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Office of Civilian Radioactive Waste Management
Yucca Mountain Site Characterization Office
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QA: L

AUG 19 1994

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ISSUANCE OF SURVEILLANCE RECORD YMP-SR-94-059 RESULTING FROM
YUCCA MOUNTAIN QUALITY ASSURANCE DIVISION (YMQAD) SURVEILLANCE
OF RAYTHEON SERVICES NEVADA (RSN) (SCPB: N/A)

Enclosed is the record of Surveillance YMP-SR-94-059 conducted
by the YMQAD at the RSN facilities, Yucca Mountain site, Nevada,
July 7-15, 1994.

The purpose of the surveillance was to determine whether the
process for obtaining borehole depth measurements is adequate
for ongoing coring activities.

This surveillance is considered completed and closed as of the
date of this letter. A response to this surveillance record and
any documented recommendations is not required.

If you have any questions, please contact either Robert B.
Constable at 794-7945 or Kristi A. Hodges 794-7807.

Richard E. Spence, Director
Yucca Mountain Quality Assurance Division

YMQAD:RBC-4726

Enclosure:
Surveillance Record YMP-SR-94-059

YMP-5

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cc w/encl:

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OFFICE OF
RADIOACTIVE WASTE MANAGEMENT
U.S. DEPARTMENT OF ENERGY
WASHINGTON, D.C.

QUALITY ASSURANCE SURVEILLANCE RECORD

SURVEILLANCE DATA

¹ORGANIZATION/LOCATION:
Raytheon Services Nevada
(RSN), Las Vegas, NV

²SUBJECT:
Borehole Depth Control

³DATE: 7/7-15/94

⁴SURVEILLANCE OBJECTIVE:

To evaluate the process described in RSN procedure PP-10-01, "Field Drilling Engineer Support Activities," and to determine whether adequate controls exist to ensure accurate borehole depth measurement in support of Surface Based Testing (SBT) activities.

⁵SURVEILLANCE SCOPE:

1. Pipe Measurement (drill pipe/core rod)
2. Stick up measurement
3. Recovered core measurement.

⁶SURVEILLANCE TEAM:

Team Leader:

K. A. Hodges

Additional Team Members:

J. R. Doyle

⁷PREPARED BY:

Kristi A. Hodges 7/6/94
Surveillance Team Leader Date

⁸CONCURRENCE:

N/A
QA Division Director Date

SURVEILLANCE RESULTS

⁹BASIS OF EVALUATION/DESCRIPTION OF OBSERVATIONS:

See page 2

¹⁰SURVEILLANCE CONCLUSIONS:

See page 3

¹¹COMPLETED BY:

Kristi A. Hodges 8-17-94
Surveillance Team Leader Date

¹²APPROVED BY:

Robert Dowd 8-17-94
QA Division Director Date

Block 9 Basis (Continued) Basis of Evaluation/Description of Observations:

The purpose of this surveillance was to determine whether the process for obtaining borehole depth measurements is adequate for ongoing coring activities. The surveillance was performed from July 7 through July 15, 1994, at the Yucca Mountain Site.

Based upon Nonconformance Report (NCR) YMPO-94-0039, recovered core for core run 284 at borehole USW-UZ-14 was measured as greater than the length of the core cut. 0.5 feet of core could not be reconciled with previous core interval(s). In addition, 0.2 feet of core from core run 310 could not be reconciled, bringing the extra (E) core tally to 0.7 feet. The NCR was generated to document the discrepancy.

Prior to dispositioning of the subject NCR, U.S. Department of Energy (DOE) field personnel requested that the Yucca Mountain Quality Assurance Division (YMQAD) conduct a Quality Assurance surveillance of field techniques used for measuring core lengths, drilling depth, and the drill string length. Technical personnel from RSN and the Drilling Support & Sample Management (DS&SM) Department had analyzed the discrepant condition with no apparent resolution. The intent of this surveillance was to ensure that adequate programmatic controls are in place, as well as provide a limited technical evaluation. No Corrective Action Requests (CARs) were generated, however, several recommendations for consideration are detailed in Block 10 of this report.

Personnel Contacted

D. P. Neubauer	RSN
S. M. Weber	Science Applications International Corporation (SAIC)
R. W. Morris	SAIC
J. N. Stellavato	Nye County
J. L. Rue	RSN
D. M. Cunningham	RSN
A. W. Girdley	Yucca Mountain Site Characterization Office (YMSCO)
K. J. Skipper	YMSCO
W. A. Lindquist	RSN
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Measurements Taken and Methodology

Three coring depth control measurements are taken and recorded: pipe (core rod) length, stick up, and core recovery. These measurements are taken by RSN, Reynolds Electrical and Engineering Company (REECO), and the DS&SM Department as follows:

- **Pipe (drill pipe/core rod) Measurement** - According to PP-10-01, the drilling contractor (REECO) measures pipe prior to its use in drilling/coring operations. The combined pipe length is used to calculate borehole depth. Measurements are taken using a steel tape with readings made to the nearest 0.01 foot with no correction applied to the steel tape for temperature/stretch factors.
- **Stick Up Measurement** - Stick up refers to the measurement(s) of pipe above ground level (G/L) which are taken at the start and end of each core run by the RSN Field Drilling Engineer (FDE). The distance from G/L to a given reference point; e.g., drill rig floor, and the distance from that reference point to the top of the pipe or kelly are measured. This calculation is documented on a Core Run Record (CRR) which contains both coring and depth information. All stick up measurements and calculations are made relative to G/L in tension with a Weight on Bit (WOB) of zero. No correction is applied for pipe/rod temperature/stretch factors. The procedure states that the elevation of G/L shall be established by surveying after the hole is completed.
- **Recovered Core Measurement** - Core recovery is the amount of core measured in the core barrel to + or - 0.1 foot by the DS&SM Department versus the amount cut and measured to 0.01 foot by the RSN FDE. E core is determined when the recovered core length exceeds the documented cut. Due to disintegration during the coring process and geologic conditions encountered down hole, core recovery is generally expected to be less than the recorded core taken. No correction is applied for core temperature/stretch factors.

Block 10 (Continued) Surveillance Conclusions:

It appears that in spite of many controls and checks and balances that are present in the process, discrepancies can occur in measuring both depth and core recovery. Core recovery can be, at best, an imprecise process because of the many geologic unknowns encountered during the coring process; i.e., natural fracturing and faulting, lithophysical cavities, and varying thickness of cooling units. Depth control likewise has its share of imprecision in the processes and varying accuracies used in the taking and recording of measurements.

Plans were underway to transition RSN's work scope to Technical and Management Support Services (T&MSS) at the time of this surveillance. The transition will result in development of new procedures and an opportunity to improve the existing processes. It is, however, the opinion of the surveillance team that borehole depth measurements performed to date by RSN are adequate to support ongoing scientific investigations. RSN personnel initiated a procedure change during the surveillance to remove REECO as responsible for taking pipe measurements. However, with pending organizational changes, any RSN procedure revisions are viewed as unnecessary. The YMQAD will monitor the transitioned organization via future surveillances and audits to ensure that appropriate personnel perform depth measurements. The surveillance results are as follows:

- **Pipe (drill pipe/core rod) Measurement** - It was stated by RSN personnel that REECO personnel assist in the measurement of pipe by holding the tape measurer, reading to the nearest 0.01 foot, and calling out numbers to the FDE for inclusion on an RSN YMP Depth Control Data Sheet. It was also stated that REECO personnel are not directly recording measurements on RSN quality affecting documentation. Although the use of a tape measurer is routine, the activity in regard to borehole depth control is quality affecting. Since REECO's work scope in support of SBT has been established as not quality affecting, the utilization of measurements taken by REECO personnel as the basis for RSN's quality affecting borehole depth information is not appropriate. It should be noted that RSN performed a strapped pipe tally on the USW-UZ-14 borehole with a stated variation of only .79 in 2,000 + feet. The tally results indicate that pipe measurements taken by RSN/REECO are reliable (see recommendation #1).

It is not clear in PP-10-01 whether the measurement of pipe includes core rod measurements. Also, terms used; e.g., drill rig floor, top of slips, and table, are not uniquely defined (see recommendation #2).

Measuring tapes are not necessarily equivalent, some being more accurate than others. Measurements taken with a clip tape can differ from a strap tape and because of viewing restrictions, the direction the reading is taken from may also impact results. With the many variables, standardized measuring techniques as well as measuring devices should be utilized by all personnel taking and recording SBT measurements (see recommendation #3).

If the stringent measurement to the nearest 0.01 foot is deemed critical, the failure to account for measuring device stretch/temperature factors could undermine measurement accuracy (see recommendation #4).

- **Stick Up Measurement** - It is not clear in PP-10-01 whether stick up measurements are taken in an upward or downward direction. The definitions section indicates that the measurement is taken from G/L to a given reference point and from that reference point to another reference point; i.e., top of the pipe. However, the Depth Control Data Sheet indicates that the stick up measurement is taken from a given reference above ground to G/L (see recommendation #5).

The procedure states that a survey of G/L is taken upon completion of the borehole, but does not indicate that a preliminary survey is taken. The surveillance team questioned the validity of stick up measurements without accurate elevation prior to drilling/coring. It was stated that G/L is considered zero regardless of actual elevation and that the surveyed elevation has no bearing on RSN depth control measurements. Although the procedure does not mention a preliminary survey, it was stated that one does occur prior to borehole drilling. It was also stated that the final G/L survey does not impact recorded depth measurements and that the elevation surveys are taken in support of other scientific investigations (see recommendation #6).

According to procedure, all stick up measurements are made relative to G/L in tension with a WOB of zero. The question of how one determines a WOB of zero and whether this determination requires use of calibrated Measuring and Test Equipment (M&TE) was discussed. It was stated that the WOB of zero is currently based upon a combination of monitoring hydraulic pressure gauge fluctuations and the "feel" of the drill string to determine whether the bit is on or off bottom (see recommendation #7).

The stick up measurement does not account for possible temperature/stretch factors. If the stringent 0.01 foot measurement is critical, perhaps this should be reevaluated (see recommendation #4).

- **Recovered Core Measurement** - Core is transferred to the custody of the DS&SM Department where it is fitted together and measured to the nearest 0.1 foot as opposed to RSN's 0.01 foot pipe measurement. It is conceivable that differences in measurement accuracies could account for some measurement discrepancies. Because core is generally recovered in pieces, often small fragments, it is difficult to reconstruct to an accurate length in the time constraints dictated by sample handling instructions. Although core

recovery is generally less than the cut, it is feasible that pieces that do not precisely fit together could result in measurements that exceed the recorded cut.

A theory was explained by DS&SM personnel which provides a likely explanation for the discrepant core measurements. It is based upon break off of core during one interval that is not recovered until the next interval. Breaks occur leaving stubs downhill to be recovered at the beginning of the next interval. Although core can be cut to a given footage, additional core may be recovered, possibly protruding from the core barrel. E core can be backed up, via DS&SM Department procedure, to previous intervals and reconciled. However, it is apparently difficult to reconcile this core when unique identification/labeling has occurred. DS&SM Department personnel are in the process of changing its core labeling process to accommodate measurement adjustments that impact core recovery.

An alternative method of obtaining depth measurements was explained which called for elimination of any stubs down hole prior to beginning a new core interval. This zeroing out method would result in less recovered core but would minimize E core occurrences.

In conclusion, the process defined in RSN procedure PP-10-01 is considered adequate. The surveillance resulted in no CARs being issued. However, an opportunity exists to improve the borehole depth measurement process as the workscope is transitioned to T&MSS. Developers of the forthcoming T&MSS field drilling procedures should take into account the following recommendations.

Recommendations

1. Based upon the transition in progress, recommend that T&MSS reevaluate the drilling contractor's role in the taking and recording of pipe measurements. Since REECO's SBT work scope was established as not quality affecting, any measurements taken by REECO personnel should be directly observed, verified, and documented by appropriate personnel.
2. PP-10-01 currently defines "pipe" as drill pipe or core rod. It also defines a core rod tally unique from a drill pipe tally. The coring section, however, does not mention a core rod measurement or a core rod tally. To preclude future procedure disconnects/incomplete processes, recommend flowcharting the borehole depth measurement process.
3. The use of like measuring tapes to ensure equivalent results among individual workers and between affected organizations is recommended.

4. Since stringent measurements to 0.01 foot have been imposed by RSN, it would appear that temperature and stretch should be calculated. If this stringent measurement is not considered critical to the program, consider loosening it or adjusting the tolerances to account for temperature/stretch factors.
5. Recommend procedure revision to clarify the direction (reference point to G/L or G/L to reference point) when performing a stick up measurement.
6. Recommend procedure revision to clearly state and justify the use of G/L as zero as opposed to an accurate surveyed elevation. If accuracy to 0.01 foot is deemed necessary, would there be an impact on recorded depth if G/L and reference point changes occur; e.g., inadvertent rig movement or G/L subsidence at the collar during operations? It seems that pre and post surveys would be necessary to determine any impact on documented measurements.
7. Reevaluate the WOB as zero without benefit of calibrated M&TE.
8. Recommend that organizations involved in the measurement of borehole depth and recovered core arrive at some consistency with numbers measured to and measuring techniques. The measurement standard should be consistent with Project requirements and if none are specified, based upon standard industry practice.
9. During coring of more incompetent units, rather than coring intervals of ten feet, consider whether shorter runs decrease the possibility of jamming more core in the inner barrel (evidenced by compression fractures).
10. PP-10-01 involves multiple organizational interfaces (RSN, DS&SM, REECO, YMSCO). Consider whether a Yucca Mountain Administrative Procedure (YAP) is appropriate to establish the drilling/coring operations interfaces and standard methodology.