See the LBNL deficient condition closed during the course of the audit in Section 5.5.2, and LLNL deficiency report YM-97-D-047 in Section 5.5.1. Additional management attention relative to procurement issues is apparently necessary.

DR YM-97-D-032 (previously issued as YM-97-D-023) identified that study plans had not been maintained, kept current or used as required. While this was not found deficient at the laboratories, it appears that the laboratories had received written direction from the CRWMS M&O to discontinue the use of study plans. This was of concern to LLNL and LBNL since the study plans have driven their scientific investigation processes. This DR has not been resolved to date, but appropriate resolution of this issue with the CRWMS M&O and OCRWM should result in clearing up the inconsistencies and direction that the laboratories are receiving. Presently this issue does not have an adverse impact on the activities examined.

6.0 RECOMMENDATIONS

The following recommendations resulted from the audit and are presented for consideration by management.

1. In order to improve/maintain the consistency and quality of scientific notebooks, periodic reviews of notebooks should be initiated/continued.

2. The DR 97-D-048 cited in Section 5.5 cites procedural and program implementation deficiencies. The OCRWM requirements for the use of scientific notebooks is to provide sufficient detail to be able to retrace the investigation without recourse to the original investigator. The following suggestions are mechanisms that may aid in achieving that goal and in addressing the deficiency

- Often, several notebooks were in use during one test and it was sometimes difficult to retrace the progress of the test. In cases like this, cross referencing between notebooks would be very helpful to later reviewers.

- Opinions/thought processes/logic trains are the hardest thing to follow when trying to "retrace the investigation without recourse to the original investigator." Try to add more explanatory statements. For example, rather than just stating that air injection times were increased, state that "air injection times were increased because --- ."

- Clearly label any sketches. A hand drawn sketch of a borehole video log looks remarkably like a hand drawn sketch of a length of core and a label eliminates any possible confusion. Similarly, label the axes of any sketched graphs.

- Most of the notebooks examined were weak on stating testing requirements such as needed equipment or environmental conditions. More detail in these areas would be desirable.

- Quite often data and/or calculations are in computer files, be sure to reference where and how to access these files in the scientific notebook.

- Try to limit the use of project jargon and cryptic notations that require prior knowledge to understand. For example, a notebook entry that indicates "the blue holes were tested" or "the red holes were tested" is not meaningful to a reviewer unless they have the color coded borehole layout from the TCO (and none of the notebooks examined included or referenced the color coded layout).

3. To document the locations of conductive fracture intersections with the heated drift walls, evaluate the feasibility of warming the drift, drawing a vacuum with the ventilation system, and obtaining IR images of the thermal contrast when cool rock gas enters the drift through conductive fractures.

4. Revisit the thermal goal of raising the surface temperature by no more than 2^0 C, and if it is a valid goal, better define where and how it is measured and establish a schedule for baseline monitoring.

5. Given the uncertainty in the temperature and duration of the DST, establish a planning link between test design, the probability of heat pipe formation, and the potential need for monitoring vapor loss at the surface.

6. Continue to devote appropriate resources to assessing the impact of excavations, boreholes, and instrumentation on test results.

Attachment 1: Personnel Contacted During the Audit

Attachment 2: Summary Table of Audit Results

ATTACHMENT 1

Personnel Contacted During the Audit

Name	Organization/Title	Pre-audit Meeting	Contacted During Audit	Post-audit Meeting
Alegre, Barbara	LLNL, Records Coordinator		X	
Aragon, Kate	LBNL, QA	X	X	X
Bodvarsson, Bo	LBNL, Project Manager	X	X	
Brumbaugh, Cami	LLNL, QA	X	X	X
Bryan, Barbara	LLNL, Administration	X		X
Buscheck, Tom	LLNL, PI		X	
Clarke, Willis	LLNL, YMP Laboratory Lead	X	X	X
Fissekidou, Vivi	LBNL, Training	X	X	X
Glassley, Bill	LLNL, PI		X	
Hastings, Cheryl	LBNL, Program Administrator	X	X	X
Lin, Wunan	LLNL, PI	X	X	X
Kneafsey, Tim	LBNL, Post Doctoral Fellow		X	
Mangold, Donald	LBNL, QA Manager	X	X	X
McCreary, Julie	LLNL, Training	X	X	X
McCright, Dan	LLNL, PI		X	
Meike, Annemarie	LLNL, PI		X	
Monks, Royce	LLNL, QA Manager	X	X	X
O'Shea, Colleen	LBNL, QA	X		X
Podobnik, John	LLNL, Project Controls Manager	X	X	X
Ramirez, Abe	LLNL, Scientist		X	
Ruddle, Dave	LLNL, Lab Technician		X	
Simmons, Ardyth,	LBNL, PI		X	
Tsang, Yvonne	LBNL, PI	X	X	X
Wang, Joe	LBNL, PI		X	
Wilder, Dale G.	LLNL, TAL	X	X	X

LEGEND:
PI.....Principal Investigator
LLNL..Lawrence Livermore National Laboratories
LBNL..Lawrence Berkeley National Laboratories
TAL... Technical Area Leader

ATTACHMENT 2

AUDIT LLNL/LBNL-ARP-97-16 DETAIL SUMMARY OF AUDIT RESULTS

QA ELEMENT/ ACTIVITIES	PROCESS STEPS/ MGMT OBJECTIVES	DETAILS (Checklist)	DEFICIENCIES	REC	PROCESS EFF.	PRODUCT ADEQUACY	OVERALL
Supplement III: First ESF Thermal Tests- Single Element Heater Tests (SHT) Drift Scale Tests (DST)	Interfaces defined. Personnel assigned. (M/O)	item 1, p. 1 item 20, p. 13	N	N	SAT	SAT	SAT
	Training/qualification (M/O)	item 2, p. 2	N	N	SAT		
	Resources: personnel, equipment, communications, feedback, facilities (M/O)	item 3, p. 2 item 22-24, p. 10	N	N	SAT		
	Work activities identified and defined/documented (CPS)	item 4, p. 3 Item 21, p. 9	YM-97-D-032 Issued Previously	N	UNSAT		
	Controls established: Scientific notebook, technical procedures	item 5, p. 3	YM-97-D-048	Rec. #1, #2	UNSAT		
	Intended use of data (CPS)	item 6, p. 4	N	N	SAT		
	Use of contract or subtier suppliers (CPS)	item 6, p. 4 item 33, p. 13	N	N	SAT		
	Documentation of intended use Repository Licensing? (CPS)	item 7, p. 4 item 36, p. 15	N	N	SAT		

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QA ELEMENT/ ACTIVITIES	PROCESS STEPS/ MGMT OBJECTIVES	DETAILS (Checklist)	DEFICIENCIES	REC	PROCESS EFF.	PRODUCT ADEQUACY	OVERALL
Drift Scale Tests (DST)	Timing/Project Milestones (M/O)	item 8, p. 5 item 22, p. 14	N	N	SAT	SAT	SAT
	M&TE useage (procurement) (CPS)	item 10, p. 6-7 item 1, p. 12	YM-97-D-047, CDA	N	UNSAT		
	Equipment Qualification: Q/Non-Q grading? (CPS)	item 10, p. 6-7	YM-97-D-047	N	UNSAT		
	Data acquisition and reporting (CPS)	item 17, p. 11 item 28-34, p. 17-20	N	N	SAT		
	Planning: Data Needs, Design Requirements, Testing, Test Strategy, Lessons Learned (from SHT) (CPS)	item 35-48 item 49-54 item 55-70 item 71-88 p. 21-47	N *see related issue re: study plans DR# YM-97-D-032	See Rec. #4,5 See Rec. 3,6	SAT*		
	Review and submittal - reports (CPS & M/O)	item 9, p. 6	N	N	SAT		
	SHT Reports - Technical content: (adequacy, effectiveness, accuracy, continuity) (CPS & M/O)	item 9, p. 6	N	N	SAT		
	Software Controls (CPS)	item 27, p. 16	N	N	SAT		

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QA ELEMENT/ ACTIVITIES	PROCESS STEPS/ MGMT OBJECTIVES	DETAILS (Checklist)	DEFICIENCIES	REC	PROCESS EFF.	PRODUCT ADEQUACY	OVERALL
Drift Scale Tests (DST)	Deficiency protocol/documents	item 13, p. 9 Item 17, p. 11	N	N	SAT	SAT	SAT
	Impact/interferences on testing (CPS)	item 14, p. 10 item 21, p. 13	N	N	SAT		
	Borehole acceptance/ instrumentation (CPS)	item 12, p. 9	N	N	SAT		
	QA controls (CPS&M&O)	item 17, p. 11 item 23, p. 14 item 24, p. 15	N	N	SAT		
	Sample Control	item 15, p. 10 item 16, p. 11 item 25, p. 15 item 26, p. 16	N	N	SAT		
	Records	item 19, p. 12	N	N	SAT		

LEGEND:

CDS = Corrected During Audit
CPS = Critical Process Steps
M/O = Management Objective