JUL 16 1999

ENGINEERING DATA TRANSMITTAL

Page 1 of 1

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(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature
1	1	D. L. Becker (HTI/CP.)	<i>D. L. Becker</i>	7/12/99	H0-22				
1	1	W. S. Callaway (HTI/CP/DA)	<i>W. S. Callaway</i>	5/25/99	H1-19				
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18. Signature of EDT Originator <i>G. L. Troyer</i> 5/24/99	19. D. L. Becker Authorized Representative Date for Receiving Organization <i>D. L. Becker</i> 7/12/99	20. W. S. Callaway Design Authority/Cognizant Manager <i>W. S. Callaway</i> 5/25/99	21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments
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Acceptance/Status of Construction At Suspension of the Hanford Cone Penetrometer Multi-Sensor and Multi-Sample Soil Sampler Probe Systems

G. L. Troyer
Numatec Hanford Corporation, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

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Key Words: conc, penetrometer, soil, sampler, gamma, x-ray, deliverables

Abstract: This document describes the condition of the multi-sensor cone penetrometer probe system at project termination..

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Approved for Public Release

Acceptance/Status of Construction At Suspension of the Hanford Cone Penetrometer Multi-Sensor and Multi-Sample Soil Sampler Probe Systems

G. L. Troyer

Numatec Hanford Corporation, Richland, WA 99352

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Acceptance/Status of Construction At
Project Suspension of the Hanford Cone Penetrometer
Multi-Sensor and Multi-Sample Soil Sampler
Probe Systems

Prepared by
Numatec Hanford Corporation
May 1999

For the
United States Department of Energy
Richland Operations Office
Richland WA

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Acceptance/Status of Construction At Project Suspension of the Hanford Cone Penetrometer Multi-Sensor and Multi-Sample Soil Sampler Probe Systems

1.0 Introduction

1.1 Purpose

This document provides a statement of condition of the tested components of the integrated Multi-sensor probe (MSP), soil sampler probe (SSP), Grout modules, and data acquisition system (DAS) at the point of suspension of the Hanford Tank Initiative (HTI) cone penetrometer (CP) demonstration activity. This document provides information supportive to the closure of CP probe construction and procurement responsibilities within the guidance intent of Project Hanford Management Contract procedure (HNF-PRO-572, 1997).

1.2 Scope

This document captures test results accumulated through the time of project suspension under guidance of the CP probe test plans (HNF-3551, 1998) and contract requirements (HNF-2881, 1998). Identified conditions and status are as found on March 4, 1999. Where appropriate, results, exceptions, and component status are included. Due to sudden project suspension, evaluation and recommendations are limited. Use of this document is warranted due to the abrupt project suspension and because the contracted vendor constructed and delivered materials to the HTI program.

1.3 Test Methodology

The testing was performed in phases as logistics of equipment placement and support facilities required. This was to facilitate logistics of probe preparation and to ensure traceability of components. As testing was performed, BUYER direction and witnessing of key steps was performed. On-site test phases occurred as the probes were assembled and as the full system was configured and presented with known situations.

The nature of the evolution of the MSP/SSP/DAS required a combination of guidelines as presented in the SOW, establishment of performance characteristics, and qualification of system capability. Performance characteristics were established through witnessed measurements during development and through the test phase. Tests were used to identify and correct technical deficiencies and optimize solutions, followed by re-testing. Results presented here are the last measurements made in these tests.

The various tests were performed against specific function or sensor categories. Although the measurements were separate classes, the tests were all performed with fully assembled probes attached to the CPP and MSP data acquisition systems.

1.4 Participants and Roles In Planned Testing

Test Director(s)

W. S. Callaway

G. L. Troyer

Identify deficiencies or exceptions and log descriptions and resolutions.

Overall responsibilities for maintaining control of testing and original testing documentation.

Provide control of exception or deficiency decisions.

Provide liaison with Quality Assurance (QA) for testing activities as required.

Approve test procedure and final report and determine appropriate other approval signatures required.

Review test results and prepare/issue test report.

Authorize test performer to perform Test Director responsibilities on a limited basis.

CPP Vendor/Operator

CP technical lead, Applied Research Associates, Inc (ARA), operations support personnel

Perform test in accordance with approved test procedure.

Assure safe conduct of the CPP operations.

Provide platform push operations support.

2.0 Status of CP Probes and Testing

2.1 System Test Status

Due to abrupt project suspension, all identified tests (HNF-3551, 1998) were not performed. The status of test groups and components is summarized in Table 1.

Table 1 MSP/SSP/DAS Test Status			
Component	Test Complete	Exception	Resolution
MSP Tip Pressure	No	No	See 2.2.1
MSP Sleeve Pressure	No	No	See 2.2.1
MSP Soil Resistivity	Yes	Yes	See 2.2.2
MSP Soil Moisture	No	No	See 2.2.2
MSP Magnetometer	Yes	Yes	See 2.2.3

Table 1 MSP/SSP/DAS Test Status			
Component	Test Complete	Exception	Resolution
SSP Magnetometer	Yes	Yes	See 2.2.4
MSP Inclinometer	Yes	Yes	See 2.2.5
SSP Inclinometer	Yes	Yes	See 2.2.6
Gamma System	Yes	No	See 2.2.7
X-ray Fluorescence (XRF)	No	No	See 2.2.8
MSP demonstration push	No	No	See 2.2.9
MSP Umbilical Cable	Yes	Yes	See 2.2.10
SSP demonstration push	No	No	See 2.2.11
SSP Grout Module	Yes	No	See 2.2.12
Stand Alone Grout Module	No	Yes	See 2.2.13

2.2 Exceptions

2.2.1 Tip and Sleeve Pressure

The verification protocols and procedures showed some lack of reproducibility. This was especially evident in the sleeve sensor. During the testing phase, it was noted that the method of applying a steady pressure was difficult. To add some semblance of reproducibility, the SELLER provided

high pressure hydraulic jack and test jigs. While this helped, some questions still remained regarding the established variance checks versus practical measurement. Some of this can be seen in computer generated check sheets in the appendices. Finally, since no official test push was attempted, correlation of pressures with stratigraphy was not demonstrated.

2.2.2 Soil Resistivity and Moisture

The only measurements possible for acceptance testing was the use of a resistivity verification tool (HTI-R1) strapped onto the probe. These verification measurements were performed several times but with varying results as can be seen in the appendix. In addition, the probe was disassembled and re-tuned during the qualification test phase. No re-calibration was attempted nor was a true cross-reference to the original calibration established. Finally, since no official test push was attempted, correlation of sensor readings with known soil moisture profiles was not investigated.

2.2.3 MSP Magnetometer

The MSP magnetometer did not achieve 100% success on dynamic testing against certain pipe samples.

Initial testing showed that general performance was below expectations, due to the computer hardware in the CPP-DAS system and the processing requirements of the CPP-DAS. As a result, the SELLER upgraded the CPP-DAS computer motherboard and optimized the

processing algorithms to improve sensitivity and reliability. The test data are for the final configuration.

The MSP magnetometer was tested by recording the sensor response to various iron-metal plate and pipe samples in proximity to the MSP tip. The response was recorded for both static and dynamic operation. The static measurements were generally reproducible and as expected. The primary operational test for the magnetometer is the ability to halt downward motion of the MSP before it touches a subsurface metal object such as a buried pipe.

As shown in the included data sheets and diagrams, the MSP magnetometer sensor successfully stopped the downward motion of the MSP before hitting a specimen in 33 of 36 surface dynamic tests and in 5 of 6 subsurface dynamic tests. The data show that sensor response is sensitive to the magnetic characteristics of particular locations on the test samples. The majority of pre-contact shutdown failures were observed at push speeds exceeding approximately 1.5 1 cm/sec.

2.2.4 SSP Magnetometer

Similarly, the SSP magnetometer did not achieve 100% success on dynamic testing against test samples. As shown in the included data sheets and diagrams, the SSP magnetometer sensor successfully stopped the downward motion of the SSP before hitting a specimen in 33 of 36 surface dynamic tests and in 5 of 6 subsurface dynamic tests.

In general, the commentary for the MSP magnetometer also applies to the SSP magnetometer. The SSP unit has a slightly different sensing system and is, by design, capable of better sensitivity than the MSP sensor.

2.2.5 MSP Inclinometer

The MSP inclinometer did not achieve 100% of technical goals. It did perform sufficiently to assure the design goal of indicating probe tip subsurface position within acceptable practical needs.

During testing, some ambiguity between the test method and the calibration techniques were noted. Significant testing and review of documentation led to changes in the data reduction calculations. These were implemented and the system re-tested. The system presents a combination of depth and deflection from vertical as a calculated 'bulls eye', real time display. The corrected calculation produced reasonable and acceptable probe position information.

The revised calculation is based, approximately, on a rotational translation applied to the sensor raw data. During the testing, this approach proved to have little correlation to the actual sensor operation. The test team predicts that further improvements in the position prediction accuracy can be achieved with a re-designed data reduction system (*e.g.* least squares modeling).

2.2.6 SSP Inclinometer

The discussion for the SSP inclinometer follows along the same lines as that for the MSP inclinometer.

2.2.7 Gamma System

The gamma system was calibrated external to the Hanford activities. During that period, performance was significantly improved over previous experience. Spectral resolution was improved from approximately 11% to current 7.9% (Full Width at Half Maximum @662 keV). This agrees with the detector supplier's data and exceeds the test requirements.

The linearity requirement was based on expectations for research grade fine resolution detector systems, ie., Hyperpure germanium. It is difficult to practically determine that degree with the NaI(Tl) detector only, but the spectral linearity as derived from the mixed isotope standard tests is acceptable.

A challenge for this type of system is maintaining energy calibration while experiencing wide temperature fluctuations found in field applications. A temperature compensation system was included. After a proper startup procedures was developed, this system showed good tracking of temperature within the tests made. It should be noted however, that the method attempts to select correction from a mathematical curve which mimics the inverted parabolic temperature response of combined crystal and photomultiplier. This can have more than one solution for a given case. This system will require this knowledge for proper data interpretation.

It was recommended that an alternative internal pulser injection approach be implemented for subsequent systems.

It should also be noted that the spectral data reduction approach is strictly region of interest in type. Efficiency responses and reported detection limits are based on unspiked soil backgrounds and net peak area response to free standing peaks across the usable energy range of 100 to 2800 keV. The resulting detection limits are within requirements.

2.2.8 X-ray Fluorescence (XRF)

The XRF system was plagued by operational failures throughout the majority of testing. The originally supplied system was rebuilt with a new pre-amplifier provided by ARA. The final unit was bench tested, installed and development tested by BUYER representatives. Due to the extended effort required to bring this sensor operational, qualification testing was not completed by the time of project suspension.

Spectra descriptive of the final performance status of the SRF sensor, collected using a commercially available software package (MAESTRO, Ortec), are included in Appendix 4. Without access to data processing software resident in the MSP-DAS, quantitative evaluation of the overall XRF sensor performance is not possible. At the time of suspension of testing, spectrum processing algorithms required to optimize XRF sensor performance had not been tested.

Copies of the spectra included in Appendix 4 are available on magnetic storage media should further evaluation of the XRF sensor status be required.

2.2.9 MSP Demonstration Push

The required 'cold' demonstration push (HNF-3551, 1998) of the CP sensors at the Immobilized Low Activity Waste (ILAW) test site was not completed due to the abrupt project suspension. Although a limited push to 7.8 m (25.6 ft) was performed on September 24, 1998,

the goal of obtaining and field processing all sensor responses and then correlating that information with existing data from the site was not achieved.

In addition to providing an actual operational test of all CP sensor and probe hardware, the 'cold' demonstration push was to be the sole integrated test of the operational status of the MSP and CPP Data Acquisition Systems (DAS). Therefore, no evaluation as to the current state of completion of the DAS hardware, firmware and software components can be made here.

2.2.10 MSP Umbilical Cable

The MSP umbilical cable showed several problems during development and final testing. The MSP umbilical cable is a multi-conductor cable that runs the length of the push rod string and connects the various sensors in the probe to the DAS. It was found during testing that electrical cross-talk into the gamma and XRF signals from the other sensor systems is occurring. The cross-talk is observable as low energy 'noise' in the gamma and XRF energy spectra. It was possible to set threshold values in the final data conversion step for masking out this noise. However, some non-critical spectral information is lost. In addition, the presence of this noise reduces the total data throughput of the spectroscopy sensors. As a result, a second cable and probe system was started with emphasis on shielding out this noise component and providing a new connector style. The second system was not completed by project suspension.

It was further noted during testing that the umbilical connectors have a certain degree of non-reliability. The system, as provided, underwent several repairs of the cable connections before becoming reliable enough to proceed with testing. This item requires careful monitoring during operations. It is recommended that a different connector style be provided and the older connector system be replaced prior to formal field use.

2.2.11 SSP Demonstration Push

The required 'cold' demonstration push (HNF-3551, 1998) the SSP at the ILAW test site was not completed due to abrupt project suspension.

The SSP was pushed at the test site to a depth of 13 m (42.6 ft) on October 7, 1998. Five samples were recovered between 7.6 and 13 m depth. The goals of demonstrating sampling at depths determined from MSP data or at maximum operational depths of the system were not achieved.

2.2.12 SSP Grout Module

Development testing of the SSP Grout Module was successfully completed on October 8, 1998 (Bratton, 1998). CP deployment planning at the time of work suspension did not include use of this module so further testing is not required.

2.2.13 Stand Alone Grout Module.

Qualification testing of the Stand Alone grout module was conducted on October 19, 1998 with notes included in Appendix 7. Some deviations from the test plan occurred and a final qualification test report was not completed.

2.3 Test Results

Data sheets generated during Hanford testing representing the current CP probe and DAS status are included in the appendices. Supporting data generated during offsite development testing are included in reference 4 (ARA, 1998). Due to abrupt project suspension, detailed analysis was not completed and is not provided.

3.0 References

- 1) HNF-PRO-572, Rev 0, "Project Acceptance and Closeout", Project Hanford Policy and Procedure System, 1997.
- 2) HNF-3551, Rev. 0, "Test Plan for the Hanford Cone Penetrometer Multi-Sensor and Soil Sampler Probe Systems", Numatec Hanford Corporation, November 1998.
- 3) HNF-2881, Rev. 0, "Preparation and Testing of Cone Penetrometer Deployable Soil Multi-Sensor and Multi-Sample Soil Sampling Probes: Phase II", Statement of Work to Applied Research Associates, June, 1998.
- 4) HNF-3560, Rev. 1, "MSP Development Test Report", Applied Research Associates, December 1998.
- 5) Letter report, W. L. Bratton to D. Iwatate, "Soil Sample Grouting Module Performance Test:", Applied Research Associates, October 13, 1998.

Appendix 1. MSP/SSP Magnetometer Test Data

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Appendix 1. MSP/SSP Magnetometer Test Data

1. Test Specimen Diagrams

The following diagrams show the basic configuration of various ferrous metal test specimens used in testing of both magnetometer sensors (MSP and SSP).

Appendix 1. MSP/SSP Magnetometer Test Data

2. Static Surface Tests (MSP & SSP)

MAGNETOMETER SENSITIVITY

PROBE: MSP
DATE: 2/2/99 HNF-4151 Rev 0, Page **016**

SET-UP: BOTTOM CPP to GROUND: 58.5"
BOTTOM CPP to TEST SURFACE: 53.5"
BOTTOM CPP to BOTTOM GUIDE TUBE: 0.
BOTTOM GUIDE TUBE to TEST SURFACE: 53.5"
TOP TEST SURFACE to GROUND: 3.5"

GUIDE TUBES: 3 segments - raised until bottom segment
is flush w/ bottom of CPP

TEST OBJECT: TP1

STEP	PROBE TIP to TEST SURFACE		MAGNETOMETER OUTPUT	
	Inches	Centimeters	LR (V)	HR (V)
1	15.775	40	0.0486	0.307
2	13.775	35	0.0510	.344
3	11.850	30	.0524	.376
4	9.850	25	.0536	.400
5	7.900	20	.0552	.424
6	4.950	15	.0568	.463
7	3.975	10	.0573	.473
8	3.000	7.5	.0583	.499
9				
10	2.075	5	.0602	.532
11				
12	1.125	2.5	.0658	.639
13				
14	0.0	0.0	0.135	2.05
15				
16				
17				
18				
19				
20	MEASURED	TARGET		

COMMENTS: _____

WS Callaway

2/2/99

MAGNETOMETER SENSITIVITY

 PROBE: SSP M&T
 DATE: 2/8/99 HNF-4151, Rev 0, Page 017

 SET-UP: BOTTOM CPP to GROUND: 56.5"
 BOTTOM CPP to TEST SURFACE: 53.0"
 BOTTOM CPP to BOTTOM GUIDE TUBE: 0
 BOTTOM GUIDE TUBE to TEST SURFACE: 53.0
 TOP TEST SURFACE to GROUND: 3.5"

 GUIDE TUBES: 3 segments. Raised until bottom of bottom segment is flush w/ bottom of CPP.

 TEST OBJECT: TP 1

STEP	PROBE TIP to TEST SURFACE		MAGNETOMETER OUTPUT	
	Inches	Centimeters	LR (V)	HR (V)
1	15.70	40	- 0.854	
2	13.90	35	- .772	
3	11.775	30	- .704	
4	9.75	25	- .633	
5	7.85	20	- .605	
6	5.85	15	- .555	
7	4.00	10	- .554	
8	2.875	7.5	- .603	
9	1.925	5	- .711	
10	1.00	2.5	- 1.062	
11	.550	1.25	- 1.557	
12	0.00	0	- 3.456	
13				
14				
15				
16				
17				
18				
19				
20	MEASURED	TARGET		

11:50

COMMENTS:

W.S. Callaway2/8/99

SET-UP: BOTTOM CPP to GROUND: 55"
 BOTTOM CPP to TEST SURFACE: 49.5"
 BOTTOM CPP to BOTTOM GUIDE TUBE: 0
 BOTTOM GUIDE TUBE to TEST SURFACE: 49.5"
 TOP TEST SURFACE to GROUND: ~ 7.0"

GUIDE TUBES: 3 SEGMENTS. BOTTOM SEGMENT FLUSH W/
BOTTOM OF CPP

TEST OBJECT: TP 1 (VERIFICATION SPOT)

STEP	PROBE TIP to TEST SURFACE		MAGNETOMETER OUTPUT	
	Inches	Centimeters	SENSOR OUTPUT (mV)	SSPAR (V)
1	15.65	40	56.2	2.182
2	13.875	35	57.1	1.940
3	11.75	30	58.1	1.673
4	9.80	25	58.9	1.453
5	7.775	20	59.5	1.265
6	5.825	15	59.9	1.166
7	4.05	10	59.9	1.126
8	2.975	7.5	59.6	1.233
9	2.00	5	58.7	1.494
10	1.00	2.5	56.0	2.227 2.271
11	.475	1.25	52.4	3.331
12	0.	0	43.4	5.976
13				
14				
15				
16				
17				
18				
19				
20	MEASURED	TARGET		

wsc 2/11

COMMENTS: _____

W. J. Callaway

2/11/99

SET-UP: BOTTOM CPP to GROUND: 55"
 BOTTOM CPP to TEST SURFACE: 50.5"
 BOTTOM CPP to BOTTOM GUIDE TUBE: 2.5"
 BOTTOM GUIDE TUBE to TEST SURFACE: 48
 TOP TEST SURFACE to GROUND: 5.5 - 6"

GUIDE TUBES: 3 SEGMENTS - BOTTOM SEGMENT 2.5" BELOW CPP

TEST OBJECT: TP1 - VERIFICATION SPOT

STEP	PROBE TIP to TEST SURFACE		MAGNETOMETER OUTPUT	
	Inches	Centimeters	LR (V)	HR (V)
1	16.025	40	0.065	0.640
2	14.075	35	.068	.678
3	11.850	30	.070	.722
4	9.825	25	.071	.755
5	7.900	20	.072	.783
6	5.925	15	.074	.813
7	3.975	10	.076	.846
8	2.950	7.5	.077	.873
9	2.000	5	.079	.913
10	1.025	2.5	.089	1.022
11	0.500	1.25	.092 .057 wsc	1.175
12	0.	0	.129	2.00
13				
14				
15				
16				
17				
18				
19				
20	MEASURED	TARGET		

COMMENTS:

W. S. Callaway

2/17/99

Appendix 1. MSP/SSP Magnetometer Test Data

3. Dynamic Surface Tests – MSP

TEST #: # 97
TIME: 10:20FILE #: Z17F99 03 C.DAT
TEST OBJECT: TPI V SPOT
PUSH SPEED: 2 1.5 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>24.25"</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	<u>50.25</u>
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	<u>24.25</u>
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	<u>50.25</u>
	INITIAL	PROBE TIP to TEST SURFACE:	<u>26.00</u>

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 2.400COMMENTS: _____

_____TEST #: 2 98
TIME: 10:28FILE #: Z17F99 04 C.DAT
TEST OBJECT: TPI V SPOT
PUSH SPEED: 2 0.25 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME AS 1</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 1.175COMMENTS: 0.29 ft FALSE SHUT DOWN

_____TEST #: 3 99
TIME: 10:36FILE #: Z17F99 05 C.DAT
TEST OBJECT: TPI V SPOT
PUSH SPEED: 2 2.8 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME AS 1</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 0.575COMMENTS: _____

Error

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TEST #: 4 100
TIME: 10:40FILE #: 06 C.DAT
TEST OBJECT: TP1 SPOT 3
PUSH SPEED: ≈ 1.4 cm/secDISTANCES: INITIAL BOTTOM CPP to PROBE TIP: SAME AS 1
INITIAL BOTTOM CPP to TEST SURFACE:
INITIAL BOTTOM GUIDE TUBE to PROBE TIP:
INITIAL BOTTOM GUIDE TUBE to TEST SURFACE:
INITIAL PROBE TIP to TEST SURFACE:PROBE TIP to TEST SURFACE @ SHUT-DOWN: 1.300

COMMENTS:

TEST #: 5 101
TIME: 10:42FILE #: 07 C.DAT
TEST OBJECT: TP1 SPOT 3
PUSH SPEED: ≈ 0.40 cm/secDISTANCES: INITIAL BOTTOM CPP to PROBE TIP: SAME AS 1
INITIAL BOTTOM CPP to TEST SURFACE:
INITIAL BOTTOM GUIDE TUBE to PROBE TIP:
INITIAL BOTTOM GUIDE TUBE to TEST SURFACE:
INITIAL PROBE TIP to TEST SURFACE:PROBE TIP to TEST SURFACE @ SHUT-DOWN: 1.700

COMMENTS:

TEST #: 6 102
TIME: 10:48FILE #: 08 C.DAT
TEST OBJECT: TP1 SPOT 3
PUSH SPEED: ≈ 230 cm/secDISTANCES: INITIAL BOTTOM CPP to PROBE TIP: SAME AS 1
INITIAL BOTTOM CPP to TEST SURFACE:
INITIAL BOTTOM GUIDE TUBE to PROBE TIP:
INITIAL BOTTOM GUIDE TUBE to TEST SURFACE:
INITIAL PROBE TIP to TEST SURFACE:PROBE TIP to TEST SURFACE @ SHUT-DOWN: 0.975

COMMENTS:

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TEST #: 7 103
TIME: 10:50FILE #: Z17F9909C.DAT
TEST OBJECT: TP1 SPOT 2
PUSH SPEED: 2 1.5 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME As 1</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 2.225

COMMENTS:

TEST #: 8 104
TIME: 10:54FILE #: ~ 10 C.DAT
TEST OBJECT: TP1 SPOT 2
PUSH SPEED: 2 0.4 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME As 1</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 1.575

COMMENTS:

TEST #: 9 105
TIME: 10:58FILE #: ~ 11 C.DAT
TEST OBJECT: TP1 SPOT 2
PUSH SPEED: 2 2.5 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME As 1</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 2 1.300

COMMENTS:

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TEST #: 106
TIME: 11:05FILE #: 217F9912 C.DAT
TEST OBJECT: ORIGINAL GUIDE TUBE SPOT 1
PUSH SPEED: 2 1.5 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>21.5</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	<u>47.5</u>
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	<u>21.5</u>
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	<u>47.5</u>
	INITIAL	PROBE TIP to TEST SURFACE:	<u>26.0</u>

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 0.675

COMMENTS:

TEST #: # 107
TIME: 11:10FILE #: ~ 13 C.DAT
TEST OBJECT: OGT (SPOT 1)
PUSH SPEED: 2 0.41 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME As 10</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 1.025

COMMENTS:

TEST #: 12 108
TIME: 11:16FILE #: ~ 14 C.DAT
TEST OBJECT: OGT (SPOT 1)
PUSH SPEED: 2 2.1 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME As 10</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 0.375

COMMENTS:

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TEST #: 13 109
TIME: 11:20FILE #: Z17F9915C.DAT
TEST OBJECT: ORIGINAL GUIDE TUBE SPOT 2
PUSH SPEED: 1.3 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME As 10</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 1.650

COMMENTS:

TEST #: 14 110
TIME: 11:23FILE #: 16 C.DAT
TEST OBJECT: OGT SPOT 2
PUSH SPEED: 0.3 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME As 10</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 1.125

COMMENTS:

TEST #: 15 111
TIME: 11:30FILE #: 17 C.DAT
TEST OBJECT: OGT SPOT 2
PUSH SPEED: 2.3 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME As 10</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 1.250

COMMENTS:

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TEST #: 112
TIME: 11:35FILE #: Z17F9918 C.DAT
TEST OBJECT: ORIGINAL GUIDE TUBE SPOT 3
PUSH SPEED: 1.5 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME AS 10</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 4.875

COMMENTS:

TEST #: 113
TIME: 11:38FILE #: 19 C.DAT
TEST OBJECT: OGT SPOT 3
PUSH SPEED: 0.30 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME AS 10</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 2.475

COMMENTS:

TEST #: 114
TIME: 11:43FILE #: 20 C.DAT
TEST OBJECT: OGT SPOT 3
PUSH SPEED: 2.1 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME AS 10</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 3.425

COMMENTS:

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TEST #: 19 115
TIME: 11:48FILE #: 217F99 21 C.DAT
TEST OBJECT: SSP GUIDE TUBE SPOT 1
PUSH SPEED: 1.7 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME AS 10</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 1.100

COMMENTS: _____

TEST #: 20 116
TIME: 11:51FILE #: 22 C.DAT
TEST OBJECT: SGT SPOT 1
PUSH SPEED: 0.4 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME AS 10</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 1.450

COMMENTS: _____

TEST #: 21 117
TIME: 11:56FILE #: 23 C.DAT
TEST OBJECT: SGT SPOT 1
PUSH SPEED: 2.1 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME AS 10</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 1.025

COMMENTS: _____

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TEST #: 22 118
TIME: 12:00FILE #: 217F9924C.DAT
TEST OBJECT: SSP GUIDE TUBE SPOT 2
PUSH SPEED: ~ 1.4 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME As 10</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 1.000

COMMENTS:

TEST #: 23 119
TIME: 12:02FILE #: ~ 25C.DAT
TEST OBJECT: SGT SPOT 2
PUSH SPEED: ~ 0.4 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME As 10</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 1.100

COMMENTS:

TEST #: 24 120
TIME: 12:06FILE #: ~ 26C.DAT
TEST OBJECT: SGT SPOT 2
PUSH SPEED: ~ 2.3 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME As 10</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 0.500

COMMENTS:

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TEST #: 25 121
TIME: 12:10FILE #: Z17F9927C.DAT
TEST OBJECT: SSP GUIDE TUBE SPOT 3
PUSH SPEED: 2.17 cm/sec

DISTANCES: INITIAL BOTTOM CPP to PROBE TIP: SAME AS 10
INITIAL BOTTOM CPP to TEST SURFACE:
INITIAL BOTTOM GUIDE TUBE to PROBE TIP:
INITIAL BOTTOM GUIDE TUBE to TEST SURFACE:
INITIAL PROBE TIP to TEST SURFACE:

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 0.725

COMMENTS:

TEST #: 26 122
TIME: 12:13FILE #: 28 C.DAT
TEST OBJECT: SGT SPOT 3
PUSH SPEED: 2.40 cm/sec

DISTANCES: INITIAL BOTTOM CPP to PROBE TIP: SAME AS 10
INITIAL BOTTOM CPP to TEST SURFACE:
INITIAL BOTTOM GUIDE TUBE to PROBE TIP:
INITIAL BOTTOM GUIDE TUBE to TEST SURFACE:
INITIAL PROBE TIP to TEST SURFACE:

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 1.250

COMMENTS:

TEST #: 27 123
TIME: 12:17FILE #: 29 C.DAT
TEST OBJECT: SGT SPOT 3
PUSH SPEED: 2.1 cm/sec

DISTANCES: INITIAL BOTTOM CPP to PROBE TIP: SAME AS 10
INITIAL BOTTOM CPP to TEST SURFACE:
INITIAL BOTTOM GUIDE TUBE to PROBE TIP:
INITIAL BOTTOM GUIDE TUBE to TEST SURFACE:
INITIAL PROBE TIP to TEST SURFACE:

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 1.425

COMMENTS:

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TEST #: 28 124
TIME: 12:23FILE #: Z17F9930C.DAT
TEST OBJECT: 4" PIPE SPOT 1
PUSH SPEED: 2 1.4 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	21
	INITIAL	BOTTOM CPP to TEST SURFACE:	47.0 "
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	21
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	47.0 "
	INITIAL	PROBE TIP to TEST SURFACE:	26.0

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 0.250

COMMENTS:

TEST #: 29 125
TIME: 12:26FILE #: 31 C.DAT
TEST OBJECT: 4 PIPE SPOT 1
PUSH SPEED: 2 0.30 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	SAME AS 28
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 1.025

COMMENTS:

TEST #: 30 126
TIME: 12:31FILE #: 32 C.DAT
TEST OBJECT: 4" PIPE SPOT 1
PUSH SPEED: 2 2.4 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	SAME AS 28
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 0

COMMENTS:

SHUT DOWN BY OPERATOR
TIP PRESSURE → ≈ 1200 PSI

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TEST #: 31 127
TIME: 12:36FILE #: 217F99 33 C.DAT
TEST OBJECT: 4" PIPE SPOT 2
PUSH SPEED: 2 1.5 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME As 28</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 2.150

COMMENTS: _____

TEST #: 32 128
TIME: 12:40FILE #: 217F99 34 C.DAT
TEST OBJECT: 4" PIPE SPOT 2
PUSH SPEED: 2 0.30 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME As 28</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 3.350COMMENTS: SUSPECT Readings immediately before shut downTEST #: 33 129
TIME: 12:45FILE #: 217F99 35 C.DAT
TEST OBJECT: 4" PIPE SPOT 2
PUSH SPEED: 2 0.25 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME As 28</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 1.675COMMENTS: RE-RUN OF 128

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TEST #: 34 130
TIME: 12:52FILE #: 217F9936C.DAT
TEST OBJECT: 4" PIPE SPOT 2
PUSH SPEED: 2.7 cm/secDISTANCES: INITIAL BOTTOM CPP to PROBE TIP: SAME AS 28
INITIAL BOTTOM CPP to TEST SURFACE:
INITIAL BOTTOM GUIDE TUBE to PROBE TIP:
INITIAL BOTTOM GUIDE TUBE to TEST SURFACE:
INITIAL PROBE TIP to TEST SURFACE:PROBE TIP to TEST SURFACE @ SHUT-DOWN: 2.025

COMMENTS:

TEST #: 35 131
TIME: 12:55FILE #: 37 C.DAT
TEST OBJECT: 4" PIPE SPOT 3
PUSH SPEED: 1.4 cm/secDISTANCES: INITIAL BOTTOM CPP to PROBE TIP: SAME AS 28
INITIAL BOTTOM CPP to TEST SURFACE:
INITIAL BOTTOM GUIDE TUBE to PROBE TIP:
INITIAL BOTTOM GUIDE TUBE to TEST SURFACE:
INITIAL PROBE TIP to TEST SURFACE:PROBE TIP to TEST SURFACE @ SHUT-DOWN: 0COMMENTS: SHUTDOWN ALARM AFTER CONTACTTEST #: 36 132
TIME: 12:56FILE #: 38 C.DAT
TEST OBJECT: 4" PIPE SPOT 3
PUSH SPEED: 3.30 cm/secDISTANCES: INITIAL BOTTOM CPP to PROBE TIP: SAME AS 28
INITIAL BOTTOM CPP to TEST SURFACE:
INITIAL BOTTOM GUIDE TUBE to PROBE TIP:
INITIAL BOTTOM GUIDE TUBE to TEST SURFACE:
INITIAL PROBE TIP to TEST SURFACE:PROBE TIP to TEST SURFACE @ SHUT-DOWN: 0.650

COMMENTS:

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TEST #: 37 133
TIME: 13:05FILE #: Z17F9939C.DAT
TEST OBJECT: 4" PIPE SPOT 3
PUSH SPEED: 2 2.2 cm/secDISTANCES: INITIAL BOTTOM CPP to PROBE TIP: SAME AS 28
INITIAL BOTTOM CPP to TEST SURFACE:
INITIAL BOTTOM GUIDE TUBE to PROBE TIP:
INITIAL BOTTOM GUIDE TUBE to TEST SURFACE:
INITIAL PROBE TIP to TEST SURFACE:PROBE TIP to TEST SURFACE @ SHUT-DOWN: 0.0COMMENTS: PRESSED INTO PLYWOOD SUPPORT BEFORE OPERATOR
SHUT DOWN - YELLOW ALARM NOTED
TIP PRESSURE $\approx$ 1400 psiTEST #: 38 134
TIME: 13:10FILE #: 40C.DAT
TEST OBJECT: 4" PIPE
PUSH SPEED: 2 1.4 cm/secDISTANCES: INITIAL BOTTOM CPP to PROBE TIP: SAME AS 28
INITIAL BOTTOM CPP to TEST SURFACE:
INITIAL BOTTOM GUIDE TUBE to PROBE TIP:
INITIAL BOTTOM GUIDE TUBE to TEST SURFACE:
INITIAL PROBE TIP to TEST SURFACE:PROBE TIP to TEST SURFACE @ SHUT-DOWN: 0.325COMMENTS: SAME LINE AS SPOT 3 @ Center of pipe segmentTEST #: 39 135
TIME: 13:20FILE #: 41C.DAT
TEST OBJECT: 4" PIPE
PUSH SPEED: 2 2 cm/secDISTANCES: INITIAL BOTTOM CPP to PROBE TIP: SAME AS 28
INITIAL BOTTOM CPP to TEST SURFACE:
INITIAL BOTTOM GUIDE TUBE to PROBE TIP:
INITIAL BOTTOM GUIDE TUBE to TEST SURFACE:
INITIAL PROBE TIP to TEST SURFACE:PROBE TIP to TEST SURFACE @ SHUT-DOWN: 0.500COMMENTS: SAME SPOT AS TEST 38

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Appendix 1. MSP/SSP Magnetometer Test Data

4. Dynamic Surface Tests – SSP

MAGNETOMETER SURFACE SHUT-DOWN

PROBE HNF-4151 Rev 0, Page 1

DATE: 2/11/99

TEST #: 60
TIME: 10:37FILE #: Z11F9903C.DAT
TEST OBJECT: TP1 (SPOT V)
PUSH SPEED: 0.35 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	12.75 18.0"
	INITIAL	BOTTOM CPP to TEST SURFACE:	49.25 49.5"
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	12.75 18.0"
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	49.25 49.5"
	INITIAL	PROBE TIP to TEST SURFACE:	36.50 31.5"

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 3.500

COMMENTS:

TEST #: 61
TIME: 10:48FILE #: Z11F9904C.DAT
TEST OBJECT: TP1 (V SPOT)
PUSH SPEED: 1.1 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	SAME AS 1
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 3.050

COMMENTS:

TEST #: 62
TIME: 10:54FILE #: 05C.DAT
TEST OBJECT: TP1 (V SPOT)
PUSH SPEED: 2.2 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	SAME AS 1
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 2.600

COMMENTS:

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MAGNETOMETER SURFACE SHUT-DOWN

PROBE: HNF-4151, Rev 0, Page 1
DATE: 2/11/99TEST #: 4 63
TIME: 10:58FILE #: 06C.DAT
TEST OBJECT: TPI (SPOT 2)
PUSH SPEED: 0.40 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	SAME AS 1
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 2.475

COMMENTS:

TEST #: 8 64
TIME: 11:01FILE #: 07C.DAT
TEST OBJECT: TPI (SPOT 2)
PUSH SPEED: 1.4 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	SAME AS 1
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 2.075

COMMENTS:

TEST #: 6 65
TIME: 11:06FILE #: 08C.DAT
TEST OBJECT: TPI (SPOT 2)
PUSH SPEED: 3.2 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	SAME AS 1
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 1.200

COMMENTS:

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MAGNETOMETER SURFACE SHUT-DOWN

PROBE HNF-4151 Rev 0 Page 8
DATE: 2/11/99TEST #: 7 66
TIME: 11:09FILE #: mm 09 C.DAT
TEST OBJECT: TP1 (SPOT 3)
PUSH SPEED: 0.35 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	SAME AS 1
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 4.50

COMMENTS:

TEST #: 8 67
TIME: 11:13FILE #: mm 10 C.DAT
TEST OBJECT: TP1 (SPOT 3)
PUSH SPEED: 1.0 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	SAME AS 1
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	28.5

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 3.500

COMMENTS: 95m Approximately 3" of movement required before
penetration could be started ie repeated mag'er
shutdownTEST #: 9 68
TIME: 11:19FILE #: mm 11 C.DAT
TEST OBJECT: TP1 (SPOT 3)
PUSH SPEED: 2.0 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	SAME AS 1
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 2.750

COMMENTS:

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MAGNETOMETER SURFACE SHUT-DOWN

PROBE HNF-4151 Rev M & Page

DATE: 2/11/99

TEST #: 69
TIME: 11:23FILE #: mm 12 C.DAT
TEST OBJECT: TP 1 (SPOT 3)
PUSH SPEED: 2.3 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME AS 1</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 2.825

COMMENTS:

TEST #: # 70
TIME: 11:35FILE #: mm 13 C.DAT
TEST OBJECT: GUIDE TUBE (1)
PUSH SPEED: 0.25 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>21.0</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	<u>46.0</u>
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	<u>21.0</u>
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	<u>46.0</u>
	INITIAL	PROBE TIP to TEST SURFACE:	<u>25.0</u>

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 4.575

COMMENTS:

TEST #: 71
TIME: 11:39FILE #: mm 14 C.DAT
TEST OBJECT: GUIDE TUBE (SPOT 1)
PUSH SPEED: 1.3 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME AS 11</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 3.825COMMENTS: LOWERED 1.5" Before Penetration could be started

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MAGNETOMETER SURFACE SHUT-DOWN

PROBE HNF-4151 Rev 0 Page 1

DATE: 2/11/99

TEST #: 13 72
TIME: 11:43FILE #: MM 15C.DAT
TEST OBJECT: GUIDE TUBE (SPOT 1)
PUSH SPEED: @ 2.6 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	SAME AS 11
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 2.925

COMMENTS:

TEST #: 14 73
TIME: 11:47FILE #: MM 16C.DAT
TEST OBJECT: GUIDE TUBE (SPOT 2)
PUSH SPEED: @ 0.20 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	21.0
	INITIAL	BOTTOM CPP to TEST SURFACE:	46.0
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	21.0
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	46.0
	INITIAL	PROBE TIP to TEST SURFACE:	25.0

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 4.250

COMMENTS:

TEST #: 15 74
TIME: 11:51FILE #: MM 17C.DAT
TEST OBJECT: GUIDE TUBE (SPOT 2)
PUSH SPEED: @ 1.2 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	SAME AS 14
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	22"

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 4.375

COMMENTS: Lowered 3" so penetration could start

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TEST #: 16 75
TIME: 11:55FILE #: mm 18C.DAT
TEST OBJECT: GUIDE TUBE (SPOT 2)
PUSH SPEED: 2.2 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME AS 14</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 3.650

COMMENTS:

TEST #: 17 76
TIME: 11:59FILE #: mm 19²⁰C.DAT
TEST OBJECT: GUIDE TUBE (SPOT 3)
PUSH SPEED: 0.25 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME AS 14</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 4.925

COMMENTS:

TEST #: 18 77
TIME: 12:04FILE #: mm 21C.DAT
TEST OBJECT: GUIDE TUBE (SPOT 3)
PUSH SPEED: 1.4 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME AS 14</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 3.725

COMMENTS:

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TEST #: 19 78
TIME: 12:07FILE #: mm 22C.DAT
TEST OBJECT: GUIDE TUBE (SPOT 3)
PUSH SPEED: 2.6 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME As 14</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 2.825

COMMENTS: _____

TEST #: 20 79
TIME: 12:15FILE #: mm 23C.DAT
TEST OBJECT: 4" PIPE (SPOT 1)
PUSH SPEED: 0.35 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>20.5</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	<u>45.5</u>
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	<u>20.5</u>
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	<u>45.5</u>
	INITIAL	PROBE TIP to TEST SURFACE:	<u>25.0</u>

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 5.950

COMMENTS: _____

TEST #: 21 80
TIME: 12:18FILE #: mm 24C.DAT
TEST OBJECT: 4" PIPE (SPOT 1)
PUSH SPEED: 1.2 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME As 20</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 5.250

COMMENTS: _____

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TEST #: 22 81
TIME: 12:20FILE #: mm 25C.DAT
TEST OBJECT: 4" PIPE (SPOT 1)
PUSH SPEED: 2.5 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME As 20</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 4.800

COMMENTS: _____

TEST #: 23 82
TIME: 12:23FILE #: mm 26C.DAT
TEST OBJECT: 4" PIPE (SPOT 2)
PUSH SPEED: 0.20 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME As 20</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 0.525

COMMENTS: _____

TEST #: 24 83
TIME: 12:28FILE #: mm 27C.DAT
TEST OBJECT: 4" PIPE (SPOT 2)
PUSH SPEED: 1.2 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME As 20</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 0.050COMMENTS: Lowered 1" To Allow START

Error

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TEST #: 25 84
TIME: 12:33FILE #: mm28C.DAT
TEST OBJECT: 4" PIPE (SPOT 2)
PUSH SPEED: 2.1 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME AS 20</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: - 0.25

COMMENTS: _____

TEST #: 26 85
TIME: 12:37FILE #: mm29C.DAT
TEST OBJECT: 4" PIPE (SPOT 2)
PUSH SPEED: 0.35 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME AS 20</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 5.475

COMMENTS: _____

TEST #: 27 86
TIME: 12:40FILE #: mm30C.DAT
TEST OBJECT: 4" PIPE (SPOT 3)
PUSH SPEED: 1.3 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME AS 20</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 5.125

COMMENTS: _____

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TEST #: 28 87
TIME: 12:43FILE #: mm 31C.DAT
TEST OBJECT: 4" PIPE (SPOT 3)
PUSH SPEED: \$ 2.2 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME AS 20</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 4.675

COMMENTS: _____

TEST #:	FILE #:
TIME:	TEST OBJECT:
	PUSH SPEED:

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:
	INITIAL	BOTTOM CPP to TEST SURFACE:
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:
	INITIAL	PROBE TIP to TEST SURFACE:

PROBE TIP to TEST SURFACE @ SHUT-DOWN: _____

COMMENTS: _____

TEST #:	FILE #:
TIME:	TEST OBJECT:
	PUSH SPEED:

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:
	INITIAL	BOTTOM CPP to TEST SURFACE:
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:
	INITIAL	PROBE TIP to TEST SURFACE:

PROBE TIP to TEST SURFACE @ SHUT-DOWN: _____

COMMENTS: _____

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TEST #: 29 88
TIME: 10:37FILE #: 712F9902C.DAT
TEST OBJECT: ORIGINAL GUIDE TUBE (SPOT 1)
PUSH SPEED: 0.7 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>25.0</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	<u>46.5</u>
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	<u>25.0</u>
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	<u>46.5</u>
	INITIAL	PROBE TIP to TEST SURFACE:	<u>21.5</u>

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 8.650

COMMENTS:

TEST #: 30 89
TIME: 10:41FILE #: mm 03C.DAT
TEST OBJECT: O.G.T. (SPOT 1)
PUSH SPEED: 0.25 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME AS 29</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 8.450

COMMENTS:

TEST #: 31 90
TIME: 10:45FILE #: mm 04C.DAT
TEST OBJECT: O.G.T. (SPOT 1)
PUSH SPEED: 3.2 cm/sec

DISTANCES:	INITIAL	BOTTOM CPP to PROBE TIP:	<u>SAME AS 29</u>
	INITIAL	BOTTOM CPP to TEST SURFACE:	
	INITIAL	BOTTOM GUIDE TUBE to PROBE TIP:	
	INITIAL	BOTTOM GUIDE TUBE to TEST SURFACE:	
	INITIAL	PROBE TIP to TEST SURFACE:	

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 6.675"

COMMENTS:

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TEST #: 32 91 FILE #: MM 05C.DAT
TIME: 10:50 TEST OBJECT: O.G.T. (SPOT 2)
PUSH SPEED: 2 0.35 cm/sec

DISTANCES: INITIAL BOTTOM CPP to PROBE TIP: SAME AS 29
INITIAL BOTTOM CPP to TEST SURFACE:
INITIAL BOTTOM GUIDE TUBE to PROBE TIP:
INITIAL BOTTOM GUIDE TUBE to TEST SURFACE:
INITIAL PROBE TIP to TEST SURFACE:

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 3.350

COMMENTS:

TEST #: 33 92 FILE #: MM 06C.DAT
TIME: 10:55 TEST OBJECT: O.G.T. (SPOT 2)
PUSH SPEED: 2 1.5 cm/sec

DISTANCES: INITIAL BOTTOM CPP to PROBE TIP: SAME AS 29
INITIAL BOTTOM CPP to TEST SURFACE:
INITIAL BOTTOM GUIDE TUBE to PROBE TIP:
INITIAL BOTTOM GUIDE TUBE to TEST SURFACE:
INITIAL PROBE TIP to TEST SURFACE:

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 2.575

COMMENTS:

TEST #: 34 93 FILE #: MM 07C.DAT
TIME: 10:58 TEST OBJECT: O.G.T. (SPOT 2)
PUSH SPEED: 2 2.6 cm/sec

DISTANCES: INITIAL BOTTOM CPP to PROBE TIP: SAME AS 29
INITIAL BOTTOM CPP to TEST SURFACE:
INITIAL BOTTOM GUIDE TUBE to PROBE TIP:
INITIAL BOTTOM GUIDE TUBE to TEST SURFACE:
INITIAL PROBE TIP to TEST SURFACE:

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 2.225

COMMENTS:

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TEST #: 35 94
TIME: 11:00

FILE #: mm 08C.DAT
TEST OBJECT: O.G.T. (SPOT 3)
PUSH SPEED: ~ 0.3 cm/sec

DISTANCES: INITIAL BOTTOM CPP to PROBE TIP: SAME AS 29
INITIAL BOTTOM CPP to TEST SURFACE:
INITIAL BOTTOM GUIDE TUBE to PROBE TIP:
INITIAL BOTTOM GUIDE TUBE to TEST SURFACE:
INITIAL PROBE TIP to TEST SURFACE:

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 0.950

COMMENTS: _____

TEST #: 36 95
TIME: 11:05

FILE #: mm 09C.DAT
TEST OBJECT: O.G.T. (SPOT 3)
PUSH SPEED: ~ 1.3 cm/sec

DISTANCES: INITIAL BOTTOM CPP to PROBE TIP: SAME AS 29
INITIAL BOTTOM CPP to TEST SURFACE:
INITIAL BOTTOM GUIDE TUBE to PROBE TIP:
INITIAL BOTTOM GUIDE TUBE to TEST SURFACE:
INITIAL PROBE TIP to TEST SURFACE:

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 0.400

COMMENTS: _____

TEST #: 37 96
TIME: 11:10

FILE #: mm 10C.DAT
TEST OBJECT: O.G.T. (SPOT 3)
PUSH SPEED: # 2.3 cm/sec

DISTANCES: INITIAL BOTTOM CPP to PROBE TIP: SAME AS 29
INITIAL BOTTOM CPP to TEST SURFACE:
INITIAL BOTTOM GUIDE TUBE to PROBE TIP:
INITIAL BOTTOM GUIDE TUBE to TEST SURFACE:
INITIAL PROBE TIP to TEST SURFACE:

PROBE TIP to TEST SURFACE @ SHUT-DOWN: 0.0

COMMENTS: SHUT DOWN ✓

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Appendix 1. MSP/SSP Magnetometer Test Data**5. Subsurface Test Configuration**

The following diagrams show the basic test configuration used in dynamic subsurface proximity testing of both magnetometer sensors (MSP and SSP).

MAGNETOMETER SUB SURFACE TEST

HNF-4151 Rev 0, Page 124
TOP VIEW

MAGNETOMETER SUB SURFACE TEST

SIDE VIEW
HNF-4151, Rev 0, Page 125

MAGNETOMETER SUB SURFACE TEST

SIDE VIEW
HNF-4151, Rev 0, Page
WEST

MAGNETOMETER SUB SURFACE TEST

MSP MEASUREMENT
HNF-4151, Rev 0, Page
~~127~~ BASIS

MAGNETOMETER SUBSURFACE TESTS

SSP MEASUREMENT BASIS

PIPE REFERENCE

+ RESIDUAL

REFERENCE ②

PIPE JOINT

SSP

23.06"

62.31"

39.25"

Appendix 1. MSP/SSP Magnetometer Test Data

6. Dynamic Subsurface Tests – MSP

PROBE: MSP

DATE: 02/16/99
TIME: _____

PENETRATION FILE: Z16F9902C.DAT

TEST OBJECT: ORIGINAL GUIDE TUBE (WEST) CENTER

REFERENCE BAR ZERO to OBJECT SURFACE 48.13"
APPROXIMATE PENETRATION RATE 0.25 cm/sec

DEPTH PUSHED:

CPP	Initial (ft)	<u>-0.042</u>	
		<u>.90</u>	<u>FALSE MAG ALARM & SHUTDOWN</u>
		<u>2.457</u>	<u>ADDITION OF PUSH PIPE ROD</u>
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		Final (ft)	<u>3.96</u>
CPP TOTAL :		<u>4.002 (48.02")</u>	

PIPE	Pipe Reference to Probe Tip	<u>45.50"</u>
	- Final Residual	<u>- 1.94</u>
	PIPE TOTAL :	<u>47.44"</u>

DISTANCE FROM TEST OBJECT at SHUTDOWN

CPP :	<u>48.13"</u>	PIPE :	<u>48.13"</u>
-	<u>48.02</u>	-	<u>47.44</u>
<u>0.11" (0.28 cm)</u>		<u>0.69" (1.75 cm)</u>	

COMMENTS : SHUTDOWN PARAMETER SET AT 0.8

Error

An error occurred while processing this page. See the system log for more details.

PROBE: MSPDATE: 02/16/99
TIME: _____PENETRATION FILE: Z16F9903C.DATTEST OBJECT: ORIGINAL GUIDE TUBE (WEST) CENTERREFERENCE BAR ZERO to OBJECT SURFACE 48.13
APPROXIMATE PENETRATION RATE 0.

DEPTH PUSHED:

CPP

Initial (ft) -0.040.90MAG ALARM.92MAG ALARM.95MAG ALARM.97MAG ALARM.98MAG ALARM1.17MOVED TO 1.17 IN ATTEMPT TO RESTART

Final (ft) _____

DEPTH OVER RANGE ALARM

CPP TOTAL :

PIPE

Pipe Reference to Probe Tip _____

Final Residual _____

PIPE TOTAL :

DISTANCE FROM TEST OBJECT at SHUTDOWN

CPP : _____

PIPE : _____

COMMENTS : SHUTDOWN PARAMETER RESET TO 0.60

PROBE: MSPDATE: 02/16/99

TIME: _____

PENETRATION FILE: Z16F9904C.DATTEST OBJECT: ORIGINAL GUIDE TUBE (WEST) CENTERREFERENCE BAR ZERO to OBJECT SURFACE 48.13"
APPROXIMATE PENETRATION RATE 5 cm/sec

DEPTH PUSHED:

CPP

Initial (ft) 0.001.8DEPTH OVERRANGE ALARM
CPP READING 84.6 E36 FT

Final (ft) _____

CPP TOTAL :

PIPE

Pipe Reference to Probe Tip _____

Final Residual _____

PIPE TOTAL :

DISTANCE FROM TEST OBJECT at SHUTDOWN

CPP : _____

PIPE : _____

COMMENTS : _____

PROBE: MSP

DATE: 02/16/99
TIME: _____

PENETRATION FILE: Z16F9905C.DAT

TEST OBJECT: ORIGINAL GUIDE TUBE (WEST) CENTER

REFERENCE BAR ZERO to OBJECT SURFACE 48.13"
APPROXIMATE PENETRATION RATE ≈ 0.25 cm/sec

DEPTH PUSHED:

CPP

Initial (ft) - 0.04
1.70

ADJUST CLAMPS FOR FULL STROKE

Final (ft) 3.89

MAG SHUTDOWN

CPP TOTAL : 3.93 FT (47.16 ")

PIPE

Pipe Reference to Probe Tip 45.50
Final Residual - 1.13

PIPE TOTAL : 46.63"

DISTANCE FROM TEST OBJECT at SHUTDOWN

CPP : 48.13"
- 47.16

0.97" (2.46 cm)

PIPE : 48.13"
- 46.63

1.50" (3.81 cm)

COMMENTS : _____

Error

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PROBE: MSP

DATE: 02/16/99
TIME: _____

PENETRATION FILE: Z16F 99 06 C. DAT

TEST OBJECT: ORIGINAL GUIDE TUBE (WEST) SOUTH END

REFERENCE BAR ZERO to OBJECT SURFACE 48.13
APPROXIMATE PENETRATION RATE 2.1 cm/sec

DEPTH PUSHED:

CPP	Initial (ft)	<u>0.040</u>	
		<u>1.77</u>	<u>ADJUST CLAMPS FOR FULL STROKE</u>
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		Final (ft)	<u>3.99</u>
CPP TOTAL :		<u>3.95' (47.40")</u>	

PIPE	Pipe Reference to Probe Tip	<u>45.50"</u>
	- Final Residual	<u>- 2.44"</u>
	PIPE TOTAL :	<u>47.94"</u>

DISTANCE FROM TEST OBJECT at SHUTDOWN

CPP :	<u>48.13"</u>	PIPE :	<u>48.13"</u>
-	<u>47.40"</u>	-	<u>47.94"</u>
	<u>0.73" (1.85 cm)</u>		<u>0.19" (0.48 cm)</u>

COMMENTS : _____

Error

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Error

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PROBE: MSP

DATE: 02/16/99

TIME: _____

PENETRATION FILE: Z16F9907C.DAT

TEST OBJECT: ORIGINAL GUIDE TUBE (WEST) NORTH END

REFERENCE BAR ZERO to OBJECT SURFACE 48.13"
 APPROXIMATE PENETRATION RATE ≈ 1.5 cm/sec

DEPTH PUSHED:

CPP	Initial (ft)	<u>- 0.040</u>	
		<u>.03</u>	<u>MAG ALARM</u>
		<u>1.94</u>	<u>ADJUST CP CLAMPS FOR FULL STROKE</u>
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		Final (ft)	<u>3.68</u>
CPP TOTAL :		<div style="border: 1px solid black; padding: 2px;"><u>3.72' (44.64")</u></div>	

PIPE	Pipe Reference to Probe Tip	<u>45.50"</u>
	- Final Residual	<u>1.38</u>
	PIPE TOTAL :	<div style="border: 1px solid black; padding: 2px;"><u>44.12"</u></div>

DISTANCE FROM TEST OBJECT at SHUTDOWN

CPP :	<u>48.13"</u>	PIPE :	<u>48.13"</u>
	<u>- 44.64</u>		<u>44.12"</u>
	<div style="border: 1px solid black; padding: 2px;"><u>3.49" (8.86 cm)</u></div>		<div style="border: 1px solid black; padding: 2px;"><u>4.01" (10.19 cm)</u></div>

COMMENTS : _____

Error

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PROBE: MSP

DATE: 02/16/99
TIME: _____

PENETRATION FILE: Z16 F99 08 C.DAT

TEST OBJECT: SSP GUIDE TUBE (EAST) NORTH END

REFERENCE BAR ZERO to OBJECT SURFACE 48.06"
APPROXIMATE PENETRATION RATE ≈ 2.4 cm/sec

DEPTH PUSHED:

CPP	Initial (ft)	<u>-0.040</u>	
		<u>2.025</u>	<u>ADJUST CP ROD CLAMPS FOR FULL STROKE</u>
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		_____	_____
	Final (ft)	<u>3.96</u>	<u>MAG SHUT DOWN</u>
CPP TOTAL :		<u>4.00' (48.00")</u>	

PIPE	Pipe Reference to Probe Tip	<u>45.50"</u>
	- Final Residual	<u>- 2.00</u>
	PIPE TOTAL :	<u>47.50</u>

DISTANCE FROM TEST OBJECT at SHUTDOWN

CPP :	<u>48.06"</u>	PIPE :	<u>48.06"</u>
	<u>- 48.00</u>		<u>- 47.50</u>
	<u>0.06" (0.15 cm)</u>		<u>0.56" (1.42 cm)</u>

COMMENTS : _____

Error

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PROBE: MSP

DATE: 02/16/99

TIME: _____

PENETRATION FILE: Z16F9909C.DAT

TEST OBJECT: SSP GUIDE TUBE (EAST) CENTER

REFERENCE BAR ZERO to OBJECT SURFACE 48.00"
 APPROXIMATE PENETRATION RATE ≈ 1.5 cm/sec

DEPTH PUSHED:

CPP	Initial (ft)	<u>-0.040</u>	
		<u>2.31</u>	<u>ADJUST CP ROD CLAMPS FOR FULL STROKE</u>
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		Final (ft)	<u>3.93</u>
CPP TOTAL :		<u>3.97' (47.64")</u>	

PIPE	Pipe Reference to Probe Tip	<u>45.50"</u>
	- Final Residual	<u>- 1.56</u>
	PIPE TOTAL :	<u>47.06"</u>

DISTANCE FROM TEST OBJECT at SHUTDOWN

CPP :	<u>48.00"</u>	PIPE :	<u>48.00"</u>
-	<u>47.64</u>	-	<u>47.06"</u>
<u>0.36" (0.91 cm)</u>		<u>0.94" (2.39 cm)</u>	

COMMENTS : _____

Error

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PROBE: MSP

DATE: 02/16/99
TIME: _____

PENETRATION FILE: Z16F9910C.DAT

TEST OBJECT: SSP GUIDE TUBE (EAST) SOUTH END

REFERENCE BAR ZERO to OBJECT SURFACE 47.94"
APPROXIMATE PENETRATION RATE ≈ 0.25 cm/sec

DEPTH PUSHED:

CPP	Initial (ft)	- 0.040	
		.17	MAG ALARM
		.87	MAG ALARM
		.88	MAG ALARM
		1.01	MOVE TO 1.01 FT TO ALLOW PENETRATION
		1.82	ADJUST CP ROD CLAMPS FOR FULL STROKE
	Final (ft)	3.86	MAG SHUTDOWN
CPP TOTAL :		3.90' (46.80")	

PIPE	Pipe Reference to Probe Tip	45.50"
	- Final Residual	- 0.63
PIPE TOTAL :		46.13"

DISTANCE FROM TEST OBJECT at SHUTDOWN

CPP :	47.94"	PIPE :	47.94"
	- 46.80		- 46.13"
1.14" (2.90 cm)		1.81" (4.60 cm)	

COMMENTS : _____

Error

An error occurred while processing this page. See the system log for more details.

PROBE: MSP

DATE: 02/16/99
TIME: _____

PENETRATION FILE: Z16F9911C.DAT

TEST OBJECT: BETWEEN TEST CP GUIDE TUBES ; SOUTH END (C) SOUTH

REFERENCE BAR ZERO to OBJECT SURFACE ≈ 48"
APPROXIMATE PENETRATION RATE ≈ 1.4 cm/sec

DEPTH PUSHED:

CPP

Initial (ft) -0.040

.60
1.80
5.25

MAG ALARM
ADJUST CP ROD CLAMPS FOR FULL STROKE
ADJUST CP ROD CLAMPS TO TOP OF MSP STRING

Final (ft) 7.02

END OF AVAILABLE PIPE - NO SHUTDOWN

CPP TOTAL : 7.06' (84.72")

PIPE

Pipe Reference to Probe Tip

NR

- Final Residual

NR

PIPE TOTAL : NR

DISTANCE FROM TEST OBJECT at SHUTDOWN

CPP : 49.75"
- 84.72

PIPE : _____

34.97" (88.82 cm)

NR

COMMENTS : PUSHED ≈ 35" PAST DEPTH OF ESTIMATED MINIMUM DISTANCE
BETWEEN PIPE SEGMENTS (48" + 0.5 (3.50" OD)) = 49.75"

Error

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PROBE: MSP

DATE: 02/16/99
TIME: _____

PENETRATION FILE: 716F99 12C.DAT

TEST OBJECT: BETWEEN TEST CP GUIDE TUBES; NORTH END (C) NORTH

REFERENCE BAR ZERO to OBJECT SURFACE ≈ 48"
APPROXIMATE PENETRATION RATE ≈ 1.4 cm/sec

DEPTH PUSHED:

CPP	Initial (ft)	<u>-0.040</u>	
		<u>2.28</u>	<u>ADJUST CP ROD CLAMPS TO FULL STROKE</u>
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		_____	_____
	Final (ft)	<u>3.94</u>	<u>MAG SHUTDOWN</u>
CPP TOTAL :		<u>3.98' (47.76")</u>	

PIPE	Pipe Reference to Probe Tip	<u>45.50"</u>
	- Final Residual	<u>- 1.63</u>
	PIPE TOTAL :	<u>47.13"</u>

DISTANCE FROM TEST OBJECT at SHUTDOWN

CPP :	<u>48.0"</u>	PIPE :	<u>48.0"</u>
-	<u>47.8</u>	-	<u>47.1"</u>
<u>0.2" (0.5 cm)</u>		<u>0.9" (2.3 cm)</u>	

COMMENTS : _____

Error

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Appendix 1. MSP/SSP Magnetometer Test Data

7. Dynamic Subsurface Tests – SSP

PROBE: SSP M&I

DATE: 2/12/99
TIME: _____

PENETRATION FILE: Z12F9911C.DAT

TEST OBJECT: SSP GUIDE TUBE (EAST) SOUTH END

REFERENCE BAR ZERO to OBJECT SURFACE 47.94"
APPROXIMATE PENETRATION RATE 0.4 cm/sec

DEPTH PUSHED:

CPP Initial (ft) - 0.040

Final (ft) _____

CPP TOTAL : NR

*MALFUNCTION IN
CPP DEPTH
MEASUREMENT*

PIPE

Pipe Reference to Probe Tip 62.31"
Final Residual 18.56"

PIPE TOTAL : 43.75"

DISTANCE FROM TEST OBJECT at SHUTDOWN

CPP : _____

NR

PIPE : 47.94"
- 43.75"

4.19" (10.64 cm)

COMMENTS : CPP DEPTH MALFUNCTION DURING ADJUSTMENT OF
CP PUSH HYDRAULICS

Error

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PROBE: SSP M&TDATE: 2/12/99

TIME: _____

PENETRATION FILE: Z12F9912C.DATTEST OBJECT: SSP GUIDE TUBE (EAST) CENTERREFERENCE BAR ZERO to OBJECT SURFACE
APPROXIMATE PENETRATION RATE48.00"
≈ 1.5 cm/sec

DEPTH PUSHED:

CPP

Initial (ft) -0.038Final (ft) 3.64AUTO MAG SHUTDOWNCPP TOTAL : 3.678' (44.14")

PIPE

Pipe Reference to Probe Tip

62.31

Final Residual

18.50PIPE TOTAL : 43.81"

DISTANCE FROM TEST OBJECT at SHUTDOWN

CPP : 48.00
- 44.143.86" (9.80 cm)PIPE : 48.00
- 43.814.19" (10.64 cm)

COMMENTS : _____

Error

An error occurred while processing this page. See the system log for more details.

PROBE: SSP M&T

DATE: 02/12/99
TIME: _____

PENETRATION FILE: Z12F9913C.DAT

TEST OBJECT: SSP GUIDE TUBE (EAST) NORTH END

REFERENCE BAR ZERO to OBJECT SURFACE 48.06"
APPROXIMATE PENETRATION RATE 2.5 cm/sec

DEPTH PUSHED:

CPP

Initial (ft) -0.045

Final (ft) 3.725

AUTO MAG SHUT DOWN

CPP TOTAL : 3.77' (45.24")

PIPE

Pipe Reference to Probe Tip

62.31"

- Final Residual

17.50

PIPE TOTAL : 44.81"

DISTANCE FROM TEST OBJECT at SHUTDOWN

CPP : 48.06"
- 45.24

2.82" (7.16 cm)

PIPE : 48.06"
- 44.81

3.25" (8.26 cm)

COMMENTS : _____

Error

An error occurred while processing this page. See the system log for more details.

PROBE: SSP M&I

DATE: 02/16/99

TIME: _____

PENETRATION FILE: Z16F9913C.DAT

TEST OBJECT: ORIGINAL GUIDE TUBE (WEST) CENTER

REFERENCE BAR ZERO to OBJECT SURFACE
APPROXIMATE PENETRATION RATE

48.13"
≈ 0.40 cm/sec

DEPTH PUSHED:

CPP

Initial (ft) ~ 0.040

1.52

ADJUST CP ROD CLAMPS FOR FULL STROKE

Final (ft) 3.79

MAG SHUT DOWN

CPP TOTAL : 3.83' (45.96")

PIPE

Pipe Reference to Probe Tip

62.31"

- Final Residual

16.56

PIPE TOTAL : 45.75"

DISTANCE FROM TEST OBJECT at SHUTDOWN

CPP : 48.13"
- 45.96

2.17" (5.51 cm)

PIPE : 48.13"
- 45.75

2.38" (6.05 cm)

COMMENTS : _____

Error

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PROBE: SSP M&I

DATE: 02/16/99
TIME: _____

PENETRATION FILE: Z16F9914C.DAT

TEST OBJECT: ORIGINAL GUIDE TUBE (WEST) SOUTH END

REFERENCE BAR ZERO to OBJECT SURFACE 48.13"
APPROXIMATE PENETRATION RATE ≈ 2.7 cm/sec

DEPTH PUSHED:

CPP	Initial (ft) -	<u>0.040</u>	
		<u>1.69</u>	<u>ADJUST CP ROD CLAMPS FOR FULL STROKE</u>
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		_____	_____
		Final (ft)	<u>3.45</u>
CPP TOTAL :		<u>3.49'</u>	<u>(41.88")</u>

PIPE	Pipe Reference to Probe Tip	<u>62.31"</u>
	- Final Residual	<u>20.75</u>
	PIPE TOTAL :	<u>41.56"</u>

DISTANCE FROM TEST OBJECT at SHUTDOWN

CPP :	<u>48.13"</u>	PIPE :	<u>48.13</u>
-	<u>41.88"</u>	-	<u>41.56</u>
	<u>6.25" (15.88 cm)</u>		<u>6.57" (16.69 cm)</u>

COMMENTS : _____

Error

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PROBE: SSP M&I

DATE: 02/16/99
TIME: _____

PENETRATION FILE: Z16F9915 C.DAT

TEST OBJECT: ORIGINAL GUIDE TUBE (WEST) NORTH END

REFERENCE BAR ZERO to OBJECT SURFACE 48.13"
APPROXIMATE PENETRATION RATE ≈ 1.5 cm/sec

DEPTH PUSHED:

CPP

Initial (ft) -0.040
1.64

ADJUST CP ROD CLAMPS FOR FULL STROKE

Final (ft) 4.02

MAG SHUT DOWN

CPP TOTAL : 4.06' (48.72")

PIPE

Pipe Reference to Probe Tip

62.31

- Final Residual

13.94

PIPE TOTAL : 48.37"

DISTANCE FROM TEST OBJECT at SHUTDOWN

CPP : 48.13"
48.72"

PIPE : 48.13"
48.37"

- 0.6"

- 0.2"

COMMENTS :

CONTACT !

Error

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PROBE: SSP M&I

DATE: 02/16/99
TIME: _____

PENETRATION FILE: Z16F9916C.DAT

TEST OBJECT: BETWEEN TEST PIPES at NORTH ENDS (C) NORTH

REFERENCE BAR ZERO to OBJECT SURFACE 48.0"
APPROXIMATE PENETRATION RATE _____

DEPTH PUSHED:

CPP Initial (ft) -0.040
1.67

ADJUST CP ROD CLAMPS FOR FULL STROKE

TEST ABORTED

*MULTIPLE MAGNETOMETER
& CP DEPTH ALARMS*

Final (ft) _____

CPP TOTAL :

PIPE

Pipe Reference to Probe Tip _____
Final Residual _____

PIPE TOTAL :

DISTANCE FROM TEST OBJECT at SHUTDOWN

CPP : _____

PIPE : _____

COMMENTS : _____

PROBE: SSP M&IDATE: 02/16/99
TIME: _____PENETRATION FILE: Z16F9917C.DATTEST OBJECT: BETWEEN TEST GUIDE TUBES @ NORTH ENDS (C) NORTHREFERENCE BAR ZERO to OBJECT SURFACE 48.0
APPROXIMATE PENETRATION RATE 1.5 cm/sec

DEPTH PUSHED:

CPP	Initial (ft)	<u>- 0.040</u>	
		<u>2.21</u>	<u>ADJUST CP ROD CLAMPS FOR FULL STROKE</u>
			<u>CP DEPTH MALFUNCTION</u>
		<u>4.44</u>	<u>NEW DEPTH READING (NO MOVEMENT)</u>
	Final (ft)	<u>6.62</u>	<u>MAG SHUT DOWN (4.39 CORRECTED)</u>
CPP TOTAL :		<u>4.43'</u>	<u>(53.16")</u>

PIPE

	Pipe Reference to Probe Tip	<u>62.31</u>
-	Final Residual	<u>9.81</u>
PIPE TOTAL :		<u>52.50"</u>

DISTANCE FROM TEST OBJECT at SHUTDOWN

CPP :	<u>48.00"</u>	PIPE :	<u>48.00</u>
	<u>- 53.16</u>		<u>- 52.5</u>
	<u>- 5.16" (-13.1 cm)</u>		<u>- 4.5" (-11.4 cm)</u>

COMMENTS : MAGNETOMETER SHUTDOWN APPROXIMATELY 5" PAST TOP
OF GUIDE TUBES AND APPROX 3.25" PAST NARROWEST SPAN BETWEEN
TEST TUBES

Error

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PROBE: SSP M&I

DATE: 02/16/99
TIME: _____

PENETRATION FILE: Z16F9918C.DAT

TEST OBJECT: BETWEEN TEST GUIDE TUBES @ SOUTH END, (C) SOUTH

REFERENCE BAR ZERO to OBJECT SURFACE 48.0"
APPROXIMATE PENETRATION RATE ≈ 1.5 cm/sec

DEPTH PUSHED:

CPP	Initial (ft)	<u>-0.040</u>	
		<u>1.94</u>	<u>ADJUST CP ROD CLAMPS TO FULL STROKE</u>
	Final (ft)	<u>4.98</u>	<u>MAG SHUTDOWN</u>
CPP TOTAL :		<u>5.02' (60.24")</u>	

PIPE	Pipe Reference to Probe Tip	<u>62.31"</u>
	- Final Residual	<u>2.50</u>
PIPE TOTAL :		<u>59.81"</u>

DISTANCE FROM TEST OBJECT at SHUTDOWN

CPP :	<u>48.00"</u>	PIPE :	<u>48.0</u>
	<u>- 60.24"</u>		<u>- 59.8</u>
	<u>-12.2" (-31.1 cm)</u>		<u>- 11.8" (-30 cm)</u>

COMMENTS : MAGNETOMETER SHUTDOWN AT APPROXIMATELY 10"
PAST VERTICAL CENTER OF TEST PIPES ???

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Appendix 1. MSP/SSP Magnetometer Test Data

8. Data Summaries for Dynamic Tests

The following spreadsheets summarize the results of the dynamic surface and subsurface testing of the MSP and SSP magnetometer sensors. The probes were pushed at different push rates toward various locations on four ferrous metal test objects until the CPP initiated an auto-shutdown or until the CP operator executed a manual shutdown. The final measured distances of the probe tips from the surfaces of the test objects are recorded. Test runs where a probe made probable contact with a test object before auto-shutdown are flagged as '???'. Tests where contact with the test object prior to manual CP shutdown was unambiguous are flagged as '**HIT**'.

SUMMARY OF MSP MAGNETOMETER SURFACE DYNAMIC TESTS
FEBRUARY 17, 1999

TEST #	TEST OBJECT		PUSH SPEED		DISTANCE OF PROBE TIP FROM SURFACE AT SHUTDOWN (cm)	
		Spot		cm/sec		
97	Test Plate 1	V	Medium	1.5	6.1	
98	"	V	Slow	0.3	3.0	
99	"	V	Fast	2.8	1.5	
100	"	3	Medium	1.4	3.3	
101	"	3	Slow	0.4	4.3	
102	"	3	Fast	2.3	2.5	
103	"	2	Medium	1.5	5.7	
104	"	2	Slow	0.4	4.0	
105	"	2	Fast	2.5	3.3	
106	Original Guide Tube	1	Medium	1.5	1.7	
107	"	1	Slow	0.4	2.6	
108	"	1	Fast	2.1	1.0	
109	"	2	Medium	1.3	4.2	
110	"	2	Slow	0.3	2.9	
111	"	2	Fast	2.3	3.2	
112	"	3	Medium	1.5	12.4	
113	"	3	Slow	0.3	6.3	
114	"	3	Fast	2.1	8.7	
115	SSP Guide Tube	1	Medium	1.7	2.8	
116	"	1	Slow	0.4	3.7	
117	"	1	Fast	2.1	2.6	
118	"	2	Medium	1.4	2.5	
119	"	2	Slow	0.4	2.8	
120	"	2	Fast	2.3	1.3	
121	"	3	Medium	1.7	1.8	
122	"	3	Slow	0.4	3.2	
123	"	3	Fast	2.1	3.6	
124	4" OD Thin Wall Pipe	1	Medium	1.4	0.6	
125	"	1	Slow	0.3	2.6	
126	"	1	Fast	2.4	0.0	HIT
127	"	2	Medium	1.5	5.5	
128	"	2	Slow	0.3	8.5	
129	"	2	Slow	0.3	4.3	ReTest
130	"	2	Fast	2.7	5.1	
131	"	3	Medium	1.4	0.0	HIT
132	"	3	Slow	0.3	1.7	
133	"	3	Fast	2.2	0.0	HIT

SUMMARY OF SSP MAGNETOMETER SURFACE DYNAMIC TESTS
FEBRUARY 11 - 12, 1999

TEST #	TEST OBJECT		PUSH SPEED		DISTANCE OF PROBE TIP FROM SURFACE AT SHUTDOWN (cm)	
		Spot		cm/sec		
60	Test Plate 1	V	Slow	0.4	8.9	
61	"	V	Medium	1.1	7.7	
62	"	V	Fast	2.2	6.6	
63	"	2	Slow	0.4	6.3	
64	"	2	Medium	1.4	5.3	
65	"	2	Fast	3.2	3.0	
66	"	3	Slow	0.4	11.4	
67	"	3	Medium	1.0	8.9	
68	"	3	Fast	2.0	7.0	
69	"	3	Fast	2.3	7.2	ReTest
70	SSP Guide Tube	1	Slow	0.3	11.6	
71	"	1	Medium	1.3	9.7	
72	"	1	Fast	2.6	7.4	
73	"	2	Slow	0.2	10.8	
74	"	2	Medium	1.2	11.1	
75	"	2	Fast	2.2	9.3	
76	"	3	Slow	0.3	12.5	
77	"	3	Medium	1.4	9.5	
78	"	3	Fast	2.6	7.2	
79	4" OD Thin Wall Pipe	1	Slow	0.4	15.1	
80	"	1	Medium	1.2	13.3	
81	"	1	Fast	2.5	12.2	
82	"	2	Slow	0.2	1.3	
83	"	2	Medium	1.2	0.1	???
84	"	2	Fast	2.1	-0.6	HIT
85	"	3	Slow	0.4	13.9	
86	"	3	Medium	1.3	13.0	
87	"	3	Fast	2.2	11.9	
88	Original Guide Tube	1	Medium	0.7	22.0	
89	"	1	Slow	0.3	21.5	
90	"	1	Fast	3.2	17.0	
91	"	2	Slow	0.4	8.5	
92	"	2	Medium	1.5	6.5	
93	"	2	Fast	2.6	5.7	
94	"	3	Slow	0.3	2.4	
95	"	3	Medium	1.3	1.0	
96	"	3	Fast	2.3	0.0	HIT

SUMMARY OF MSP & SSP MAGNETOMETER SUBSURFACE TESTS
FEBRUARY 12 - 16, 1999

TEST #	TEST OBJECT		PUSH SPEED		DISTANCE OF PROBE TIP FROM SURFACE AT SHUTDOWN (cm)	
		Spot		cm/sec		
MSP						
Z16F9902C	Original Guide Tube	Center	Slow	0.3	1.8	
Z16F9905C	"	Center	Slow	0.3	3.8	ReTest
Z16F9906C	"	South	Fast	2.1	0.5	???
Z16F9907C	"	North	Med	1.5	10.2	
Z16F9908C	SSP Guide Tube	North	Fast	2.4	1.4	
Z16F9909C	"	Center	Med	1.5	2.4	
Z16F9910C	"	South	Slow	0.3	4.6	
Z16F9911C	Between Guide Tubes	South	Med	1.4	No Shutdown	N/A
Z16F9912C	"	North	Med	1.4	2.3	N/A
SSP						
Z12F9911C	SSP Guide Tube	South	Slow	0.4	10.6	
Z12F9912C	"	Center	Med	1.5	10.6	
Z12F9913C	"	North	Fast	2.5	8.3	
Z16F9913C	Original Guide Tube	Center	Slow	0.4	6.0	
Z16F9914C	"	South	Fast	2.7	16.7	
Z16F9915C	"	North	Med	1.5	-0.5	HIT
Z16F9917C	Between Guide Tubes	North	Med	1.5	-11.4	N/A
Z16F9918C	"	South	Med	1.5	-30.0	N/A

Appendix 2. MSP/SSP Inclinator Test Data

1. MSP Inclinator Test Data	176
2. SSP Inclinator Test Data.....	196

Appendix 2. MSP/SSP Inclinometer Test Data

1. MSP Inclinometer Test Data

Concept for correcting till

$$X_{Ve} = X_V = f_{X_0}(Y_{V,1})$$

12/8/98

$$Y_{Ve} = Y_V = f_{Y_0}(X_{V,1})$$

$$X' = f(X_V, \frac{1}{X_0})$$

$$Y' = f(Y_V, \frac{1}{Y_0})$$

Regression 1 CY component when moving on Xemb

$$X_R = X_{VORTB}$$

$$Y_R = Y_{VORTB}$$

$$Y_{Vbase corr} = Y_{Vbase} = f_{Y_0}(X_{Vbase}) =$$

$$Y_L = 0.153447 + 2.790408 Y_{Vbase corr}$$

Quad

$$0.0082 X_{Vbase}^2 - 0.0588 X_{Vbase} - 0.0246$$

std dev of connection 0.043

Linear

$$-0.0601 X + 0.596$$

std dev of correction = 0.087

$$X_{Vbase corr} = f(X_{Vbase} = f_{X_0}(Y_{Vbase})) = -0.381 Y_{Vbase} + 0.01765$$

$$X_L = -0.1789 + 2.93315 X_{Vbase corr}$$

X_{VRB} = Baseline voltage in X

X_{VR} = X voltage raw

X_{VB} = Baseline corrected X_{VR}

X_{VC} = X voltage corrected for off axis component

X' = Final angle for X in degrees

$Y_{VRB}, Y_{VR}, Y_{VB}, Y_{VC}, Y'$ similar

$$X_{VB} = X_{VR} - X_{VR \text{ Baseline}}$$

$$X_{VC} = X_{VB} - (0.053807 - 0.279149 \cdot X_{VB})$$

$$X' = 0.120791 + 5.78341 \cdot X_{VC}$$

$$Y_{VB} = Y_{VR} - Y_{VRB}$$

$$Y_{VC} = Y_{VB} - (-0.037434 - 0.13335 \cdot Y_{VB})$$

$$Y' = 0.013129 + 5.90546 \cdot Y_{VC}$$

Error

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2SC 12/11/98

MSP X-Axis calibration

Y SENSOR OUTPUT MINIMIZED @ -0.290V

25C 12/11/98

MSP Y-Axis calibration

X sensor output MINIMIZED = 0.195 V

Error

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INCLINOMETER LINEAR RESPONSE

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MSP INCLINOMETER

12/11/98 10:45-11:25

14.41 -1.47 2.784 -0.158

STEP	TEST JIG POSITION		SMARTLEVEL	L	V	CPP L	V
	AXIS	INCLINATION	Inclination	X Inclination		Y Inclination	
1	+X	15	40.28 75.5	0.041	0.2415	0.024	-0.376
2	+X	10	80.1	0.15	1.946	-0.700	-0.510
3	+X	5	85.3	5.07	1.10	-0.48	-0.468
4	+X	0	40.2	0.041	0.2415	0.024	-0.376
5	+Y	0	40.2	0.465	0.336	-0.343	-0.444
6	+Y	5	85.2	0.805	0.018	4.63	0.461
7	+Y	10	80.1	-0.288	-0.332	4.73	1.384
8	+Y	15	75.5	1.14	-0.153	14.52	2.262
9	-X	15	75.5	-14.30	-2.260	2.16	0.013
10	-X	10	80.1	-4.41	-1.382	1.33	-0.136
11	-X	5	85.1	-4.20	-0.504	0.755	-0.242
12	-X	0	40.2	0.535	0.372	0.018	-0.377
13	-Y	0	40.2	0.462	0.283	0.422	-0.347
14	-Y	5	85.1	-0.310	0.547	-4.56	-1.20
15	-Y	10	80.1	-0.260	0.412	-4.67	-2.14
16	-Y	15	75.5	0.227	1.258	-14.56	-3.03
17	+X	15	75.5	14.87	2.787	-1.63	-0.677
18	+X	10	80.1	10.12	1.969	-1.07	-0.577
19	+X	5	85.1	5.07	1.092	-0.317	-0.448
20	+X	0	40.2	0.052	0.2408	0.061	-0.368
21	+Y	0	40.2	0.484	0.338	-0.325	-0.439
22	+Y	5	85.2	0.650	0.004	4.65	0.466
23	+Y	10	80.1	0.940	-0.309	4.71	1.384
24	+Y	15	75.5	0.806	-0.694	14.54	2.263
25	-X	15	75.5	-14.29	-2.250	1.87	-0.041
26	-X	10	80.1	-9.36	-1.40	1.45	-0.120
27	-X	5	85.1	-4.20	-0.499	0.680	-0.256
28	-X	0	40.2	0.834	0.369	0.045	-0.372
29	-Y	0	40.1	0.417	0.273	0.436	-0.301
30	-Y	5	85.2	0.210	0.603	-4.55	-1.209
31	-Y	10	80.1	-0.180	0.902	-4.64	-2.135
32	-Y	15	75.5	-0.050	1.287	-14.56	-3.03

VERIFICATION 12/11/98 @ 10:30 +X @ 14.5 & +Y @ 14.5 AGREE + 5%

+X SL 14.5
+Y CORR 14.8+Y SL 14.5
+Y CORR = 14.44

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J. Callaway 12/11/98
W. Bratton 12/11/98

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INCLINOMETER POSITION TRACKING

MSP QUAL TEST

12/14/98

STEP	TEST JIG POSITION		SMARTLEVEL	CPP			Bull's Eye	
	Radial	Angle		Depth (ft)	X Inclination	Y Inclination	Radial	Displacement (ft)
1	0 +	0	90.0	10.26	.004	.011	77.01	.001
2	90 +	0	90.0	20.57	.354	-.470	-51.89	.106
3	90 +	5	85.0	30.8	.823	4.602	73.54	.777
4	135 - +	5	85.0	41.17	-2.78	3.55	101.29	1.42
5	180 -	5	85.0	51.48	-4.31	0.537	125.3	1.82
6	225 - -	5	85.0	61.78	-3.146	-2.97	149.6	1.88
7	270 -	10	80.1	72.1	-0.246	-9.83	-153.4	1.86
8	315 + -	10	80.1	82.4	6.62	-7.96	-101.8	2.33
9	0 +	10	80.1	92.7	10.31	-1.05	-60.48	2.84
10	45 + +	10	80.0	103	7.83	6.13	-25.96	3.13
11	90 +	15	75.4	113.3	1.216	14.55	23.31	3.3
12	135 - +	15	75.5	123.4	-9.5	11.39	68.85	3.63
13	180 -	15	75.4	133.9	-14.56	1.66	110.35	3.93
14	225 - -	15	75.5	144.3	-11.02	-9.39	149.57	3.91
15	135 - +	15	75.4	154.6	-9.56	11.3	141.6	6.51
16	135 - +	15	75.4	164.9	-9.56	11.29	138.3	9.16
17	135 - +	15	75.4	175.1	-9.55	11.28	136.4	11.83

DATA SET FILE:

Z14D9807C.DAT

W.S. Callaway 12/14/98
W.L. Bratcher 12/14/98
G.L. Traylor 12/14/98

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SENSOR: MSP
 FILE: Z1409807C.DAT

SIMULATED
 INCLINOMETER DEPLOYMENT

DATE: 12/14/98
 TIME: _____

STEP	INCLINATION	RADIAL	DEPTH	DEVIATION	STEP TIP MOVEMENT		CARTESIAN TIP		CALCULATED		OBSERVED	
#	(o)	(o)	(ft)	(ft)	X (ft)	Y (ft)	X (ft)	Y (ft)	BULLS-EYE TIP		BULLS-EYE TIP	
									RADIAL (o)	VECTOR (ft)	RADIAL (o)	VECTOR (ft)
0							0.00	0.00				
1	0.0	0	10.26	0.00	0.00	0.00	0.00	0.00		0.00	77.01	0.001
2	0.0	90	20.57	0.00	0.00	0.00	0.00	0.00		0.00	308.31	0.106
3	5.0	90	30.80	0.89	0.00	0.89	0.00	0.89	90.00	0.89	73.54	0.777
4	5.0	135	41.17	0.90	-0.64	0.64	-0.64	1.53	112.66	1.66	101.29	1.42
5	5.0	180	51.48	0.90	-0.90	0.00	-1.54	1.53	135.13	2.17	125.30	1.82
6	5.0	225	61.78	0.90	-0.63	-0.63	-2.17	0.90	157.59	2.35	149.60	1.88
7	9.9	270	72.10	1.77	0.00	-1.77	-2.17	-0.88	202.02	2.34	206.60	1.86
8	9.9	315	82.40	1.77	1.25	-1.25	-0.92	-2.13	246.64	2.32	258.20	2.33
9	9.9	0	92.70	1.77	1.77	0.00	0.85	-2.13	291.76	2.29	299.52	2.84
10	10.0	45	103.00	1.79	1.26	1.26	2.12	-0.87	337.74	2.29	334.04	3.13
11	14.6	90	113.30	2.60	0.00	2.60	2.12	1.73	39.28	2.73	23.31	3.30
12	14.5	135	123.40	2.53	-1.79	1.79	0.33	3.52	84.69	3.53	68.85	3.63
13	14.6	180	133.90	2.65	-2.65	0.00	-2.32	3.52	123.39	4.21	110.35	3.93
14	14.5	225	144.30	2.60	-1.84	-1.84	-4.16	1.68	158.04	4.49	149.57	3.91
15	14.6	135	154.6	2.60	-1.84	1.84	-6.00	3.51	149.64	6.95	141.6	6.51
16	14.6	135	164.9	2.60	-1.84	1.84	-7.83	5.35	145.67	9.48	138.3	9.16
17	14.6	135	175.1	2.57	-1.82	1.82	-9.65	7.17	143.40	12.02	136.4	11.83
18												
19												
20												

COMMENTS:

ACCEPT RADIAL 143.4 $\pm$ 15° ✓
 VECTOR 12.02 $\pm$ 15.20' ✓

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Appendix 2. MSP/SSP Inclinometer Test Data

2. SSP Inclinometer Test Data

Error

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Sw. QUAL TEST 12/10/98
CAL REPORT RECORD

SSP calibration along minimized axis

SEE QUAL TEST 12/10/98
CAL REPORT RECORD X

SPP calibration along minimized axis
X inclination

Error

An error occurred while processing this page. See the system log for more details.

INCLINOMETER LINEAR RESPONSE

SSP Qual Test Sheet 1 of 2

12/10/98

STEP	TEST JIG POSITION		SMARTLEVEL		L°		CPP	
	AXIS	INCLINATION	Inclination		X Inclination		Y Inclination	
1	+X	15	75.5	14.5	14.18	7.338	0.957	-1.601
2	+X	10	80.1	10.1	9.67	5.637	0.577	-1.453
3	+X	5	85.2	4.8	4.74	3.801	-0.255	-1.327
4	+X	0	90	0	0.024	2.024	0.020	-1.216 *
5	+Y	0	89.8	0.1	0.382	2.231	-0.335	-1.357
6	+Y	5	85.3	4.7	0.466	1.453	4.66	0.593
7	+Y	10	80.1	10.1	0.410	6.637	9.59	2.515
8	+Y	15	75.4	14.6	0.841	0.050	14.18	4.309
9	-X	15	75.5	-14.5	-13.31	-3.015	1.38	-0.690
10	-X	10	80.1	-10.1	-8.72	-1.293	1.03	-0.827
11	-X	5	85.2	-4.8	-4.06	0.486	0.478	-1.042
12	-X	0	89.8	-0.2	0.748	2.306	0.024	-1.218 *
13	-Y	0	89.9	-0.1	0.343	2.094	0.43	-1.06
14	-Y	5	85.2	-4.8	0.358	2.898	-4.55	-3.004
15	-Y	10	80.1	-10.1	0.336	3.703	-9.55	-4.955
16	-Y	15	75.5	-14.5	0.202	4.433	-14.4	-6.84
17	+X	15	75.6	14.4	13.77	7.20	-1.02	-1.626
18	+X	10	80.1	9.9	9.19	5.423	-0.300	-1.348
19	+X	5	85.2	4.8	4.38	3.649	-0.133	-1.28
20	+X	0	89.8	0.2	0.157	1.944	0.257	-1.137 *
21	+Y	0	90	0	0.257	2.15	0.113	-1.223
22	+Y	5	85.1	4.9	0.218	1.37	4.61	0.571
23	+Y	10	80.1	9.9	0.299	0.619	9.46	2.463
24	+Y	15	75.5	14.5	0.717	0.049	13.93	4.207
25	-X	15	75.5	-14.5	-13.04	-2.945	1.55	-0.621
26	-X	10	80.2	-9.8	-8.73	-1.318	1.18	-0.767
27	-X	5	85.1	-4.9	-4.13	0.436	0.646	0.976
28	-X	0	89.8	-0.2	0.568	2.206	0.257	-1.136 *
29	-Y	0	89.8	-0.2	0.179	1.997	0.645	-0.976
30	-Y	5	85.2	-4.8	0.035	2.732	-4.22	-2.877
31	-Y	10	80.1	-9.9	0.039	3.543	-9.22	-4.828
32	-Y	15	75.5	-14.5	0.047	4.316	-13.99	-6.691

* See 2nd sheet for zero measurements. Error in Smartlevel interpretation - remeasured. *[Signature]*
 Recorded by G. Trager, for ARA WCDickson

INCLINOMETER LINEAR RESPONSE

SSP Qual Test Sheet 2 of 2

12/10/98

STEP	TEST JIG POSITION		SMARTLEVEL	CPP	
	AXIS	INCLINATION	Inclination	X Inclination	Y Inclination
1	+X	15			
2	+X	10			
3	+X	5			
4	+X	0	90.2 -0.2	-0.285 1.893	0.249 -1.131
5	+Y	0	90.1 -0.1	0.104 2.093	-0.111 -1.274
6	+Y	5			
7	+Y	10			
8	+Y	15			
9	-X	15			
10	-X	10			
11	-X	5			
12	-X	0	90.1 0.1	0.461 2.175	0.186 -1.154
13	-Y	0	90.2 0.2	0.076 1.973	0.260 -0.986
14	-Y	5			
15	-Y	10			
16	-Y	15			
17	+X	15			
18	+X	10			
19	+X	5			
20	+X	0	90.1 -0.1	-0.269 1.901	0.240 -1.134
21	+Y	0	90.1 -0.1	0.100 2.096	-0.134 -1.128
22	+Y	5			
23	+Y	10			
24	+Y	15			
25	-X	15			
26	-X	10			
27	-X	5			
28	-X	0	90.2 +0.2	0.428 2.158	0.215 -1.144
29	-Y	0	90.2 +0.2	0.065 1.96	0.626 -0.984
30	-Y	5			
31	-Y	10			
32	-Y	15			

Recorded by G. Troyer
for ARA DCD, Johnson

Error

An error occurred while processing this page. See the system log for more details.

INCLINOMETER POSITION TRACKING

SSP SPIRAL TEST

12/10/98

STEP	TEST JIG POSITION		SMARTLEVEL	CPP			Bull's Eye	
	Radial X y	Angle	Inclination	Depth (ft)	X Inclination	Y Inclination	Radial	Displacement (ft)
1	0 +	0	90.0	10.26	-.012	-.004	-157	.002
2	90 +	0	90.1	20.55	.330	-.321	-45.85	.082
3	90 +	5	85.1	30.86	.556	4.36	77.8	.744
4	135 - +	5	85.1	41.19	-2.61	3.31	103.3	1.36
5	180 -	5	85.0	51.4	-3.84	0.476	125.5	1.73
6	225 - -	5	85.1	61.82	-2.67	-2.81	148.7	1.74
7	270 -	10	80.0	72.13	0.351	-9.35	-150.8	1.63
8	315 + -	10	80.0	82.45	6.701	-7.15	-95.8	2.10
9	0 +	10	80.0	92.76	9.324	-0.648	-56.1	2.66
10	45 + +	10	80.0	103.1	6.88	5.86	-22.7	2.95
11	90 +	15	75.4	113.4	0.646	13.61	25.59	3.15
12	135 - +	15	75.3	123.7	-9.004	10.15	69.38	3.43
13	180 -	15	75.4	134	-12.71	1.11	108.21	3.58
14	225 - -	15	75.4	144.3	-9.27	-8.72	146.91	3.34
15	225 - -	15	75.6	10.28	-9.226	-8.651	-136.87	2.30
16	180 -	15	75.5	20.57	-12.6	1.076	-160.88	4.21
17	180 -	15	75.5	30.87	-12.59	1.075	-169.31	6.39
18	180 -	15	75.5	41.1	-12.58	1.079	-173.41	8.63

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Data set name Z10D9806C.DAT (STEPS 1-14)

CPP/Bullseye data recorded by J. T. Trapp 12/10/98

STEPS (15-19) Z10D9807C.DAT

19 135 - + 15 75.4 51.49 - 8.62 10.32 174.99 10.18

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STEP	INCLINATION	RADIAL	DEPTH	DEVIATION	STEP TIP MOVEMENT	CARTESIAN TIP	CALCULATED	OBSERVED
#	(o)	(o)	(ft)	(ft)	X (ft)	Y (ft)	BULLS-EYE TIP	BULLS-EYE TIP
							RADIAL (o)	VECTOR (ft)
							RADIAL (o)	VECTOR (ft)
0							0.00	
1	0.0	0.0	10.26	0.00	0.00	0.00	0.00	203.00
2	359.9	90.0	20.55	-0.02	0.00	-0.02	270.00	314.15
3	4.9	90.0	30.86	0.88	0.00	0.88	90.00	77.80
4	4.9	135.0	41.19	0.88	-0.62	-0.62	112.77	103.30
5	5.0	180.0	51.40	0.89	-0.89	-1.51	135.52	125.50
6	4.9	225.0	61.82	0.89	-0.63	-2.14	158.20	148.70
7	10.0	270.0	72.13	1.79	-1.79	-2.14	203.53	209.20
8	10.0	315.0	82.45	1.79	-1.27	-0.88	248.29	264.20
9	10.0	0.0	92.76	1.79	1.79	0.91	292.57	303.90
10	10.0	45.0	103.10	1.80	1.27	2.18	336.92	337.30
11	14.6	90.0	113.40	2.60	0.00	2.18	37.33	25.59
12	14.7	135.0	123.70	2.61	-1.85	0.34	84.54	69.38
13	14.6	180.0	134.00	2.60	-2.60	-2.26	122.75	108.21
14	14.6	225.0	144.30	2.60	-1.84	-4.10	157.72	146.91
15								3.34
16								
17								
18								
19								
20								

COMMENTS:

ACCEPTABLE

RADIAL VECTOR

157.72° ± 15

4.43' ± 12.53

SIMULATED
INCLINOMETER DEPLOYMENTDATE: 12/10/98
TIME:SENSOR: SSP (TEST 1)
FILE: Z10D9806C.DAT

SENSOR: SSP (TEST 2)
 FILE: Z10D9807C.DAT

SIMULATED
 INCLINOMETER DEPLOYMENT

DATE: 12/10/98
 TIME: _____

STEP #	INCLINATION (o)	RADIAL (o)	DEPTH (ft)	DEVIATION (ft)	STEP TIP MOVEMENT		CARTESIAN TIP		CALCULATED		OBSERVED	
					X (ft)	Y (ft)	X (ft)	Y (ft)	BULLS-EYE TIP		BULLS-EYE TIP	
									RADIAL (o)	VECTOR (ft)	RADIAL (o)	VECTOR (ft)
0												
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14							0.00	0.00				
15	14.4	225	10.28	2.56	-1.81	-1.81	-1.81	-1.81	45.00	2.56	223.13	2.30
16	14.5	180	20.57	2.58	-2.58	0.00	-4.38	-1.81	22.41	4.74	199.12	4.21
17	14.5	180	30.87	2.58	-2.58	0.00	-6.96	-1.81	14.55	7.19	190.69	6.39
18	14.5	180	40.10	2.31	-2.31	0.00	-9.27	-1.81	11.03	9.45	186.59	8.63
19	14.6	135	51.49	2.87	-2.03	2.03	-11.30	0.22	178.87	11.31	174.99	10.18
20												

COMMENTS:

ACCEPTABLE RADIAL 178.9° ± 15° ✓
 VECTOR 11.31' ± 0.45' X

Error

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Appendix 3. MSP Soil Moisture/Resistivity Tests

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Appendix 4. XRF Test Data

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3. XRF Test Spectra.....239

Appendix 4. XRF Test Data

1. Log of XRF Test Spectra

2/26 Q Am²⁴¹

CHN	304.34	396.82	1406.9
KeV	13.95	17.77	59.58
FWHM	.38	.39	.34
FWFM	.59	.63	.51
GROSS	13205	11808	623
NET	9981	8647	398

LIVE 225 Real 257.7

PX2T GAIN 1.20 GATE TO BUSY on TRIM
RTD ON

X90226b BASELINE - No SOURCE
AI sample Holder

No GRASS Observed

SENSOR/UMBILICAL MALFUNCTION

X90226c Background

Cd source IN AI sample Holder

No spectra at first. Reset PX2T →

No spectra. Fooled w/ Umbilical connectors
Collection started

SENSOR/UMBILICAL MALFUNCTION
WSE

X90226 d Baseline (Recollect b)

X90226 e Check ~~Source~~ Std
Live 225 Real

CHN	162.93	223.85	273.97	390.64
KeV	8.09	10.61	12.69	17.52
FWHM	.51	.54	.42	.59
FWFM	.80	.83	.98	.97
Gross	88298	71046	80001	149228
Net	40394	33036	41248	80902

X 90226 f SPEX MIX 1000

X 90226 g 240 Sapphire Blank

X90226 h Soil Blank 1

X90226 i 500 URANIUM B1

X90226 j 1000 URANIUM A1

X90226 k Soil Blank 2

X90226 l 500 URANIUM B2

X90226 m 1000 U in Soil A2

X90226 n Soil Blank 3

X90226 o 500 U in Soil B3

X90226 p 1000 U in Soil A3

X90226 q Sapphire Blank

X90226 r 50 Mo in Sapphire

X90226 s 100 Mo in Sapphire

X90226 t 200 Mo in Sapphire

X90226 u NIST 694

X90226 v NIST 1633a

X90226 w NIST 2704

X90226 x NIST 2710

X90226 y NIST 2711

X90226 z Check Std.

CHN	162.9	223.74	273.88	390.49
KeV	8.09	10.61	12.69	17.51
FWHM	0.50	0.55	0.62	0.61
FWFM	0.78	0.85	0.95	0.97
Gross	90268	72008	80164	150384
Net	40471	33608	40937	81877

LIVE 225 Real 325.4

X 90226 aa Baseline (No source)

X90226 ab Am²⁴¹

CHN	304.03	396.26	1403.3
KeV	13.93	17.75	59.43
FWHM	0.34	0.40	0.46
FWFM	0.56	0.65	0.71
Gross	12538	11487	518
Net	9525	8563	456

Appendix 4. XRF Test Data

2. Standard Data Sheets

8/14/98

XRF CHECK SPECIMEN

X-RAY MIX POWDER	19.1371 g	CHEMPLEX INDUSTRIES
CuO	.5020	
PbO	.2182	
MoO ₃	.1618	
	<hr/> 20.0191	

CuO → Cu	⇒ x .79884 =	0.4010 g Cu	2.003 %
PbO → Pb	⇒ x .92831 =	0.2026 g Pb	1.012 %
MoO ₃ → Mo	⇒ x .66653 =	0.1078 g Mo	0.539 %

TWO PELLETS PRESSED @
31 mm Diameter

30 TONS
1 MINUTE DWELL
2 MINUTE BLEED

PELLET A	9.998 g
PELLET B	5.248 g

X-RAY ENERGIES

Cu	K α	8.04 keV
	K β	8.9
Pb	L α	10.5
	L β	12.6
Mo	K α	17.4
	K β_1	19.61
Ag	K α	22.10

200 ppm Mo in Al_2O_3

10.0023	g	GDF 240 GRIT SAPPHIRE POLISHING COMPOUND
.0020	g	MOLYBDENUM*
<hr/>		
10.0043	g	$\Rightarrow$ 200.9 ppm Mo

* 2 ml of 1005 $\mu g/ml$ Mo in H_2O STANDARD
QCD ANALYSTS 942W15

100 ppm Mo in Al_2O_3

9.9976	g	G.D.F. 240 GRIT SAPPHIRE POLISHING POWDER
.0010	g	MOLYBDENUM*
<hr/>		
9.9986	g	$\Rightarrow$ 100.5 ppm Mo

* 1 ml of 1005 $\mu g/ml$ Mo in H_2O STANDARD
QCD ANALYSTS 942W15

10-07-98 - Prepare a 10 gram Soil Sample and Spike with 1 mL Cr (10 mg/mL ± 0.03 mg)
This will equal ± 1000 ppm. The Calibration of Balance and Pipette will be attach with
Sample along with Certificate of Analysis of standard.

Prepare a 10 gram Saffine powder Sample and Spike with 0.5 mL Mo. (Mo:
= 1005 mg/L ± 50 mg/mL. This will equal ± 500 ppm. The same paper work as above will be
attached to this Sample.

$$\begin{aligned} 50 \text{ ppm Mo } 10 \text{ g} &\Rightarrow 0.0005 \text{ g Mo } 1000 \text{ ppm } 0.0005 \text{ g Mo} \Rightarrow 0.5 \text{ mL} \\ 0.5 \text{ mL of } 1000 \text{ ppm Mo} &\rightarrow 10 \text{ g} \Rightarrow 50 \text{ ppm Mo in Soil} \\ 0.0005 \text{ g Mo} &\rightarrow 10 \text{ g} \Rightarrow 0.005 \text{ wt } \% = 50 \text{ ppm} \end{aligned}$$

Soil wt 10.0007 g added one mL 10,000 ppm Cr
Saffire wt 10.0007 g added 0.5 mL 1,000 ppm Mo

Eppendorf Pipet Calibration (41903) 0.250 mL, 0.254, 0.246, 0.248 = 0.2493 = 99.732
0.500 mL, 0.499, 0.497, 0.4976 = 0.4976 = 99.532

Mettler AT 261 wt set 95.5065244

100 g = 100.0009
50 g = 50.0000
10 g = 10.0001
5 g = 5.0000
0.5 g = 0.5010
0.2 g = 0.1999

Dried Soil Sample @ $\pm 100^\circ$ F for approximately 2 hrs. added Six glass Beads
and shook Sample for a minimum of Two hours. This is the Cr Sample.
The Mo Sample was air dried for 2 hours so there was no visible moisture. Add
Six glass beads and shook for a minimum of Two hours.

Cr Standard = 10,000 ppm ± 300 ppm: Mo Standard = 1005 ppm ± 50 ppm.

Placed Both Standards on TCLP Rotator @ 15.15, 30 RPM. This should mix
the materials fairly well. Standards Removed from TCLP Rotator @ 0800 10/7/98
Rotated for 16 hours and 45.

L.D. LOCKARD 10/7/98

Continued on Page

Read and Understood By

Signed

Date

HNF-4151, Rev 0, Page

Signed

Date

QCD ANALYSTS

environmental science solutions

CERTIFICATE OF ANALYSIS**ELEMENT****MOLYBDENUM****Mo/H₂O**

List ID : 942W15 100ml
Description : 1000ug/ml Mo in H₂O
Lot ID : 7O421W511

The following information is provided for your records. Should you have any questions, please refer to the above referenced lot number.

Starting Material used to prepare this standard:

Ammonium Molybdate	Lot #	: 42W-511J
(NH ₄) ₆ Mo ₇ O ₂₄ ·H ₂ O	Purity	: 99.999%
	TMI	: Aggregate Impurities less than 10ppm

The standard was stoichiometrically prepared using electronic grade acids, 18 megohm double de-ionized water, Class A glassware and packaged in pre-cleaned bottles.

Assay via Classical Wet Chemical Method: Gravimetry. NIST SRM 333.

The resulting solution standard was verified on ICP at 202.030nm.

Actual Assay of Standard: 1005ug/ml (+/-50ug/ml)

NIST Traceability: SRM 3134 Mo Spectrometric Solution.

Certificate : COA425 Expiration: 30 DEC 1998

PO# : WBS-UBD-A40187

Date : OCT 23 1997

By: JOSE E. ALFANO

JOHN E. ALFANO, SENIOR CHEMIST

10-07-98 - Prepare a 10 gram Soil Sample and Spike with 1 mL Cr ($10,000 \text{ ppm} \pm 300 \text{ ppm}$)
This will equal $\pm 1000 \text{ ppm}$. The Calibrations of Balance and Pipette will be attached with
Sample along with Certificate of Analysis of standard.

Prepare a 10 gram Safflower powder Sample and spike with 0.5 mL Mo ($1005 \text{ ppm} \pm 50 \text{ ppm}$). This will equal $\pm 50 \text{ ppm}$. The same paper work as above will be
attached to this Sample.

$$\begin{aligned} 50 \text{ ppm Mo } 10 \text{ g} &\Rightarrow 0.0005 \text{ g Mo } 1000 \text{ ppm } 0.0005 \text{ g Mo} \Rightarrow 0.5 \text{ mL} \\ 0.5 \text{ mL of } 1000 \text{ ppm Mo} &\rightarrow 10 \text{ g} \Rightarrow 50 \text{ ppm Mo in Soil} \\ 0.0005 \text{ g Mo} &\rightarrow 10 \text{ g} \Rightarrow 0.005 \text{ wt } \% = 50 \text{ ppm} \end{aligned}$$

Soil wt 10.0007 g added one mL 10,000 ppm Cr
Safflower wt 10.0007 g added 0.5 mL 1,000 ppm Mo

Eppendorf Pipette Calibration (41963) 0.250 mL, 0.254, 0.246, 0.248 = 0.2493 = 99.73%
0.500 mL, 0.499, 0.497, 0.4976 = 0.4976 = 99.53%

Met/let. At 261 wt set 95.5065244

$$100 \text{ g} = 100.0009$$

$$50 \text{ g} = 50.0000$$

$$10 \text{ g} = 10.0001$$

$$5 \text{ g} = 5.0000$$

$$0.5 \text{ g} = 0.5000$$

$$0.2 \text{ g} = 0.1999$$

Dried Soil Sample @ $\pm 100^\circ \text{F}$ for approximately 2 hrs. added Six glass Beads
and shook Sample for a minimum of Two hours. This is the Cr Sample.

The Mo Sample was air Dried for 2 hours as there was no visible moisture. add
Six glass beads and shook for a minimum of Two hours.

Cr Standard = 10,000 ppm $\pm 300 \text{ ppm}$; Mo Standard = 1005 ppm $\pm 50 \text{ ppm}$.

Placed Both Standards on TCLP Rotator @ 15.15, 30 RPM. This should mix
the materials fairly well. Standards Removed from TCLP Rotator @ 0800 10/
Rotated for 16 hours and 45.

L.D. LOCKARD 10/17/98

Continued on Page

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Date

Signed

HNF-4151, Rev 0, Page

Date

CAT. NO. 10M 12-7

Certificate of Analysis

Chromium as Cr⁺⁶

Lot # 707634

<u>Source</u>	<u>Source Purity</u>	<u>Matrix</u>	<u>Density g/mL @ 21°C</u>	<u>Standard Concentration</u>
10 Potassium Dichromate	99.998%	H ₂ O	1.0171	10.00 ± 0.03 mg/mL

This spectrometric standard solution has been prepared from high-purity reference materials. Subboiled high-purity acid has been used to place the materials in solution and to stabilize the standard. The matrix is 18 megaohm deionized water. The reference materials have been assayed by optical emission spectrometry and atomic absorption spectrometry and are certified to contain less than 20 µg/g total impurities.

The standard has been prepared gravimetrically by weighing the reference material to 5 significant figures. Volumetric glassware has been calibrated gravimetrically to 5 significant figures.

The Standard Concentration has been certified by spectrometric analysis against an independent source which is traceable to National Institute of Standards and Technology, Standard Reference Material No. 3112.

This standard is valid for one year from the shipping date provided the solution is kept tightly capped and stored under normal laboratory conditions.

Theodore C. Rains
President

MSDS ATTACHED

Optical Emission and X-Ray Spectroscopy Standards

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- Qualitative standards
- Semi-quantitative standards
- OES/XRF

SPEX offers a variety of qualitative and semi-quantitative standards for emission and x-ray spectroscopy that can be used to obtain dependable results in analyses ranging from qualitative to truly quantitative.

SPEX-Mixes are mixtures of elements used as spiking standards. Spikes are added to samples so that trace elements may be determined semi-quantitatively by the method of standard additions. SPEX-Mixes are available for the 49 common elements, 16 rare earth elements and the 10 noble elements.

Our 1010 Element Kit is very useful as a spike via the method of standard additions. The kit contains separate vials of the 49 individual common elements found in our blended SPEX-Mix. Individual packaging affords greater flexibility for the spectroscopist desiring better sample control or the advantage of single-element spiking.

As a further convenience to the spectroscopist, SPEX offers a series of diluted powder standards. Here the combination of elements used in the SPEX-Mixes are supplied and pre-diluted,

in either four, five or seven specific concentrations: in either graphite powder or lithium carbonate base. This series of diluted powder standards is helpful for the analysis of elements in an unknown where the levels of both the principal and contaminant elements are sought.

When analyzing common elements in an unknown, for example, a serial dilution with graphite powder followed by a comparison of the spectra with the four-step G Standard or the seven-step G-7 Standard containing 0.1% indium internal standard is recommended.

A lithium carbonate base, rather than graphite, will enhance sensitivity in the determination of rare earth containing unknowns. Dilutions performed in SPEX high-purity lithium carbonate can be burned and compared to the spectra of the seven-step Rare Earth L-7 Standard, which is diluted in Li_2CO_3 .

Time-Saver Standards speed the semi-quantitative analysis of relatively pure materials. A set of Time-Saver Standards consists of a blank and five steps (a series of diluted powders) spiked with a SPEX-Mix. Optical emission and x-ray spectroscopists will appreciate the ease and convenience of a Time-Saver. No longer will you have to tediously prepare each powder dilution in your calibration process. SPEX does it for you. You can depend on superior semi-quantitative results using our prepared standards. Choose from a select stock base, or we can customize a Time-Saver series for you.

SPEX-Mixes

SPEX-Mix spiking standards are added to samples so that trace elements may be determined semi-quantitatively by the method of known additions.

SPEX-Mix 1000 Series contains 1.27% each of the following 49 common elements:

Ag, Al, As, B, Ba, Be, Bi, Br, Ca, Cd, Ce, Cl, Co, Cr, Cs, Cu, F, Fe, Ga, Ge, Hg, I, In, K, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Rb, Sb, Se, Si, Sn, Sr, Ta, Te, Th, Ti, U, V, W, Zn, Zr.
CATALOG# 1000-2 SPEX-Mix, 2 grams
CATALOG# 1000-10 SPEX-Mix, 10 grams

Rare Earth SPEX-Mix 1030 Series contains 5.28% each of the following 16 elements:

Ce, Dy, Er, Eu, Gd, Ho, La, Lu, Nd, Pr, Sc, Sm, Tb, Tm, Y, Yb.
CATALOG# 1031-2 Rare Earth SPEX-Mix, 2 grams
CATALOG# 1031-10 Rare Earth SPEX-Mix, 10 grams

Noble Metal SPEX-Mix 1040 Series contains 9.32% each of the following 10 elements:

Au, Ga, Hf, In, Ir, Pd, Pt, Re, Rh, Ru.
CATALOG# 1041-1 Noble Metal SPEX-Mix, 1 gram
CATALOG# 1041-5 Noble Metal SPEX-Mix, 5 grams

Element Kits

The 1010 and 1030 Element Kits contain separate containers of compounds included in the respective SPEX-Mix (2 grams each). Use for quantitative, semi-quantitative and qualitative spectrochemical analysis. Replacements are available as indicated.

CATALOG# 1010	Common Element Kit, 49 elements, 2 grams
CATALOG# 1011-XX	(Specify Element)—Replacement elements for 1010K Kit
CATALOG# 1030	Rare Earth Element Kit, 16 elements, 2 grams

National Institute of Standards & Technology

Certificate of Analysis

Standard Reference Material 694

Western Phosphate Rock

This Standard Reference Material (SRM) is intended for use in validating analytical methods and in calibrating instruments used in the analysis of phosphate rock, fertilizers, and similar materials. A unit consists of 90 g of < 150 μm (100 mesh) powdered material.

The certified concentrations of the constituents and their uncertainties are listed in Table 1. These concentrations are the mean concentrations calculated from the interlaboratory analyses of the material; except for uranium, the uncertainties represent two standard deviations of these means.

Table 1. Certified Concentrations of Constituents

Constituent	Concentration, ¹ Wt %*	Constituent	Concentration, ¹ Wt %
Al ₂ O ₃	1.8 $\pm$ 0.1	MnO	0.0116 $\pm$ 0.0012
CaO	43.6 $\pm$ 0.4	Na ₂ O	0.86 $\pm$ 0.04
CdO	0.015 $\pm$ 0.003	P ₂ O ₅	30.2 $\pm$ 0.1
F	3.2 $\pm$ 0.1	SiO ₂	11.2 $\pm$ 0.4
Fe ₂ O ₃	0.79 $\pm$ 0.06	U	0.01414 $\pm$ 0.00006 ² <i>A little</i>
K ₂ O	0.51 $\pm$ 0.02	V ₂ O ₅	0.31 $\pm$ 0.07
MgO	0.33 $\pm$ 0.02		

¹Based on a minimum sample size of 0.5 g dried at 105 °C for 2 h.

²The uncertainty of the uranium concentration is greater than two standard deviations of the mean and includes an allowance for systematic error.

*Wt % = mg/kg $\times 10^{-4}$

This certification is valid for five years from date of shipment from NIST. Should it be invalidated before then, purchasers will be notified by NIST.

Statistical evaluation of the data was done by R.C.Paulc, NIST National Measurement Laboratory.

This Certificate of Analysis has undergone editorial revision to reflect program and organizational changes at NIST and at the Department of Commerce. No attempt was made to reevaluate the certificate values or any technical data presented on this certificate.

The technical and support aspects involved in the preparation, certification, and issuance of this SRM were coordinated through the Standard Reference Materials Program by R. Alvarez. Revision of this certificate was coordinated through the Standard Reference Materials Program by J.S. Kanc.

Gaithersburg, MD 20899
September 27, 1993
(Revision of certificate dated 7-21-84)

(over)

Thomas E. Gills, Acting Chief
Standard Reference Materials Program

ADDITIONAL INFORMATION ON THE COMPOSITION

The constituents listed in Table 2 are not certified but are included for information only.

Table 2. Noncertified Concentrations of Constituents

Constituent	Concentration, Wt %
Cr_2O_3	(0.10)
TiO_2	(0.11)
ZnO	(0.19)

PREPARATION, TESTING, AND ANALYSIS

The material for this SRM came from the Dry Valley Ridge in Southeastern Idaho and was provided by Beker Industries Corp., Conda, ID, through the courtesy of N.K. Christensen. At NIST, the material was screened and that portion passing through a 150 μm (100 mesh) sieve was retained. The retained material was then blended and bottled.

Homogeneity testing was performed by A. Marlow and P.A. Pella, NIST Inorganic Analytical Research Division, using X-ray fluorescence spectrometry.

Analyses were performed in the following laboratories:

Beker Industries Corp., Conda, ID, N.K. Christensen.

Cominco, Kimberley Fertilizer Operations, Kimberley, B.C., Canada, K.J. McKenzie.

FMC, Phosphorus Chemicals Div., Pocatello, ID, C.D. Holmes.

Intermountain Analytical Services, Inc., Pocatello, ID, G.R. Pattie.

Monsanto Co., Soda Springs, ID, G.W. George.

National Institute of Standards and Technology, Gaithersburg, MD, J.W. Gramlich, L.A. Machlan, A. Marlow, and P.A. Pella.

Western Cooperative Fertilizers Ltd., Calgary, Alberta, Canada, J.A. Simala.

J.R. Simplot Co., Helm Plant, Helm, CA, L.S. Boyer.

J.R. Simplot Co., Pocatello, ID, G. Esplin.

J.R. Simplot Co., Minerals and Chemical Div., Pocatello, ID, J.R. Felkey.

Stauffer Chemical Co., Leco, WY, J. Linford.

Trace Elements (liquid and solid forms)

SRM	1632b	1633a	1634b	1635	1643c	1646	1648	2689	2690	2691	2704
Type	Coal (Bituminous)	Coal Fly Ash	Fuel Oil	Coal (Subbitum- inous)	Water	Estu- rine Sediment	Urban Particu- late	Coal Fly Ash	Coal Fly Ash	Coal Fly Ash	Buffalo River Sediment
Unit Size	55 g	75 g	100 mL	75 g	950 mL	75 g	2 g	30 g	30 g	30 g	50 g
ELEMENT	Concentrations are in mg/kg, unless noted by a single asterisk, *, for Wt. %, a double asterisk, **, for µg/kg, or a dagger, †, for µg/L.										
Aluminum	0.855 *	14.3 *	(16)	(0.32 *)	114.6 †	6.25 *	3.42 *	12.94 *	12.35 *	9.81 *	6.11 *
Antimony	(0.24)	6.8		(0.14)		(0.4)	(45)				3.79
Arsenic	3.72	145	0.12	0.42	82.1 †	11.6	115				23.4
Barium	67.5	(0.15 *)	(1.3)		49.6 †		(737)	(0.08 *)	(0.65 *)	(0.66 *)	414
Beryllium		(12)			23.2 †	(1.5)					
Bismuth					(12 †)						
Bromine	(17)						(500)				(7)
Cadmium	0.0573	1.00		0.03	12.2 †	0.36	75				3.45
Calcium	0.204 *	1.11 *	(15)		36800 †	0.83 *		2.18 *	5.71 *	18.45 *	2.60 *
Carbon	78.11 *										3.348 *
Cerium	(9)	(180)		(3.6)		(80)	(55)				(72)
Cesium	(0.44)	(11)				(3.7)	(3)				(6)
Chlorine	(1260)						(0.45 *)				(<0.01)
Chromium	(11)	196	(0.7)	2.5	19.0 †	76	403				135
Cobalt	2.29	(46)	(0.32)	(0.65)	23.5 †	10.5	(18)				14.0
Copper	6.28	118		3.6	22.3 †	18	609				98.6
Europium	(0.17)	(4)		(0.06)		(1.5)	(0.8)				(1.3)
Gallium		(58)		(1.05)							(15)
Germanium						(1.4)					
Hafnium	(0.43)	(8)		(0.29)			(4.4)				(8)
Hydrogen	5.07 *										
Indium							(1.0)				
Iodine							(20)				(2)
Iron (Total)	0.759 *	9.4 *	31.6	0.239 *	106.9 †	3.35 *	3.91 *	9.32 *	3.57 *	4.42 *	4.11 *
Lanthanum	(5.1)						(42)				(29)
Lead	3.67	72.4	(2.8)	1.9	35.5 †	28.2	0.655 *				161
Lithium	(10)				16.5 †	(49)					(50)
Magnesium	0.0383 *	0.455 *			9450 †	1.09 *	(0.8 *)	0.61 *	1.53 *	3.12 *	1.20 *
Manganese	12.4	179	0.23	21.4	35.1 †	375	(860)	(0.03 *)	(0.03 *)	(0.02 *)	555
Mercury		0.16	(<0.001)			0.063					1.44
Molybdenum	(0.9)	(29)			104.3 †	(2.0)					
Nickel	6.10	127	28	1.74	60.6 †	32	82				44.1
Nitrogen	1.56 *										
Phosphorus						0.054 *		0.10 *	0.52 *	0.51 *	0.0998 *
Potassium	0.0748 *	1.88 *			(2300 †)	(1.4 *)	1.05 *	2.20 *	1.04 *	0.34 *	2.00 *
Rubidium	5.05	131			11.4 †	(87)	(52)				(100)
Samarium	(0.87)						(4.4)				(6.7)
Scandium	(1.9)	(40)		(0.63)		(10.8)	(7)				(12)
Selenium	1.29	10.3	0.18	0.9	12.7 †	(0.6)	27				(1.1)
Silicon	(1.4 *)	22.8 *				(31 *)		24.06 *	25.85 *	16.83 *	29.08 *
Silver					2.21 †		(6)				
Sodium	0.0515 *	0.17 *	(90)	(0.24 *)	12190 †	(2.0 *)	0.425 *	0.25 *	0.24 *	1.09 *	0.547 *
Strontium	(102)	830			263.6 †			(0.07 *)	(0.20 *)	(0.27 *)	(130)
Sulfur	1.89 *	(0.18 *)	2.80 *	0.33 *		(0.96 *)	(5 *)		0.15 *	0.83 *	(0.4) *
Tellurium					(2.7 †)	(0.5)					
Thallium		5.7			(7.9 †)	(0.5)					1.2
Thorium	1.342	24.7		0.62		(10)	(7.4)				(9.2)
Titanium	0.0454 *	(0.8 *)		(0.02 *)		(0.51 *)	(0.40 *)	0.75 *	0.52 *	0.90 *	0.457 *
Tungsten	(0.48)						(4.8)				
Uranium	0.436	10.2		0.24			5.5				3.13
Vanadium	(14)	297	55.4	5.2	31.4 †	94	140				95
Zinc	11.89	220	3.0	4.7	73.9 †	138	0.476 *				438

Values in parentheses are not certified and are given for information only.

National Institute of Standards & Technology

Certificate of Analysis

Standard Reference Material 2704

Buffalo River Sediment

This Standard Reference Material (SRM) is intended primarily for use in the analysis of sediments, soils, or materials of a similar matrix. SRM 2704 is a freeze-dried river sediment that was sieved and blended to achieve a high degree of homogeneity.

The certified elements for SRM 2704 are given in Table 1. The values are based on measurements using two or more independent and reliable analytical methods. Noncertified values for a number of elements are given in Table 2 as additional information on the composition. The noncertified values should not be used for calibration or quality control. Analytical methods used for the characterization of this SRM are given in Table 3 along with analysts and cooperating laboratories. All values (except for carbon) are based on measurements using a sample weight of at least 250 mg. Carbon measurements are based on 100 mg samples.

Notice and Warnings to Users: This certification is valid for 5 years from the shipping date. Should any of the certified values change before the expiration of the certification, purchasers will be notified by NIST.

Stability: This material was radiation sterilized (^{60}Co) at an estimated minimum dose of 2.8 megarads to reduce the rate of any biodegradation. However, its stability has not been rigorously assessed. NIST will monitor this material and will report any substantive changes in certification to the purchaser.

Use: A minimum sample weight of 250 mg (dry weight - see Instructions for Drying) should be used for analytical determinations relating to the certified values on this certificate.

Sample preparation procedures should be designed to effect complete dissolution. If volatile elements (i.e., Hg, As, Se) are to be determined, precautions should be taken in the dissolution of SRM 2704 to avoid volatilization losses.

Statistical consultation was provided by S.B. Schiller and K.R. Eberhardt of the Statistical Engineering Division.

The overall direction and coordination of the analyses were under the chairmanship of M.S. Epstein and B.I. Diamondstone of the Inorganic Analytical Research Division.

The technical and support aspects involved in the preparation, certification, and issuance of this Standard Reference Material were coordinated through the Standard Reference Materials Program by T.E. Gills.

Gaithersburg, MD 20899

July 9, 1990

(Revision of certificate dated 6-1-88)

William P. Reed, Acting Chief
Standard Reference Materials Program

(over)

Instructions for Drying: When nonvolatile elements are to be determined, samples should be dried for 2 hours at 110 °C. Volatile elements (i.e., Hg, As, Se) should be determined on samples as received; separate samples should be dried as previously described to obtain a correction factor for moisture. Correction for moisture is to be made to the data for volatile elements before comparing to the certified values. This procedure, which was used for the certification of volatile elements, ensures that these elements are not lost during drying. The approximate weight loss on drying has been found to be 0.8%.

Source and Preparation of Material: The river sediment for this SRM was collected from the Buffalo River in the area of the Ohio Street Bridge, Buffalo, N.Y. The U.S. Army Corps of Engineers, under contract to NIST, collected and screened approximately 908 kg of river sediment and placed it in six 55-gallon, Teflon-lined drums. The drums were loaded onto a refrigerated truck and transported to the Technimed Corporation, Fort Lauderdale, FL for freeze-drying of the contents. The freeze-dried sediment was shipped to an NIST contractor's laboratory where it was screened and passed through a 100 mesh sieve (nominal sieve opening of 150 μm) and retained on a 400 mesh sieve (nominal sieve opening of 38 μm). The sieved sediment was returned to NIST, radiation sterilized, blended, and bottled into 50-g units.

Analysis: The homogeneity of the bottled units was assessed using x-ray fluorescence spectrometry. Duplicate one gram samples from 8 randomly selected bottles were analyzed for the following elements: Al, Si, K, Ca, Ti, Fe, Zn, Sr, P, Mn, Rb, and Zr. No statistically significant differences in the composition of samples within or between bottles were observed relative to the uncertainty of the XRF measurements, which is less than 0.4%. Sample inhomogeneity of about 4% for lead was observed in measurements on 250 mg samples by thermal-ionization isotope dilution mass spectrometry. Sample inhomogeneity for lead is reflected in the uncertainty limits placed on the certified value for lead.

Table 1. Certified Values

Element	Wt. %	Element	Wt. %
Aluminum	6.11 $\pm$ 0.16	Phosphorus	0.0998 $\pm$ 0.0028
Calcium	2.60 $\pm$ 0.03	Potassium	2.00 $\pm$ 0.04
Carbon	3.348 $\pm$ 0.016	Silicon	29.08 $\pm$ 0.13
Iron	4.11 $\pm$ 0.10	Sodium	0.547 $\pm$ 0.014
Magnesium	1.20 $\pm$ 0.02	Sulfur	0.397 $\pm$ 0.004
		Titanium	0.457 $\pm$ 0.018

Element	$\mu\text{g/g}$	Element	$\mu\text{g/g}$
Antimony	3.79 $\pm$ 0.15	Manganese	555 $\pm$ 19
Arsenic	23.4 $\pm$ 0.8	Mercury	1.47 $\pm$ 0.07
Barium	414 $\pm$ 12	Nickel	44.1 $\pm$ 3.0
Cadmium	3.45 $\pm$ 0.22	Selenium	1.12 $\pm$ 0.05
Chromium	135 $\pm$ 5	Thallium	1.06 $\pm$ 0.07
Cobalt	14.0 $\pm$ 0.6	Uranium	3.13 $\pm$ 0.13
Copper	98.6 $\pm$ 5.0	Vanadium	95 $\pm$ 4
Lead	161 $\pm$ 17	Zinc	438 $\pm$ 12
Lithium	47.5 $\pm$ 4.1		

Certified Values and Uncertainty: The certified values are weighted means of results from two or more analytical methods. The weights for the weighted means were computed according to the iterative procedure of Paule and Mandel (NBS Journal of Research 87, 1982, pp. 377-385). Each uncertainty is obtained from a 95% prediction interval plus an allowance for systematic error among the methods used. The allowance for systematic error is equal to the greatest difference between the weighted mean (certified value) and the component means for the analytical methods used. In the absence of systematic error, the resulting uncertainty limits will cover the concentration of approximately 95% of all samples of this SRM having a minimum size of 250 mg.

Table 2. Noncertified Values

<u>Element</u>	<u>Content, Wt. %</u>	<u>Element</u>	<u>Content $\mu\text{g/g}$</u>
Chlorine	(<0.01)	Bromine	(7)
		Cerium	(72)
		Cesium	(6)
		Dysprosium	(6)
		Europium	(1.3)
		Gallium	(15)
		Hafnium	(8)
		Iodine	(7)
		Lanthanum	(29)
		Lutetium	(0.6)
		Rubidium	(100)
		Scandium	(12)
		Samarium	(6.7)
		Strontium	(130)
		Tin	(9.5)
		Thorium	(9.2)
		Ytterbium	(2.8)
		Zirconium	(300)

Noncertified Values: Noncertified values are provided for information only. An element concentration value may not be certified, if a bias is suspected in one or more of the methods used for certification, or if two independent methods are not available. Certified values for some of these elements may eventually be provided in a revised certificate when more data is available.

National Institute of Standards & Technology

Certificate of Analysis

Standard Reference Material® 2710

Montana Soil

Highly Elevated Trace Element Concentrations

This Standard Reference Material (SRM) is intended primarily for use in the analysis of soils, sediments, or other materials of a similar matrix. SRM 2710 is a highly contaminated soil that was oven-dried, sieved, and blended to achieve a high degree of homogeneity. A unit of SRM 2710 consists of 50 g of the dried material.

The certified elements for SRM 2710 are given in Table 1. The values are based on measurements using one definitive method or two or more independent and reliable analytical methods. Noncertified values for a number of elements are given in Table 2 as additional information on the composition. The noncertified values should not be used for calibration or quality control. Analytical methods used for the characterization of this SRM are given in Table 3 along with analysts and cooperating laboratories. All values (except for carbon) are based on measurements using a sample weight of at least 250 mg. Carbon measurements are based on 100 mg samples.

NOTICE AND WARNINGS TO USERS

Expiration of Certification: This certification of SRM 2710 is valid, within the measurement uncertainties specified, until 01 July 2015, provided the SRM is handled in accordance with instructions given in this certificate (see Instructions for Use). This certification is nullified if the SRM is damaged, contaminated, or modified.

Maintenance of SRM Certification: NIST will monitor this SRM over the period of its certification. If substantive technical changes occur that affect the certification before the expiration of this certificate, NIST will notify the purchaser. Return of the attached registration card will facilitate notification.

Stability: This material is considered to be stable; however, its stability has not been rigorously assessed. NIST will monitor this material and will report any substantive changes in certification to the purchaser.

Instructions for Use: A minimum sample weight of 250 mg (dry weight - see Instructions for Drying) should be used for analytical determinations to be related to the certified values on this Certificate of Analysis.

To obtain the certified values, sample preparation procedures should be designed to achieve complete dissolution. If volatile elements (i.e., Hg, As, Se) are to be determined, precautions should be taken in the dissolution of SRM 2710 to avoid volatilization losses.

The technical and support aspects involved in the original preparation, certification, and issuance of this SRM were coordinated through the Standard Reference Materials Program by T.E. Gills and J.S. Kane. Revision of this certificate was coordinated through the Standard Reference Materials Program by B.S. MacDonald.

Gaithersburg, MD 20899

Certificate Issue Date: 28 October 1997*

30 Oct 92 (original certificate date); 23 Aug 93 (addendum added); 15 Aug 97 (numerical value revised)

*This revision reports editorial changes only

Thomas E. Gills, Chief

Standard Reference Materials Program

SRM 2710

Page 1 of 5

Statistical consultation was provided by S.B. Schiller of the NIST Statistical Engineering Division.

The overall direction and coordination of the analyses were under the chairmanship of M.S. Epstein and R.L. Waters, Jr., of the NIST Analytical Chemistry Division.

Instructions for Drying: When nonvolatile elements are to be determined, samples should be dried for 2 h at 110 °C. Volatile elements (i.e., Hg, As, Se) should be determined on samples as received; separate samples should be dried as previously described to obtain a correction factor for moisture. Correction for moisture is to be made to the data for volatile elements before comparing to the certified values. This procedure ensures that these elements are not lost during drying. The weight loss on drying has been found to be in the range of 1.7% to 2.3%.

Source and Preparation of Material: The U.S. Geological Survey (USGS), under contract to the NIST, collected and processed the material for SRM 2710. The soil was collected from the top 10 cm (4 in) of pasture land located at Longitude 112° 47' and Latitude 46° 01' along Silver Bow Creek in the Butte, Montana area. The site is approximately nine miles east of the local Anaconda plant and 6.5 miles south of settling ponds that feed the creek. The creek periodically floods, depositing sediment with high concentrations of copper, manganese, and zinc at the collection site. The material was shoveled from a 6.1 m x 6.1 m (20 ft x 20 ft) area into polyethylene bags in cardboard cartons for shipment to the USGS laboratory for processing.

The material was spread on 30.5 cm x 61 cm (1 ft x 2 ft) polyethylene-lined drying trays in an air drying oven and dried for three days at room temperature. The material was then passed over a vibrating 2 mm screen to remove plant material, rocks, and large chunks of aggregated soil. Material remaining on the screen was deaggregated and rescreened. The combined material passing the screen was ground in a ball mill to pass a 75 µm screen and blended for 24 h. Twenty grab samples were taken and measured for the major oxides using x-ray fluorescence spectrometry and for several trace elements using inductively coupled plasma atomic emission analysis to provide preliminary assessment of the homogeneity of the material prior to bottling. The material was bottled into 50 g units and randomly selected bottles were taken for the final homogeneity testing.

Analysis: The homogeneity, using selected elements in the bottled material as indicators, was assessed using x-ray fluorescence spectrometry and neutron activation analysis. In a few cases, statistically significant differences were observed, and the variance due to material inhomogeneity is included in the overall uncertainties of the certified values. The estimated relative standard deviation for material inhomogeneity is less than 2% for those elements for which homogeneity was assessed.

Certified Values and Uncertainties: The certified values are weighted means of results from two or more independent analytical methods, or the mean of results from a single definitive method, except for mercury. Mercury certification is based on cold vapor atomic absorption spectrometry used by two different laboratories employing different methods of sample preparation prior to measurement. The weights for the weighted means were computed according to the iterative procedure of Paule and Mandel [1] (NBS Journal of Research 87, 1982, pp. 377-385). The stated uncertainties include allowances for measurement imprecision, material variability, and differences among analytical methods. Each uncertainty is the sum of the half-width of a 95% prediction interval and includes an allowance for systematic error among the methods used. In the absence of systematic error, a 95% prediction interval predicts where the true concentrations of 95% of the samples of this SRM lie. The certified values were corroborated by analyses from nine Polish laboratories cooperating on the certification under the direction of T. Plebanski and J. Lipinski, Polish Committee for Standardization, Measures, and Quality Control. The Polish laboratory work was supported by the Maria Skłodowska-Curie Joint Fund.

Table 1. Certified Values

Element	Mass Fraction (in %)	Element	Mass Fraction (in mg/kg)
Aluminum	6.44 ± 0.08	Antimony	38.4 ± 3
Calcium	1.25 ± 0.03	Arsenic	626 ± 38
Iron	3.38 ± 0.10	Barium	707 ± 51
Magnesium	0.853 ± 0.042	Cadmium	21.8 ± 0.2
Manganese	1.01 ± 0.04	Copper	2950 ± 130
Phosphorus	0.106 ± 0.015	Lead	5532 ± 80
Potassium	2.11 ± 0.11	Mercury	32.6 ± 1.8
Silicon	28.97 ± 0.18	Nickel	14.3 ± 1.0
Sodium	1.14 ± 0.06	Silver	35.3 ± 1.5
Sulfur	0.240 ± 0.006	Vanadium	76.6 ± 2.3
Titanium	0.283 ± 0.010	Zinc	6952 ± 91

Noncertified Values: Noncertified values are provided for information only. An element concentration value is not certified if a bias is suspected in one or more of the methods used for certification, or if two independent methods are not available.

Table 2. Noncertified Values

Element	Mass Fraction (in %)	Element	Mass Fraction (in mg/kg)
Carbon	3	Bromine	6
		Cerium	57
		Cesium	107
		Chromium	39
		Cobalt	10
		Dysprosium	5.4
		Europium	1
		Gallium	34
		Gold	0.6
		Hafnium	3.2
		Holmium	0.6
		Indium	5.1
		Lanthanum	34
		Molybdenum	19
		Neodymium	23
		Rubidium	120
		Samarium	7.8
		Scandium	8.7
		Strontium	330
		Thallium	1.3
		Thorium	13
		Tungsten	93
		Uranium	25
		Ytterbium	1.3
		Yttrium	23

National Institute of Standards & Technology

Certificate of Analysis

Standard Reference Material 2711

Montana Soil

Moderately Elevated Trace Element Concentrations

This Standard Reference Material (SRM) is intended primarily for use in the analysis of soils, sediments, or oil materials of a similar matrix. SRM 2711 is a moderately contaminated soil that was oven-dried, sieved, and blended to achieve a high degree of homogeneity. A unit of SRM 2711 consists of 50 g of the dried material. The certified elements for SRM 2711 are given in Table 1. The values are based on measurements using definitive method or two or more independent and reliable analytical methods. Noncertified values for a number of elements are given in Table 2 as additional information on the composition. The noncertified values should not be used for calibration or quality control. Analytical methods used for the characterization of this SRM are given in Table 3 along with analysts and cooperating laboratories. All values (except for carbon) are based on measurements using a sample weight of at least 250 mg. Carbon measurements are based on 100-mg samples.

NOTICE AND WARNINGS TO USERS

Expiration of Certification: This certification is valid for 5 years from the date of shipment from NIST. Should any of the certified values change before the expiration of the certification, purchasers will be notified by NIST. Return of the attached registration card will facilitate notification.

Stability: This material is considered to be stable, however, its stability has not been rigorously assessed. NIST will monitor this material and will report any substantive changes in certification to the purchaser.

Use: A minimum sample weight of 250 mg (dry weight - see Instructions for Drying) should be used for analytical determinations to be related to the certified values on this Certificate of Analysis.

To obtain the certified values, sample preparation procedures should be designed to effect complete dissolution of volatile elements (i.e., Hg, As, Se) are to be determined, precautions should be taken in the dissolution of SRM 2711 to avoid volatilization losses.

Statistical consultation was provided by S.B. Schiller of the NIST Statistical Engineering Division.

The overall direction and coordination of the analyses were under the chairmanship of M.S. Epstein and R. Walters, Jr., of the NIST Inorganic Analytical Research Division.

The technical and support aspects involved in the preparation, certification, and issuance of this SRM were coordinated through the Standard Reference Materials Program by T.E. Gills and J.S. Kane.

Gailthersburg, MD 20899
August 23, 1993
Revision of certificate dated 10-30-93

Thomas E. Gills, Acting Chief
Standard Reference Materials Program

(over)

Instructions for Drying: When nonvolatile elements are to be determined, samples should be dried for 2 h at 110 °C. Volatile elements (i.e., Hg, As, Se) should be determined on samples as received; separate samples should be dried as previously described to obtain a correction factor for moisture. Correction for moisture is to be made to the data for volatile elements before comparing to the certified values. This procedure ensures that these elements are not lost during drying. The approximate weight loss on drying has been found to be in the range of 1.5 to 2.2%.

Source and Preparation of Material: The U.S. Geological Survey (USGS), under contract to the NIST, collected and processed the material for SRM 2711. The material is an agricultural soil collected in the till layer (upper 15.2 cm (6 in)) of a wheat field. The soil from a 3.05 m x 3.05 m (10 ft x 10 ft) area was shoveled into 0.114 m³ (3 gal) plastic pails for shipment to the USGS laboratory for processing.

The material was spread on 30.5 cm x 61 cm (1 ft x 2 ft) polyethylene-lined drying trays in an air drying oven and dried for three days at room temperature. The material was then passed over a vibrating 2 mm screen to remove plant material, rocks, and large chunks of aggregated soil. Material remaining on the screen was deaggregated and rescreened. The combined material passing the screen was ground in a ball mill to pass a 74 µm screen and blended for 24 h. Twenty grab samples were taken and measured for the major oxides using x-ray fluorescence spectrometry and for several trace elements by using inductively coupled plasma atomic emission analysis to provide preliminary assessment of the homogeneity prior to bottling. The material was bottled into 50 g units; a randomly selected bottles were taken for the final homogeneity testing.

Analysis: The homogeneity, using selected elements in the bottled material as indicators, was assessed using x-ray fluorescence spectrometry and neutron activation analysis. In a few cases, statistically significant differences were observed, and the variance due to material inhomogeneity is included in the overall uncertainty of the certified value. The estimated relative standard deviation is less than 3% for those elements for which homogeneity was assessed.

Certified Values and Uncertainties: The certified values are weighted means of results from two or more analytical methods, or the mean of results from a single definitive method, except for mercury. Mercury certification is based on cold vapor atomic absorption spectrometry used by two different laboratories employing different methods of sample preparation prior to measurement. The weights for the weighted means were computed according to the iterative procedures of Paule and Mandel (NBS Journal of Research 87, 1982, pp. 373-385). The stated uncertainty includes allowances for measurement imprecision, material variability, and differences among analytical methods. Each uncertainty is the sum of the half-width of a 95% prediction interval and includes an allowance for systematic error among the methods used. In the absence of systematic error, a 95% prediction interval predicts where the true concentrations of 95% of the samples of this SRM lie. The certified values were corroborated by analyses from nine Polish laboratories cooperating on the certification under the direction of T. Plebanski and J. Lipinski, Polish Committee for Standardization Measures, and Quality Control. The Polish laboratory work was supported by the Maria Skłodowska-Curie Joint Fund.

-2-

Table 1. Certified Values

<u>Element</u>	<u>wt. %</u>		<u>Element</u>	<u>µg/g</u>	
Aluminum	6.53	± 0.09	Antimony	19.4	± 1.8
Calcium	2.88	± 0.08	Arsenic	105	± 8
Iron	2.89	± 0.06	Barium	726	± 38
Magnesium	1.05	± 0.03	Cadmium	41.70	± 0.25
Phosphorus	0.086	± 0.007	Copper	114	± 2
Potassium	2.45	± 0.08	Lead	1162	± 31
Silicon	30.44	± 0.19	Manganese	638	± 28
Sodium	1.14	± 0.03	Mercury	6.25	± 0.19
Sulfur	0.042	± 0.001	Nickel	20.6	± 1.1
Titanium	0.306	± 0.023	Selenium	1.52	± 0.14
			Silver	4.63	± 0.39
			Strontium	245.3	± 0.7
			Thallium	2.47	± 0.15
			Vanadium	81.6	± 2.9
			Zinc	350.4	± 4.8

Noncertified Values: Noncertified values, shown in parentheses, are provided for information only. An element concentration value may not be certified, if a bias is suspected in one or more of the methods used for certification or if two independent methods are not available. Certified values for some of these elements will eventually be provided in a revised certificate when more data is available.

Table 2. Noncertified Values

<u>Element</u>	<u>wt. %</u>	<u>Element</u>	<u>µg/g</u>
Carbon	(2)	Bromine	(5)
		Cerium	(69)
		Cesium	(6.1)
		Chromium	(47)
		Cobalt	(10)
		Dysprosium	(5.6)
		Europium	(1.1)
		Gallium	(15)
		Gold	(.03)
		Hafnium	(7.3)
		Holmium	(1)
		Indium	(1.1)
		Iodine	(3)
		Lanthanum	(40)
		Molybdenum	(1.6)
		Neodymium	(31)
		Rubidium	(110)
		Samarium	(5.9)
		Scandium	(9)
		Thorium	(1.0)

Appendix 4. XRF Test Data

3. XRF Test Spectra

x90226a

Counts

Acquired: 2/27/1999 10:47:54 AM
File: C:\User\x90226a.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 257.70 s. Live Time: 225.00 s.
Channels: 2048

x90226a

Acquired: 2/27/1999 10:47:54 AM
File: C:\User\x90226a.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 257.70 s. Live Time: 225.00 s.
Channels: 2048

x90226c

Acquired: 2/26/1999 11:12:17 AM
File: C:\User\x90226c.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 282.54 s. Live Time: 225.00 s.
Channels: 2048

x90226c

Acquired: 2/26/1999 11:12:17 AM
File: C:\User\x90226c.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 282.54 s. Live Time: 225.00 s.
Channels: 2048

x90226d

Acquired: 2/26/1999 11:19:38 AM
File: C:\User\x90226d.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 258.42 s. Live Time: 225.00 s.
Channels: 2048

x90226d

Acquired: 2/26/1999 11:19:38 AM
File: C:\User\x90226d.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 258.42 s. Live Time: 225.00 s.
Channels: 2048

x90226e

Acquired: 2/26/1999 - 11:26:53 AM
File: C:\User\X90226e.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 322.12 s. Live Time: 225.00 s.
Channels: 2048

x90226e

Acquired: 2/26/1999 11:26:53 AM
File: C:\User\x90226e.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 322.12 s. Live Time: 225.00 s.
Channels: 2048

x90226f

Acquired: 2/26/1999 11:39:18 AM
File: C:\User\X90226f.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 350.56 s. Live Time: 225.00 s.
Channels: 2048

x90226f

Acquired: 2/26/1999 11:39:18 AM
File: C:\User\x90226f.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 350.56 s. Live Time: 225.00 s.
Channels: 2048

x90226h

Acquired: 2/26/1999 12:09:28 PM
File: C:\User\x90226h.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 291.74 s. Live Time: 225.00 s.
Channels: 2048

x90226h

Acquired: 2/26/1999 12:09:28 PM
File: C:\User\x90226h.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 291.74 s. Live Time: 225.00 s.
Channels: 2048

x90226i

Acquired: 2/26/1999 12:15:58 PM
File: C:\User\x90226i.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 292.14 s. Live Time: 225.00 s.
Channels: 2048

Acquired: 2/26/1999 12:15:58 PM
File: C:\User\x90226i.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 292.14 s. Live Time: 225.00 s.
Channels: 2048

x90226j

Acquired: 2/26/1999 12:22:41 PM
File: C:\User\x90226j.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 290.04 s. Live Time: 225.00 s.
Channels: 2048

x90226j

Acquired: 2/26/1999 12:22:41 PM
File: C:\User\x90226j.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 290.04 s. Live Time: 225.00 s.
Channels: 2048

x90226k

Acquired: 2/26/1999 12:28:55 PM
File: C:\User\x90226k.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 286.60 s. Live Time: 225.00 s.
Channels: 2048

X90226K

Acquired: 2/26/1999 12:28:55 PM
File: C:\User\X90226K.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 286.60 s. Live Time: 225.00 s.
Channels: 2048

x90226l

500 ppm U (B2)

Acquired: 2/26/1999 12:34:51 PM
File: C:\User\x90226l.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 286.92 s. Live Time: 225.00 s.
Channels: 2048

x902261

Acquired: 2/26/1999 12:34:51 PM
File: C:\User\x902261.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 286.92 s. Live Time: 225.00 s.
Channels: 2048

x90226m

Acquired: 2/26/1999 12:41:01 PM
File: C:\User\x90226m.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 286.42 s. Live Time: 225.00 s.
Channels: 2048

x90226m

Acquired: 2/26/1999 12:41:01 PM
File: C:\User\x90226m.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 286.42 s. Live Time: 225.00 s.
Channels: 2048

x90226n

Acquired: 2/26/1999 12:47:12 PM
File: C:\User\x90226n.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 289.08 s. Live Time: 225.00 s.
Channels: 2048

x90226n

Acquired: 2/26/1999 12:47:12 PM
File: C:\User\x90226n.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 289.08 s. Live Time: 225.00 s.
Channels: 2048

x90226o

Acquired: 2/26/1999 12:52:47 PM
File: C:\User\x90226o.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 292.22 s. Live Time: 225.00 s.
Channels: 2048

x90226o

Acquired: 2/26/1999 12:52:47 PM
File: C:\User\x90226o.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 292.22 s. Live Time: 225.00 s.
Channels: 2048

x90226p

Acquired: 2/26/1999 12:58:40 PM
File: C:\User\x90226p.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 292.34 s. Live Time: 225.00 s.
Channels: 2048

x90226p

Acquired: 2/26/1999 12:58:40 PM
File: C:\User\x90226p.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 292.34 s. Live Time: 225.00 s.
Channels: 2048

x90226q

Acquired: 2/26/1999 1:05:33 PM
File: C:\User\x90226q.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 290.26 s. Live Time: 225.00 s.
Channels: 2048

x90226q

Acquired: 2/26/1999 1:05:33 PM
File: C:\User\x90226q.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 290.26 s. Live Time: 225.00 s.
Channels: 2048

x90226r

50 ppm Mo / SAPPHIRE

Counts

Acquired: 2/26/1999 1:13:10 PM
File: C:\User\x90226r.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 292.88 s. Live Time: 225.00 s.
Channels: 2048

x90226r

Counts

Acquired: 2/26/1999 1:13:10 PM
File: C:\User\x90226r.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 292.88 s. Live Time: 225.00 s.
Channels: 2048

x90226s

Acquired: 2/26/1999 1:20:23 PM
File: C:\User\x90226s.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 293.00 s. Live Time: 225.00 s.
Channels: 2048

x90226s

Acquired: 2/26/1999 1:20:23 PM
File: C:\User\x90226s.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 293.00 s. Live Time: 225.00 s.
Channels: 2048

x90226t

Acquired: 2/26/1999 1:26:32 PM
File: C:\User\x90226t.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 292.72 s. Live Time: 225.00 s.
Channels: 2048

x90226t

Acquired: 2/26/1999 1:26:32 PM
File: C:\User\X90226t.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 292.72 s. Live Time: 225.00 s.
Channels: 2048

x90226u

Acquired: 2/26/1999 1:33:27 PM
File: C:\User\x90226u.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 291.24 s. Live Time: 225.00 s.
Channels: 2048

x90226u

Acquired: 2/26/1999 1:33:27 PM
 File: C:\User\x90226u.chn
 Detector: #65538 MSPDAS MCB 2

Real Time: 291.24 s. Live Time: 225.00 s.
 Channels: 2048

x90226v

Acquired: 2/26/1999 1:40:57 PM
File: C:\User\x90226v.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 293.86 s. Live Time: 225.00 s.
Channels: 2048

x90226v

NIST 1633a

Acquired: 2/26/1999 1:40:57 PM
File: C:\User\x90226v.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 293.86 s. Live Time: 225.00 s.
Channels: 2048

x90226w

NIST 2704

Acquired: 2/26/1999 1:47:26 PM
File: C:\User\x90226w.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 293.72 s. Live Time: 225.00 s.
Channels: 2048

x90226w

Acquired: 2/26/1999 1:47:26 PM
File: C:\User\x90226w.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 293.72 s. Live Time: 225.00 s.
Channels: 2048

x90226x

Acquired: 2/26/1999 1:55:01 PM
File: C:\User\X90226x.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 296.92 s. Live Time: 225.00 s.
Channels: 2048

x90226x

Acquired: 2/26/1999 1:55:01 PM
File: C:\User\X90226x:chn
Detector: #65538 MSPDAS MCB 2

Real Time: 296.92 s. Live Time: 225.00 s.
Channels: 2048

x90226y

Acquired: 2/26/1999 2:00:57 PM
File: C:\User\X90226y.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 294.84 s. Live Time: 225.00 s.
Channels: 2048

x90226y

Acquired: 2/26/1999 2:00:57 PM

File: C:\User\X90226y.chn

Detector: #65538 MSPDAS MCB 2

Real Time: 294.84 s. Live Time: 225.00 s.

Channels: 2048

x90226z

Acquired: 2/26/1999 2:08:18 PM
File: C:\User\X90226z.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 325.46 s. Live Time: 225.00 s.
Channels: 2048

x90226z

Acquired: 2/26/1999 2:08:18 PM
File: C:\User\x90226z.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 325.46 s. Live Time: 225.00 s.
Channels: 2048

x90226aa

Counts

Acquired: 2/26/1999 2:20:38 PM

Real Time: 262.30 s. Live Time: 225.00 s.

File: C:\User\x90226aa.chn

Channels: 2048

Detector: #65538 MSPDAS MCB 2

x90226ab

Counts

10 μ Ci Am-241

Acquired: 2/26/1999 2:26:26 PM
File: C:\User\x90226ab.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 264.10 s. Live Time: 225.00 s.
Channels: 2048

x90226ab

10 μ Ci Am-241

Acquired: 2/26/1999 2:26:26 PM
File: C:\User\x90226ab.chn
Detector: #65538 MSPDAS MCB 2

Real Time: 264.10 s. Live Time: 225.00 s.
Channels: 2048

Appendix 5. Gamma Test Data

Final Quality Control Data Sheet

Detector Information

Date: 5/20/98

Customer name: Applied Research

Type of unit: 3E12/1B

Serial number: 052098A

Det (051898A) 2kg 6/30/98

INSTALLED IN
LOCATION H-4
★ 8/26/98

Measurement Data

Source: Cs137 Energy 662 KeV Source Position: side on

Source to crystal: 1 inches Resolution 7.6 %

PMT Type: R1924 Manufacturer Hamamatsu Serial Number RC6314

Voltage setting: 732 volts

Notes: _____

Technician KW

Alpha Spectra Inc. has a limited warranty on this scintillation detector. Please call for details.

email: fjwxtals@alphaspectra.com, home page www.alphaspectra.com

Final Quality Control Data Sheet

Detector Information

Date: 5/12/98
Customer name: Applied Research Assoc.
Type of unit: 3E12/1B
Serial number: 051298A

Measurement Data

Source: Cs137 Energy 662 KeV Source Position: end on
Source to crystal: 2 inches Resolution 8.7 %
PMT Type: R1924 Manufacturer Hamamatsu Serial Number RC6660
Voltage setting: 683 volts

Notes: _____

Technician FW

Alpha Spectra Inc. has a limited warranty on this scintillation detector. Please call for details.

General Response of the Cone Penetrometer Multi-sensor Gamma Probe

Soil Calibration efforts show an approximate detection limit for a 5 minute acquisition of 3-5 pCi/gm for cesium-137 and Cobalt-60. These values are based on Hanford soil background spectral regions of interest and common basis as referenced to LA Currie.

High data rate performance measurements were performed over a range of 5000 to 38000 counts per second input and corresponding instrument dead times of 7 to 35%.
Reduction in high energy gamma data recovery (Tl-208 @2614 keV) was not noticeable.

At an input count rate of 38000 cps and assuming Cs137 as the predominant nuclide, a value of soil source containing .13 uCi/gm is measurable. It is estimated that this activity could be doubled and still maintain reasonable system operation.

Graphs supporting these comments are attached.

GL Troyer
Numatec Hanford Corporation
March 3, 1999

MSP Gamma Throughput

Th228 @2614 keV

MSP Gamma Point Efficiencies

Cs/Co/Th

CONE PENETROMETER
DEVELOPMENT TESTING
FROM NOTEBOOK WHC-N-425

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PP 82-98
99
10

82

1/26/98 Cone penetrometer pipe in area of multi-sensors.

Wall thickness $\sim 3/8"$ OD $\sim 2"$, ID $\sim 1.4"$

Th²²⁸ button source from Isotope Products active element is 5mm x 3.18mm in a wafer 25.4mm diameter x 3.18mm high (thick) type D disk

1/28/98 Flux estimates based on μ Shield for Cs^{137} sources. Available point source is Amersham 15490 @ $1.25E05Ci$ on 08/01/80. Decayed to date value is $8.3E-6Ci$

μ Shield result for

gives 2.129×10^4 or 21.29 mR/hr

based on flux conversion, this is 16700 gamma/cm²/sec

8/21/78 MSP acceptance testing @ North Carolina.
 XRF source yields too much field in direction of detector. Bill Callaway (BC) postulates need for more shielding.

18" PVC Sche vol est. 4.700 ft³
 add 1/4" each end for PVC end cap gap.

Interior tube is 2 3/8" O.D.

Determination of soil packing.

Average top I.D. = 11 1/8"

Bucket 3/4 full = 48 lbs (49-1 lb bucket)

@ 4" from top unsettled

@ 5" from top settled (tapped)

Weights added to model (lbs)

48
 52
 50
 50
 50
 50
 50
 50
 50
 12
 462 lbs

Density on bucket values

$$\frac{48 \text{ lbs}}{.423 \text{ ft}^3} = 113.4 \text{ lbs/ft}^3$$

$$\frac{8^{3/4}}{13^{3/4}} = .636$$

Ave bucket diameter
 @ 8 3/4 in 10.318"

$$\begin{aligned} \text{bucket vol} &= \left(\frac{10.318}{2} \right)^2 \pi \cdot 8^{3/4} \\ &= \frac{731.6 \cdot 3}{77 \text{ in}} \\ &= .423 \text{ ft}^3 \end{aligned}$$

XRF - Initial operations showed noise from coiled cord on NEM line power supply. Easily corrected by moving cord

BLNKSNO1 spectrum - 2.5 → 6% deadtime 100 seconds

CHKSNO1 test pellet 100secs 17% deadtime

Mo, Pb, Cu, Fe

NIST 694A phosphate std. 400 sec 7%

NIST 2711 Montana soil 300 sec 7%

CS0143A Cs 10, uCi 300 sec 12% 77 KeV @ 662

84 8/22/98 CPT probe disassembled to determine XRF failure

Configuration

AMCADO1 nominally $2.08 \text{ keV} \rightarrow 61.2 \text{ MeV @ } 2047$
 671 $1.99 \text{ keV @ } 31 \times$
 Shaping time 6 BLR = PZ
 Coarse 5 RTD off.
 Fine .5
 AMPTEK gain 1.18

AMCADO2 with RTD enabled suppresses escape peaks

AMCADO3 Shaping time 10, RTD off
 AMPTEK $\frac{6.47}{0.97} \times$ gain

AMCADO4 housing RTD off

AMCADO5 umbilical + housing RTD off
 XRAY .43/22 keV resolution and .5/59 keV

NaI 50.88/683 keV $8.8\% \sim 7.5\% \times$

Required both XRF and NaI spectra using application software simultaneously

Gary T. Ingham
 8/22/98 HNF-4151, Rev 0, Page

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8/23/98 NaI(Tl) test Co Cs Th in

HV = 630

BLK AUTO

Coarse 20

INPUT FRONT/ POSITIVE

Fine ~~11.88~~ 1.18

Shaping Gaussian

Shape 1 μ Sec

Spectrum Clam shell, Cs aligned with XRF window

3CAL01 three source energy calibration Co Cs Th net

(3500 cps) Center channel energy keV Resolution

900 seconds 509.5 662 50.13 keV 7.5%

Deadtime 7% ~~1173~~ 885.01 1173 59.14 keV

1000.32 1333 67.99

1914.56 2614 —

3CAL02

Deadtime driver test Co Cs Th Na²²

(1000 cps)

570.68

662

57.29

400975⁵⁷

900 seconds

881.92

1173

50.23

49299

Deadtime 19%

397.64

571

38.91

331883

Realtime 1109

1924.6

2614

117711⁵⁷

3CAL03

Deadtime driver test Co Cs Th Na²² Ba¹³³

(20000 cps)

opened clam shell to allow closer positioning of

900 seconds

of high activity sources. Maintained

Deadtime 35%

Th²²⁸ source in original position

Realtime 1394

504.17

662

50.25

1228940

394.03

571

38.75

648104

870.44

1173

40.17

7604

1904

2614

—

769

Thorium peak shifted down energy, losing about 30% of peak
 All peaks drifted down energy slightly. (?)

Clam shell reference sources

Cone Penetrometer Calibration Sources

@8/23

isotope	Source id	t1/2 days	lambda d	Birthday	Birth uCi	now	decay days	Value uCi	Dose mR/hr
Th228	433-93-2	698.7598	0.000992	08/15/93	1.006	07/30/98	1810	0.1670	10.3 0.9
Co-60	1U511 ₃₄	1925.233	0.00036	07/21/89	3	07/30/98	3296	0.9155	90.2 0.7
Cs-137	488-35-1	11019.59	6.3E-05	03/01/98	0.9796	07/30/98	151	0.9703	77.0 1.7
Cs-137	488-35-1	11019.59	6.3E-05	03/01/98	0.09603	07/30/98	151	0.0951	9.5 0.5

86

8/23/98

Measurement of intrinsic efficiency for CPT NIST
Source mounted @ 10 inches from centerline of
detector at midpoint

Source Cs^{137} ~10 μCi
383/kg @ 8-1-93
10.35 μCi 1-AUG-93
@ 23-AUG-98, 9.22 μCi

@ 11:30

CSCAL01	Chan	energy	FWHM	N/A
Real 903.96	500.96	662	49.27	28797
Line 900				

@ 11:45

Started Clanshell 3 source again to the suspicion
of serious energy drift.

3CAL04	Chan	energy	FWHM	N/A
Line 908	492.2	662	44.57	107184
Real 965				

Temp 79.5°F = 299°C

Discussion of drift focused and temperature change
as causing a problem. Will run temperature dependence
test.

XRF measurements

XRFCAPO1 1mm B_4C window + 25mCi Cd^{109} + Sn insert
large orifice BLANK
103.80 line 17% dead Temp 255

XRFCAPO2 " XRF Check specimen
124 line 36% Dead temp 255

XRFCAPO3 " NIST 2711
line 109 21% Dead temp 255

XRFCAPO4 No Sn insert BLANK
Line 100 50% Dead temp 255.4

@ 12:50

XRFCAPO5 " XRF Check Specimen no Sn insert
Line 100.68 60% Dead temp 255.2

8/23/98

8/23/98 XRFCAPO6 " NIST 2711- No Sn Incent.
 Line 105 53% lead Temp 255.5
 @13:05 XRFCAPO7 Small orifice Sn Blank
 Line 100 7% lead Temp 255.4
 XRFCAPO8 Small orifice Sn Check specimen
 Line 100.8 20% lead Temp 255.3
 XRFCAPO9 Small orifice Sn NIST 2711
 Line 100 11% lead Temp 255.3

Data Reduction Check specimen

Resolution and efficiency energy

XRFCAPO8 Small Sn Cu e 8.75

XRFCAPO2 Large Sn Cu 8.75

XRFCAPO5 No Sn Cu 8.71

FWHM Peak 7% lead

.46 18169 21% 100 sec 1817

.5 35782 36% 124 290

0.76 20146 60% 100

Data reduction

XRFCAPO9 NIST 2711 0.15" Sn orifice
 Fe 6.94 keV .43 9967 19708 109
 Pb L_a 11.57 .39 2328 10030 109
 Pb 13.74 .41 1898 9733 109

XRFCAPO3
 Fe 6.96 .45 11662 22477 109
 Pb L_a 11.51 .39 2293 9393 109
 Pb 13.75 .28 1702 9287 109

XRFCAPO9 Fe 6.95 .41 7283 11455 141
 Pb L_a 11.50 .37 1385 4809 141
 Pb 13.74 .53 1411 5965 141

8/23/98 @ 1450 CPP/DAS temperature test data
collect 300 sec interval 60 sec 1/ulc Co⁶⁰

time	temp	X-ray
1450	283	
1451	283.1	
1452	283.1	
1453	283.1	244.2
1454	283.0	244.2
1455	283.0	244.2

Data set N

~~209~~

Z 0959601600-0Z

1457 stopped Water cooler
++

Data set

1502	282.9	244.1
1503	283.0	244.3
1504	283.1	244.3
1505	283.2	244.4
1506	283.3	244.4
1507	283.3	244.5

Z 0959601600-0A

1607	301.6	255.4
1608	301.7	255.4
1609	301.7	255.4
1610	301.8	255.4
1611	301.8	255.4
1612	301.8	255.4

Data set

Z 0959601600-0B

1617	301.9	255.5
1618	301.9	255.5
1619	301.9	255.5
1620	301.9	255.5
1621	301.9	255.5

Data set

Z 0959601600-0C

All data to date use temperature correction base of 300.
This means that all spectra were corrected to
this base temperature regardless of actual temperature

1712	317.9	265.1
1713	317.9	265.2
1714	317.4	265.2
1715	317.8	265.1
1716	317.8	265.2
1717	317.7	265.1

Data set

Z 0959601600-0D

time	temp	XRF temp
8/23/98 1718	317.7	265.1
1719	317.6	265.1
1720	317.5	265.0
1721	317.2	265.0
1722	317.0	265.0
1723	316.9	264.9

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Data Set

Z0959601 6000-0 E

A Twox 8/23/98

8/24/98 XRF CAP 10 Small orifice, no B₄C window, Blank
@ 7:45 Deadtime 3-4%, live 100, temp 252.2

@ 7:52 XRF CAP 11 No orifice, no B₄C window, blank
Deadtime 42%, live 105 temp 252.6

@ 7:59 XRF CAP 12 large orifice no B₄C window, blank
Deadtime 42%, live 105 temp 252.253.1

P2 - 0.67
671 fine .63

Note GAZ N
CHANGE
XRFCA P12

Observed clipping of XRF main amp on scope
Changed amp for .47 to .68 units. Clip disappears
for most part but a limited high end chunk appears
on spectrum.

This artifact is alleged to be result of 88KeV Cd¹⁰⁹ photon
that is beyond ROI.

Pulse shape output from AMPTEK amplifier is
significantly different with rise time discriminator (RTD)
enabled

With RTD is more normal pulse expected for
input to 671. However, 671 undershoot not resolved.

8/24/98

Setup/run at N.C. State Univ

Gamma system energy cal off. ^{60}Co peaks shifted up energy sufficient to be out of preset windows.

Shift equivalent to 120/160 channels ^{60}Co , temp 300.1
HV 1628V

Adjusted fine gain to 1.00 then to .990, temp 300.2

11:50 300 seconds at Temp 300.2

3CAL05

line 300	Channel	KeV	Resolution	Net Area
Real	508.26	662	48.28	34889
Deadtime 7%	883.37	1173	57.31	17311
	998.11	1332	62.63	17596
	1900.43	2614	-	528

Performed power cycle on full system, repeat acquire

3CAL06

	570.30	662	48.28	36944
line 300	886.72	1173	60.49	18445
Real	1002.96	1332	71.70	19634
Deadtime 7%	1913.23	2614	-	378
temp 300.2				

$\Delta C / (CAL06 - CAL05) = 2055$; RPD = 5.7%; counting err = .5% 15

XRF

12:15 CHRO1 XRF pressed pellet 256.4

12:23	<u>3CAL07</u>	506.48	662	49.27	36425
	line 300	880.56	1173	53.85	16650
	Dead 7%	996.56	1332	66.02	16747
	temp 300.2	1917.11	2614	2.13	338

temp 300.2 using MSP/DAS program.

12:32 Data set = 09596016001-0A

12:40 Set up for soil background in model 1800 sec @ 300 sec cycle

BKGCAL01 = 09596016001-0B data set.
XRF tape target
Showed very small ^{40}K signal.

AT Target 8/24/98

8/24/98 Post background check source 3CAL08 HNF-4151, Rev. 0, Page 306

@1340	line 300 276	Channel	keV	Resolution	Net area
	Real 300	507.06	662	48.6	31266
	Deadlines 72	881.24	1173	53.56	16367
	Temp 299.2	996.5	1332	65.37	17680
		1899.8	2614	+	351

3.7854 liters = 1 gallon

Power off

Moved probe from dist room to setup room

14:08	temp 300	510	662	59.40	68636
	line 600	886.14	1173	61.17	32510
	<u>Did not save</u>	1002	1332	75.13	35537
		1898.2	2614		421
1420	temp 300.1	503.82	662	49.04	69798
	line 600	876.43	1173	57.6	25588
	<u>3CAL09</u>	991.58	1332	62.63	26386
		1891	2614		768

Adjusted fine gain to ~~1.18~~ ^{*}1.02

1440	temp 300	508.2	662	49.04	72324
	3CAL10	884.02	1173	59.1	36222
	<u>Did not save</u>	999.3	1332	68.9	36655
		1910	2614		1197

1455 3CAL10

	temp 299.9	507.8	662	49.6	70601
	<u>Did not save</u>	882	1173	59.1	34334
		998.3	1332	66.74	35435
		1929	2614		863

1516 3CAL10

	Temp 299.9	506.82	662	46.85	69456
		881.45	1173	57.9	32655
		997.02	1332	64.8	33795
		1924	2614		857

Changed power supplies from ORTEC 478 to Tennessee TC 952A
Set digital voltage display to 630 V
Set fine gain to .985

1535 3CAL11

	Temp 299.8	509.23	662	48.9	70125
		884.3	1173	59	35328
		1001	1332	64.8	38069
		1926	2614		973

8/24/98 1550

3CAL12

508.66

662

50.87

74098

temp 299.8

884.3

1173

59.66

39272

999.97

1332

63.46

35587

1924

2614

1087

1600

3CAL13

508.01

662

49.36

71693

temp 299.9

883

1173

58

35289

999.46

1332

68

36818

1916

2614

713

1615

3CAL14

507.96

662

48.9

71136

temp 299.9

883.3

1173

58.1

34570

998.5

1332

65

35524

1938

2614

999

Rotated source holder ^{90°} counter clockwise

1630

3CAL15

507.3

662

48.04

77660

temp 300.1

882.5

1173

57.17

31940

997.7

1332

67.0

33767

1920.75

2614

913

Rotated source holder 90° counter clockwise (180°)

1644 3CAL16

T = 300.3

506

662

50.2

81656

882

1173

57.8

34189

997.

1332

65.8

34988

1899

2614

707

Rotated source holder 90° counter clockwise to (270°)

1701 3CAL17

T = 300.5

offset 30 mm to top of center of detector

507.5

662

50

57196

883

1173

60.7

28965

999.85

1332

68.12

30677

1923

2614

403

As for 3CAL17, but at center of detector

1719 3CAL18

temp 300.7

508.53

662

51.05

72405

884.2

1173

51.05 57.4

37900

1000.55

1332

67.82

64589 40132

1915

2614

990

1700 XRF data CHKO2 single spectrum tape target

/ J. T. Trogg 8/24/98

8/25/98

Continue performance testing of XRF/WaI

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0915 Powered up with 8/24 settings for all system.

3CAL19	520.39	662	47.44	67122
T=295.6	901.6	1173	55.96	24771
	1022.62	1332	70.83	35340
	1962.53	2614		62

Tested pole zero on XRF 671 amp. Absolutely no apparent effect on high energy clip and pole zero under shoot. See diagram page 89 for reference.

Enabling/Disabling RTD shortens/lengthens the undershoot portion respectively by approx 2X.

Problem could be that 12 μ Sec shaping in AMPTEK is not completely compatible with maximum 10 μ Sec available in 671 amp.

0947 3CAL20	516.99	662	49.52	70127
T=296.2	897.4	1173	56.14	31522
	1016.98	1332	71.56	40300
	1942	2614		168

010:04 3CAL21	515.6	662	50.59	71015
T=296.4	894.6	1173	58.44	33561
	1013.3	1332	74.67	41722
	1933	2614		98

Moved probe to model room fine gain $\rightarrow .977 \rightarrow .975$
 3CAL22 @ amp setting .977
 T=297.2

Amp setting .975 for model measurements.

Pulse shape of AMPTEK PX2T is characterized by long rise and sharp fall.

J. Troop
 8/25/98

8/25/98 Began model measurement, 300 sec, 30 increment
 Use ARA acquisition software. Transl. HV = 630 HNF-4151, Rev. 0, Page 6 = XRF = gamma

	Position (in)	angle	temp X	temp Y	Data set
10:45	0	0	297.8		Z 09596016002-00
10:49	0	120	297.9	256.1	E
10:56	0	240	298.1	256.1	F
"10:03	9	0	298.3	256.3	G
"10:09	9	120	298.4	256.3	I

Note: Data set # was cut off part way into first count.

"10:16	9	240	298.5	256.2	J
"10:23	1218	0	298.6	256.3	K
"10:30	18	120	298.7	256.3	L
"10:37	18	240	298.7	256.3	M
"10:42	27	0	298.8	256.3	N

System temperature correction provided by manually updating software table as needed.

"10:49	27	120	298.8	256.2	O
"10:56	27	240	298.8	256.0	P
12:02	36	0	298.9	256.0	Q
12:07	36	120	298.9	256.0	R
12:13	36	240	299.0	256.1	S

Return to center of model for longer count.
 20 Acquisition 600 sec, cycle 30
 12:18 18 0 299.1 256.0 T

XRF acquisition constant at 300 and 600 seconds per gamma

1238 3CAL23	504.17	662	48.96	36563
T = 299.1	878.14	1173	53.14	13986
	992.89	1332	62.32	15092
	1894.08	2614		250

1245 XRFCHK035 XRF single spectrum tape target
 T = 256.1

1600 XRFCHK06 - energy calibrate XRF Pressed pellet + Am
 T = 255.1

1620 3CAL24 NaI(th) spectrum energy cal for shell energy 900 sec.

New energy calibration
 Thrust 2614 peak very soft 900 counts added 1 count.

507.44	662-662	661.15
882.22	1173-1332	1180.86
997.21	1332	1340
1915.5	2614	2614

8/25/98

8/25/98

Continuation of 3CAL24 to 1800 seconds

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310

95

3CAL26 1800 seconds 3 sources Calibrated to 661.5 → 1332

T=300

3CAL27 600 seconds Cs only

T=300.2

3CAL28 900 sec Th only

T 300.3

3CAL29 600 sec Co only

T 300.4

H. Trough 8/25/98

8/26/98 3CAL30 12 hour count Th only

T 300.1 @ 0830 RT 256.0

line width at 609 was 44.50 indicating that resolution was stable for duration. This indicates there was no energy drift after initial step

3CAL31 600 sec. 3 source New ROI's

T 300.2	510.12	662	60.27	67927
	885.21	1173	65.59	45310
	1001.62	1332	70.97	48065
	1925.59	2614		1302

Setup repeatability test for Gamma/XRF / full connections.

5 minute acq. 1 min cycle, real time

Take clam shell off and put back on each time.

Series Z09596013003-0A G/X

-0B

-0C

-0D

-0E

-0F

-0G

-0H

H. Trough 8/26/98

Estimate of Gamma efficiency (page 83) 462.800 ± 453.57 = 91%
 Base soil mass (462.800 ± 453.57) = 2.0956 x 10⁵ g

Nominal mix of 50 µCi Co⁶⁰ + 50 µCi Cs¹³⁷

$$50 \mu\text{Ci} \times 10^6 \frac{\text{pCi}}{\mu\text{Ci}} \times \frac{1}{2.0956 \times 10^5 \text{ gm}} = 238.6 \text{ pCi/gm Co}^{60}$$

Additional water mass for mix = 3 gal = 25 lb = 11335 gm

total wet

220895 gm	226.3 pCi/gm	wet cpi/pCi/g
0.0303	0.0138	0.0136

average DEF count (30 sec) cps

Co ⁶⁰ 1173	90.72	3.124
Co ⁶⁰ 1332	92.48	3.083
Cs ¹³⁷	205.9	6.86

eff/(cpi/pCi/gm) dry

0.0131	0.0129
--------	--------

Soil Background from data set Z 09596.016 001-08 (page 92)

average

Co ⁶⁰ 1173	22.3	0.07433
Co ⁶⁰ 1332	17.08	0.05694
Cs ¹³⁷	57.2	0.1708

cps

0.04871	0.03278
---------	---------

MDA (cps) @ 4.66 x 10⁵ g

0.07335	0.064202
---------	----------

MDA (pCi/gm) (dry)

5.315	4.721
-------	-------

Temperature information - Data set D/E were sufficiently shifted. Lower energy and fell out of ROI. Hand revision showed proper correlation within temperature range

Temperature

283	1180	1340
302	1150	1310
318	1070	1215

Energy KeV

1173	1332
------	------

Change rate KeV/c -3.14 -3.57

→ This is for maximum data range table.
 see original response
 page 9/98
 9/9/98

9/9/98

Summary of temperature and affect shift.

Temperature test data

Temperature response

Energy shift data showing affect. (Slope generally same)

J. Trough
9/9/98

Fig. 3.1 Emission spectra of NaI(Tl), BGO and CsI(Tl), scaled on maximum emission intensity.

photodiode) and the required window material. Fig. 3.1 and 3.2 show the emission spectrum of some common scintillation materials.

3.6 Temperature influence on the scintillation response

The light output (number of photons per MeV gamma) of most scintillators is a function of temperature. This is caused by the fact that in scintillation crystals, radiative transitions, responsible for the production of scintillation light, compete with non-radiative transitions (no light production). In most scintillation crystals, the light output is quenched (decreased) at higher temperatures. An example of the contrary is the fast component of BaF_2 of which the emission intensity is essentially temperature independent.

Fig. 3.2 Emission spectra of CsI, CsI(Na) and CsI(Tl) scaled on maximum emission intensity. Also a typical quantum efficiency curve of a bi-alkali photocathode is shown.

The scintillation process usually involves as well production, transport and quenching centers. Competition between these three processes each behaving differently with temperature, causes a complex temperature dependence of the scintillation light output. Fig. 3.3 shows the temperature dependence of some common scintillation crystals.

For applications such as oil well logging and space research, where it is very difficult to control the temperature, this dependence should be taken into account. The doped scintillators NaI(Tl), CsI(Tl) and CsI(Na) show a distinct maximum in intensity whereas many undoped scintillators such as BGO show an increase in intensity with decreasing temperature.

From Fig. 3.3 it can be seen that at above 120 °C, NaI(Tl) has the highest light output followed by CsI(Na) and CsI(Tl). For lower temperatures CsI(Na) is a good alternative to NaI(Tl) because it has better mechanical characteristics.

Fig. 3.3 Temperature dependence of the scintillation yield of NaI(Tl), CsI(Na), CsI(Tl) and BGO.

3.7 Which scintillator for your application?

When we observe Table 3.1 carefully, it is clear that none of presently known scintillation crystals possesses all the above mentioned (ideal) characteristics such as high density, fast decay etc. The choice of a certain scintillation crystal in a radiation detector depends strongly on the application. Questions such as :

- What is the energy of the radiation to measure ?
- What is the expected count rate ? and
- What are the experimental conditions (temperature, shock) ?

3/4/99

Soil concentrations for Cs/Co were estimates based on assumed ampule values. Analysis of final soil matrix samples showed overall average values of 213.7 pCi/gm and 159.8 pCi/gm respectively

Average	DEF counts	CPS	eff cps/pCi/gm
Cs ¹³⁷	205.9	6.86	.0321
Co ⁶⁰ ₁₁₇₃	93.72	3.124	.0196
Co ⁶⁰ ₁₃₃₂	92.48	3.083	.0193
TB ²²⁸ ₂₃₂	91.41		

Soil Bkg / MDA (see page 96)

	cps	@ 4.66 $\pm$ 1 BKB, pCi/gm, 300 sec
Cs ¹³⁷	.1708	3.46
Co ⁶⁰ ₁₁₇₃	.07433	3.75
Co ⁶⁰ ₁₃₃₂	.05294	3.31

System throughput.

Based on data from page 85, an estimate of upper performance level can be made:

The spectra 3CAL01/02/03 were used for this calculation. The clamshell was loaded with the 3 sources. Additional sources of low to moderate energy isotopes were added while maintaining the 2614 Th²⁰⁸ gamma activity. As count rate increases, recovery of this peak will reflect total possible throughput.

Ratio of Cs¹³⁷ photpeak area to total is 0.103 or 10%

total cps	% Dead time	2614 ^{Total peak} Count	Count rate equiv Co ¹³⁷ pCi/gm
5219	7	2227	17.8
16639	19	2134	56.9
38184	35	2343	130.6

It is likely that a 2X increase in CPS could be handled.

3/4/99

Appendix 6. MSP Tip and Sleeve Test Data

Error

An error occurred while processing this page. See the system log for more details.

Error

An error occurred while processing this page. See the system log for more details.

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Appendix 7. Standalone Grout Module

QUALIFICATION TEST PLAN

Hanford Tank Initiative Cone Penetrometer Stand Alone Grouting Module

1.0 Purpose

This qualification test plan (QTP) defines the steps required to carry out qualification testing of the stand alone grouting hardware, support systems and procedures prepared to provide hole closure capability for the Hanford Tanks Initiative (HTI) Cone Penetrometer (CP) demonstration task.

2.0 Scope

This plan applies to qualification testing of the hole closure capabilities of the cone penetrometer platform (CPP), stand alone grouting module, support equipment, and required procedures and work instructions.

This qualification testing of HTI CP hole closure (grouting) capability fulfills a requirement of PHMC contract MJG-SLB-A52807 as specified in the associated Statement of Work (HNF-2881, Rev. 1) issued to Applied Research Associates, Inc. (ARA).

The qualification testing of the required CP hole closure capability will be considered complete when ARA has:

1. Provided or made arrangements for all hardware, support systems and materials required to close CP penetrations of 46 m depth made by the 51 mm (2.0 in. OD) diameter probes deployed by the HTI CP platform (CPP).
2. Demonstrated successful closure of a 15 m CP penetration at the Immobilized Low Activity Waste (ILAW) disposal complex.

3.0 Responsibilities

- 3.01 Hanford Tanks Initiative: Prepares QTP and issues for release as a PHMC supporting document. Inspects vendor supplied hardware and documentation for completeness prior to initiation of testing. Witnesses execution of QTP. Maintains test change control by reviewing all proposed deviations of actual operations from the QTP and documenting all actual deviations per QTP Instruction 5.25. Signs off on completion of individual and overall QTP activities. Maintains control of all documentation associated with planning, execution and reporting of these QTP activities.

- 3.02 Applied Research Associates, Inc: Delivers all engineered systems and components required to perform stand alone CP push hole closure. Ensures all other material and supplies required for hole closure are acquired. Operates CPP during grouting operations. Executes grouting QTP as defined.
- 3.03 Waste Management Federal Services, Inc., Northwest Operations (WMFS): Provides a Washington State Liscensed Driller who will observe CP penetration and hole closure activities as required by WAC 173-160. Provides platform support to ARA in performance of grouting operations.

4.0 Safety

- 4.01 All personnel involved with the performance or witnessing of the hole closure qualification testing will be briefed on hazards unique to the cone penetrometer equipment prior to initiation of test activities.
- 4.02 All personnel must read, meet all training requirements, meet all dosimetry requirements, and sign the Job Safety Analysis (JSA) and Radiological Work Permit (RWP) covering operation of HTI CP systems at the ILAW site.
- 4.03 All personnel shall wear substantial foot wear, a hard hat, and safety goggles.
- Personnel working with dry bentonite and cement powder will wear approved respiratory protection. Coveralls and work gloves are recommended for personnel working with wet grout.
- 4.04 Material Safety Data Sheets (MSDS) for materials used in preparation of the grout mixture will be available in the CPP support trailer. These materials include Portland cement, bentonite, and CFR-3 Cement Friction Reducer (Haliburton Energy Services, Duncan, Oklahoma).

5.0 QTP Instructions

5.01 Equipment Requirements

- ✓.01 Dedicated 51 mm (2.0 in.) OD CP Push Pipe String: 50, 1 m joints
- ✓.02 Stand Alone Grouting Module
- ✓.03 Adapter to 51 mm OD CP Push Pipe
- ✓.04 Sacrificial Grout Mini Tips with O-rings
- ✓.05 61 m (200 ft) length of 12.7 mm (1/2 in.) OD by 7.9 mm (5/16 in.) ID Grout Tube
- ✓.06 Diaphragm Pump: ARO Model 666053-388 or equivalent
- ✓.07 Air Compressor with Pressure Regulator: 150 psi capacity

EMGLO 125 psi Capacity

- ✓.08 1.5 m length of 12.7 mm OD by 7.9 mm ID grout tubing
- ✓.09 Grout Supply Bucket: 19 l capacity with hose barb installed near bottom
- ✓.10 60 l Grout Mixing Bucket
- ✓.11 Screen for Filtering Grout Mix
- ✓.12 12 l Grout Transfer Bucket
- ✓.13 Electric Drill with Grout Mixing Paddle

5.02 Material Requirements

- ✓.01 Water Supply: 200 l minimum
- ✓.02 Graduated Bucket for measuring water in gallons
- ✓.03 Scale or container marked for 227 g (1/2 lb) of bentonite.
- ✓.04 Ash Grove Portland Cement: Sufficient for grout mixture.
- ✓.05 Western Bentonite Powder: Sufficient to fill 15 m CP push hole with dry powder.
Sufficient for grout mixture.
- .06 CFR-3 Cement Friction Reducer: Sufficient for grout mixture

5.03 Inspect all grouting equipment supplied and verify supplied equipment and materials are sufficient to allow hole closure of a 46 m, below surface, CP penetration. Record results on Qualification Testing Log Sheet (QT Log) on pages 6-9.

5.04 Verify stand alone grouting system assembled for qualification testing could emplace grout in a 46 m CP push hole. Record results on QT Log.

5.05 Confirm presence of drawings for all engineered, stand alone grouting equipment. Document on QT Log.

5.06 Push a 15 m CP penetration with 51 mm diameter CP push string. With use of expanders on one CP push pipe segment, the final diameter of this push hole will be $\approx$ 58 mm (2.25 in.).

5.07 Record Bore Hole ID#, depth of penetration, and date of penetration on QT Log.

5.08 Fill the test CP push hole with dry bentonite powder by pouring bentonite down the hole after removal of the CP push pipe string until full.

5.09 Record date dry fill was emplaced and volume of dry bentonite poured in CP push hole on QT Log.

5.10 Assemble Stand Alone Grouting equipment and systems as described in ARA hole closure procedure (Attachment A).

- .01 CP push pipe string with grout tube, grout pump, and the grout supply bucket will be deployed on the CP platform.

- .02 Air compressor, grout mixing equipment, and grout materials will be deployed on the ground near the CP platform.
- 5.11 Push assembled, stand alone, grouting push string to bottom of dry filled CP push hole. Record depth on QT Log.
- 5.12 Document any indications that the grouting push string is not tracking the initial CP push hole or that the CP push hole has collapsed on QT Log.
- 5.13 Blow-off sacrificial mini-tip following steps described in ARA hole closure procedure.
- 5.14 Calculate estimated volume of grout required to fill CP push hole using formula provided in ARA procedure. Record calculation on QT Log.
- 5.15 Record hole closure start time on QT Log.
- 5.16 Mix one 23 liter (6 gal) batch of grout following ARA hole closure procedure.
- 5.17 Begin withdrawing push pipe and emplacing grout following ARA hole closure procedure.
- 5.18 When initial volume of grout has been emplaced, note time and length of push pipe withdrawn on QT Log.
- 5.19 Discontinue grout emplacement for 30 minutes.
- NOTE: The 30 minute pause of steps 5.18 and 5.19 may be initiated at removal of closest pipe joint preceding exhaustion of initial batch of grout mixture.
- NOTE: Mixing of the next batch of grout to be emplaced may be carried out during this pause.
- 5.20 Record time of resumption of withdrawal of CP push pipe and grout emplacement on QT Log.
- 5.21 Continue withdrawal of CP push pipe and emplacement of grout until grout module is seen at ground surface.
- 5.22 Record time of completion of grout emplacement and total volume of grout emplaced on QT Log.
- 5.23 Record general observations of grout emplacement on QT Log.
- 5.24 Clean grouting equipment and dispose of excess grout per direction of WMFS personnel.

- 5.25 Document all test plan deviations, any exceptions noted in tested systems, and any anomalous test results on the QT Log.

6.0 Qualification Testing Sign-Off

The following representatives of the Hanford Tank Initiative-Characterization project and Applied Research Associates, Inc. have performed and witnessed the qualification testing of the HTI CP Stand Alone Grouting capability as described in this qualification test plan.

Applied Research Associates, Inc.

<u>Willie Dickerson</u>	<u>Willie Dickerson</u>	<u>10/19/98</u>
Print Name	Signature	Date

_____	_____	_____
Print Name	Signature	Date

Waste Management Federal Services, Inc., Northwest Operations

<u>Robert L. Jones</u>	<u>Robert L. Jones</u>	<u>10/19/98</u>
Washington State Licensed Driller	Signature	Date

_____	_____	_____
Print Name	Signature	Date

Hanford Tank Initiative-Characterization

<u>W.S. CALLAWAY</u>	<u>W.S. Callaway (WSC)</u>	<u>10/19/98</u>
Print Name	Signature	Date

_____	_____	_____
Print Name	Signature	Date

7.0 References

Hanford Tank Initiative, *Preparation and Testing of Cone Penetrometer Deployable Soil Multi-Sensor and Multi-Sample Soil Sampling Probes: Phase II* (HNF-2881, Rev. 1), August 13, 1998.

Applied Research Associates, Inc., *ARA Hanford CPT Procedure for Hole Closure*, Rev. 0, October 5, 1998. [Attachment A]

HTI CP STAND ALONE HOLE CLOSURE QUALIFICATION TESTING LOG SHEET

5.03 Inspection of Grouting Equipment:

Comments: All items listed in 5.01 Present. Item 07 Has ONLY 125 PSI CAPACITY (EMGLO 18HCA-8P). Item 08 is 3/4" OD

Initials: WSC WCD
HTI ARA

5.04 Verification of Tested Grouting System Capability:

Comments: ONLY 20 1m segments were threaded and with grout tube and deployed on platform. SUPPLIED GROUT TUBE IS PROBABLY OF INSUFFICIENT LENGTH To GROUT A 46 m penetration.

Initials: WSC WCD
HTI ARA

5.05 Inspection of Stand Alone Grouting Systems Engineering Drawings:

Comments: WES 428 - ADAPTER ; WES 426 - MODULE ; ARA 0420 DISP. TIP Present

Initials: WSC WCD
HTI ARA

5.07 Grouting Test CP Push Hole:

Bore Hole #: _____ Depth: 52 ft Date: 10/19/98

Comments: Hole Cleared By Pushing 19 PUSH RODS w/ Dummy TIP. GROUT TUBE SEVERLY TWISTED WHEN WITHDRAWN. & 30 cm CUT OFF.
BORE HOLE originally pushed on 1/198 to a depth of

Initials: WSC WCD
HTI ARA

PUSH OF GROUT MODULE

Tip slid out FROM END OF Module & 6 mm as module
cleared guide tube

1 w/EX

2

3 < DRY Bentonite starting to go down w/ string

4

5

6

7

8

9

10

11

12 < VERY EASY PUSH 51.5 Rods

13

14

15

22" OF SEGMENT 16

3 - 10 Push Pressure 45 Klbs

12 - 14 5 25 Klbs

14 - 16 5 40 Klbs

$$\begin{array}{r}
 .2065 \\
 \hline
 52 \\
 \hline
 4130 \\
 10325 \\
 \hline
 107380
 \end{array}$$

HTI CP STAND ALONE HOLE CLOSURE QUALIFICATION TESTING LOG SHEET

5.09 Dry Fill of Test CP Push Hole:

Date Filled: 10/19/98 Volume of Bentonite: 5.2 GALComments: EVEN AFTER Clear-out push with CP to 19m + 22" hole appears to be blocked @ 7-8' depthInitials: WSC WCD RJL
HTI ARA WMFS

5.11 Initial Deployment Depth of CP Grouting Module:

Depth of Grout Module Deployment: 15 full segments + 22" of segment 16Initials: WSC WCD
HTI ARA

5.12 Initial Condition of Test Push Hole:

Observations: Following segment #3 dry bentonite fill began to follow pipe down hole. For segments 3-10 push pressures up to 45 Klbs were noted. Cycling was required. Between segment 12 & 13 an easy push was noted. Between seg. 12-14 pressures of ~25 Klbs were noted, cycling used. Between seg. 14-16 pressures up to 40 Klbs noted, cycling used.

Initials: WSC WCD
HTI ARA

5.14 Calculated Volume of Grout Required to Fill Test 57 mm CP Push Hole:

52 Feet depth X 0.2065 Gal / Foot = 10.738 GallonsComments: NONEInitials: WSC WCD RJL
HTI ARA WMFS

Each batch transferred to CPP Deck ≈ 5.5 Gal.

WITHDRAW

pump speed ≈ 30 chug/min

✓ PARTIAL

✓ 1

✓ 2

✓ 3

54:05 - 55:30

✓ 4

57:15 - 58:35

WM Closing Pressure to pump

Never stops on own accord

13:30 > ✓ 5

< 1st 6 gallons used 12:59
13:00

✓ 6

✓ 7

36:56 - 38:20

✓ 8

13:44 > ✓ 9

14:02 > ✓ 10

< second batch emplaced

✓ 11

✓ 12

08:00 - 10:50 15 seconds pump stat. before & 25 sec. stat. pump after

✓ 13

12:10 - 14:26

14:15 > ✓ 14

14:35 > ✓ 15

< 3rd batch used: $\frac{1}{2}$ batch mixed w/EXPANDERS

→ Pulled module above ground to check grout level
Mixed Pushed back to same level (top of expander section $\approx 6"$ above ground)
Mixed 6 gal grout batch.
Could not get grout to flow
Raised module above ground — still no flow

Tube 100 ft + from bottom seg.
68 ft in pipe 20 @ 41 ft

68.5
12.220
72
100
172

41
20
92

in 5
35
27
125
19.25

HTI CP STAND ALONE HOLE CLOSURE QUALIFICATION TESTING LOG SHEET

GROUT EMPLACEMENT

5.15 Grouting Start Time: 12:25 10/19/985.18 Time at Emplacement of 6 Gallons of Grout: 13:00
Length of Push Pipe Withdrawn: 22" + 4.5655 + 9"5.20 Time of Grouting Restart: 13:305.22 Time of Completion of Grout Emplacement: 14:355.22 Volume of Grout Emplaced: 19.3 galInitials: WSC WCO WMFS
HTI ARA

5.23 General Observations on Grout Emplacement:

Observations: BEGIN w/ MIXING OF 6 Gallons Grout. GROUT Mixing & Transfer
Complete 12:4530 minute hold had no observable effect. 3 6-Gallon grout batches
placed without problems. Maintenance of pump speed at ≈ 30 /sec by
slow withdrawal of pipe and brief ^{WSC} stationary pumping OK.Unable to initiate grout flow for 4th batch even with module completely
at surface due to plugging of grout in grout tube between pump and
grout module.Final 3 gallons poured down hole from bucket.Initials: WSC WCO WMFS
HTI ARA

5.25 Qualification Testing Change Control:

QTP Deviations, Exceptions or Anomalies: • GROUT TUBE only threaded through
20 1m pipe joints - NOT 50. 50 JOINTS ARE AVAILABLE.
• When grout string was pulled after clean-out push, grout
tube was severely twisted and torn at $\approx 8"$ from end. 10-12"
of tube was cut off and discarded.

Bentonite QUIK-GEL[®] (Baroid) Fast Mixing High Viscosity Bentonite

5.25 Qualification Testing Change Control (Continued):

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There is no text or other markings on the paper.

WMFS

ATTACHMENT A

QUALIFICATION TEST PLAN

Hanford Tank Initiative Cone Penetrometer
Stand Alone Grouting Module

Containing

ARA Hanford CPT Procedure for Hole Closure
Revision 0

Prepared by

Applied Research Associates, Inc.

October 5, 1998

Consisting of 7 pages

APPLIED
RESEARCH
ASSOCIATES, INC.

Engineering and Applied Science

HNF-4151-R3-5024-Page 7 REV. 0

HANFORD TANK INITIATIVE
CONE PENETROMETER
VADOSE ZONE
CHARACTERIZATION PROJECT

ARA Hanford CPT Procedure

For

HOLE CLOSURE

Revision 0.0

Approved by: Applied Research Associates, Inc.

Wesley L. Bratton, Ph.D., P.E.

10/5/98
Date

1. Purpose

The purpose of this document is to explain the procedure for hole closure as per regulatory requirements. All holes will be dry filled with bentonite at the completion of a cone penetrometer (CP) test unless immediately filled with wet grout. Holes will be wet filled (grouted) at the discretion of the project geologist based on the data from the multi-sensor probe.

2. Scope

This document covers the use of two wet grouting modules developed by Waterways Experiment Station (WES) to be used during CPT pushes for the HTI project. Figure 1 shows the two grout modules. The first WES grouting module is a standalone unit which attaches directly to the end of a typical CP rod string. Grout is pumped down tubing strung through the rod string as the rods are withdrawn. This method uses a sacrificial mini tip that fits in the end of the module and is held in place by an o-ring. The pressure of an initial flow of water (1-2 gallons typical) expels the tip and allows grout to be pushed into the hole as the rods are withdrawn.

The second unit is designed for use with the Soil Sampler Probe (SSP). This unit fits within the SSP housing in place of the SSP sampler insert following the completion of sampling activities. It allows grout to be pumped down the grouting tube and directly out an opening at the bottom of the rod string. It is not designed to be pushed and does not have a tip.

3. Safety

Material Safety Data Sheets are available in the CPP support trailer located near the CPP. These include Ash Grove Portland Cement (MSDS #11987), Western Bentonite (MSDS #2762), and CFR-3 Cement Friction Reducer.

The only personal protective clothing required is a hard hat and safety goggles. A jumpsuit and work gloves are recommended for working with wet grout.

4. Equipment/Material Requirements:

- Standalone Grouting Module or SSP Grouting Module
- Adapter to 2.0 O. D. rods

- Sacrificial Grout mini tips with O-Rings
- 200' 3/8" Grout tube (150' push depth plus extra for uphole connections)
- 5' 3/8" Grout tube (Uphole grout setup)
- 1/2" Diaphragm Pump (ARO Model 666053-388 or equal)
- 5 Gallon Bucket with hose barb installed near bottom for connection to pump inlet
- 16 Gallon Pail (for mixing grout)
- 3 Gallon Bucket for transferring grout from mix pail to pump
- Screen for filtering grout mix
- Graduated Bucket for measuring water in gallons
- Scale or container marked for 1/2 pounds of bentonite
- 1/2" Electric Drill
- Grout Mixing Paddle for Electric Drill
- 110VAC power for drill
- Air compressor (to Supply Diaphragm Pump) with pressure regulator
- Water Supply
- Portland Cement
- Bentonite Powder
- CFR-3 Cement Friction Reducer

5. Responsibilities

The CPP and the grouting equipment will be operated by ARA operators. Grout volume calculations will be performed and recorded in the Daily Field log sheet and Field Notebook located on the CPP.

6. Procedure

6.1 Assembly uphole grout equipment.

- a) Attach grout supply bucket to inlet of grout pump with 5ft section of grout tubing.
- b) Attach uphole end of the 200ft grout tube to outlet of grout pump.

- c) Attach air compressor to grout pump. Keep valve between compressor and pump closed.
- d) Start air compressor and build pressure to 150psi.

6.2 Assembly of Standalone Grout Module.

- a) Thread grout tubing through push rods.
- b) Place o-ring in o-ring groove of sacrificial tip.
- c) Insert sacrificial tip in end of standalone grout module.

CAUTION: Ensure grout tube is securely attached to barb. A failure of the connection will result in the module and rod string filling with grout.

- d) Attach the grout tube to the barb in the grout module. Push the grout tube completely onto the barb until the barb is completely covered.
- e) Attach standalone grout module to push rod with expanders.
- f) Push the stand alone grout module to the bottom of the hole to be grouted.
- g) Remove sacrificial tip.
 - i. Pour 3 gallons of water (NOT GROUT) into grout supply bucket.
 - ii. Open valve between compressor and pump to pump water to the grout module. Allow pressure to build until pump stops.
 - iii. Slowly retract the push rods (<1cm/sec). The pressure from the water will force the tip out of the module. The pump will start to cycle once the when tip is clear. Close valve on compressor to stop pump.
 - iv. If pump will not start pumping after 6 inches of retracting, the tip is stuck. Retract rod string, inspect tip, and repeat step 5.2.

6.3 Assembly of SSP Grout Module.

- a) Thread grout tubing through SSP inner poles.
- b) Assemble the SSP grout unit as shown in Figure 1b.

CAUTION: Ensure grout tube is securely attached to barb. A failure of the connection will result in the module and rod string filling with grout.

- c) Attach the grout tube to the barb in the grout module. Push the grout tube completely onto the barb until the barb is completely covered.
- d) Lower the SSP grouting module through the rod string and seat in the bottom of the SSP housing. The rod string will already be at depth following sampling activities.

6.4 Calculate the volume of the hole as shown in the equation below. Show calculations and record value in Field Notebook located on CPP.

$$\text{Grout Vol. (Gallons)} = 0.2065 * \text{Penetration Depth in Feet}$$

$$0.2065 = \pi(D/2)^2(7.48\text{gal/ft}^3) \quad D = 2.25\text{in}$$

6.5 Mix grout using the mixture procedure defined in Section 7. Mix grout in batches of 6 gallons.

NOTE: Deep holes will require mixing multiple batches of grout during the grouting procedure. If this is the case, mix additional batches just prior to needing them. Grout will harden if allowed to sit for long periods (approximately 90 minutes).

6.6 Retracting Rods and Grouting.

- a) Pour grout through screen into grout supply bucket.
- b) Turn on the pump. Pump enough grout to fill grout tube. Pump will stop when grout tube is full and it is unable to force any more grout out the tip of the grout module. (Approximately 1.5 gallons.)
- c) Start retracting rods at a rate of about 1cm/sec and monitor the grout supply bucket to make sure an adequate supply is always available. Add grout to bucket as needed.

NOTE: The pressure on the pump should be set to allow hole to fill with minimal settling, but not so high as to create void areas in loose materials outside of the area disturbed by rods during penetration. Previous field experience shows the grout in 150ft of tubing typically produces a grout flow rate of approximately 1 liter per minute. Based upon the 2.25-inch diameter of penetration hole, a pull rate of approximately 1.28 feet/min (0.7cm/sec) will ensure that the hole is filled without voids. Ideal pressure settings will allow the pressure of the grout to build up to the point where the pump does not continue when the rods are not moving. The pump should run approximately 26 strokes/min.

- d) Continue retracting rods and pumping grout. Listen for variations in the speed of the pump. Slow the rate of retraction should the pump speed increase, increase the rate of retract should the pump speed decrease. Pump should maintain a cycle rate close to 26 strokes/minute.

- e) Continue grouting the hole until the grout module is seen at the surface of the ground. Turn off pump by closing valve from the compressor.
- f) Record the amount of grout pumped into hole in the Field Notebook located on CPP.

6.7 Cleaning Equipment and Disposing of Excess Grout.

Cleaning the grouting equipment and disposing of excess grout will be performed by CPO personal following "Cone Penetrometer Cleaning Work Instructions CP-5".

7. Grout Mixing Procedure:

The grout shall be mixed in 6 gallon batches. Multiple batches may be needed for deep holes.

Recipe for 6 gallons of grout:

46 pounds of Portland Cement

1 pounds Bentonite powder

3.5 gallons of clean, potable water

0.5 pounds of CFR-3 Friction Reducer

- a) Measure water and pour in mixing bucket.
- b) Slowly add dispersant and thoroughly mix with drill mixer.
- c) Add Bentonite slowly and continue mixing.
- d) Add Portland Cement and continue mixing until all cement has been added.
- e) Place screen over pump pail.
- f) Transfer grout from mixing pail by pouring through screen.

Figure 1b. Stand Alone Grout Module and SSP Grout Module.
Ensure grout tubing is properly connected to barb.

4.0 End of Document

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