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ENGINEERING DATA TRANSMITTAL

Page 1 of 1

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Characterization	JS Schofield	NA
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See attached acceptance test procedure for the Surface Moisture Measurement System for your approval.		NA
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1	1	Cog.Eng. N/A	John Schofield	1/25/96	S7-12	DB Graves	Dennis Graves	1/23/96	L6-37	1	1
1	1	Cog. Mgr. JS Schofield	John Schofield	1/25/96	S7-12	M Gimera	Michael Gimera	1/23/96	L6-37	1	1
1	1	QA ML McElroy	M.L. McElroy	1/25/96	S1-07	JH Bussell	J.H. Bussell	1/28/96	L6-38	1	1
1	1	Safety LS Krogsrud	L.S. Krogsrud	1/24/96	R3-08	WT Watson	W.T. Watson	1/23/96	H0-38	1	1
1	1	~~Env.~~ JR THIELGES	J.R. Thielges	1/30/96	L6-38	PB Deibler/bohrer	P.B. Deibler		S7-12	4	4
1	1	Proj. Eng. GF Vargo Jr	G.F. Vargo	1/25/96	H5-09	TI Stokes	T.I. Stokes	1/23/96	L6-37	1	1
1	1	Proj. Mgr. CE Hanson	C.E. Hanson	1/24/96	H5-09	DP NIEBUHR	D.P. Niebuhr	1/30/96	S7-63	1	1

18.	19.	20.	21. DOE APPROVAL (if required) Ctrl. No.
G.A. Ritter 1/23/96 Signature of EDT Originator / Date	G.T. Dukelow 2/1/96 Authorized Representative for Receiving Organization / Date	J.S. Schofield 1/25/96 Cognizant Manager / Date	[] Approved [] Approved w/comments [] Disapproved w/comments

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Surface Moisture Measurement System Hardware Acceptance Test Procedure

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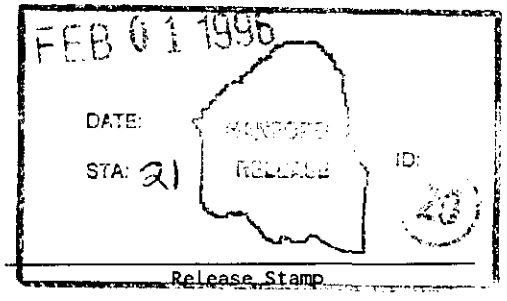
Abstract: The purpose of this acceptance test procedure is to verify that the mechanical and electrical features of the Surface Moisture Measurement System are operating as designed and that the unit is ready for field service. This procedure will be used in conjunction with a software acceptance test procedure, which addresses testing of software and electrical features not addressed in this document. Hardware testing will be performed at the 306E Facility in the 300 Area and the Fuels and Materials Examination Facility in the 400 Area. These systems were developed primarily in support of Tank Waste Remediation System (TWRS) Safety Programs for moisture measurement in organic and ferrocyanide watch list tanks.



Janis Bishop 2-1-96
Release Approval Date

Approved for Public Release

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LIST OF TERMS

ALARA	as low as reasonably achievable
ATP	acceptance test procedure
CO	carbon monoxide
DAV	Data Acquisition Van
DOT	U.S. Department of Transportation
JCS	Job Control System
LOW	liquid observation well
LOWMMS	Liquid Observation Well Moisture Measurement System
NEC	National Electrical Code
OMM	operations and maintenance manual
SMMS	Surface Moisture Measurement System
TWRS	Tank Waste Remediation System
VCR	video cassette recorder
WHC	Westinghouse Hanford Company

SURFACE MOISTURE MEASUREMENT SYSTEM HARDWARE ACCEPTANCE TEST PROCEDURE

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this acceptance test procedure (ATP) is to verify that the mechanical and electrical features of the Surface Moisture Measurement System (SMMS) are operating as designed and that the unit is ready for field service. Successful completion of this ATP, along with probe calibration, design analyses, and the software ATPs will confirm that the primary design requirements specified in WHC-SD-WM-DRD-002, *Design Requirements Document for the Surface Moisture Measurement System* (Stokes et al. 1995), have been satisfied. The design verification method appropriate for the SMMS is qualification testing as described in WHC-CM-6-1, *Standard Engineering Practices*, EP-4.1, "Design Verification Requirements."

Completion of this procedure will also verify that equipment operation complies with the safety controls specified in the unresolved safety question review, TF-95-0089, *Surface Moisture Monitoring of Hanford Tank Waste by Neutron Activation*. The accepted SMMS and LOWMMS will be used primarily in support of Tank Waste Remediation System (TWRS) Safety Programs for moisture measurement of organic and ferrocyanide watch list tanks.

1.2 SCOPE

This procedure shall be used in conjunction with the software ATP, WHC-SD-WM-ATP-158, *Software Acceptance Test Procedure for the Surface Moisture Monitor* (Gimera 1996), which includes testing of software and electrical features not addressed in this ATP. The Liquid Observation Well Moisture Measurement System (LOWMMS) will be tested in accordance with WHC-SD-WM-ATP-159, *Software Acceptance Test Procedure for the LOW Moisture Monitor* (Gimera 1996a*).

This ATP addresses testing of the SMMS hardware described in section 1.3. Hardware testing will be performed at the 306E Facility in the 300 Area and the Fuels and Materials Examination Facility (FMEF) in the 400 Area. The scope of tests to be performed at the two facilities is described in the following sections.

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*To be issued.

1.2.1 Testing Objectives at the 306E Facility

- Verify basic equipment functions and mechanical interfaces.
- Verify the deployment device winches are self-locking and will not allow unintentional spooling.
- Verify torque limiters for the winches are functioning satisfactorily.
- Verify that the SMMS probe housing is water-tight and that the probe can withstand a specified impact/shock without damage.
- Perform pre-operational check of the electrical system.
- Perform continuity tests of electrical wiring for the SMMS and LOWMMS.
- Verify the data acquisition van's battery-backed uninterruptible power supply (UPS) can supply power to the SMMS for up to 6 hours.
- Verify that the intrinsic safety barriers have been installed correctly.
- Verify the data acquisition van's heating, ventilating, and control (HVAC) system will allow vehicle idling for several hours without overheating.
- Verify performance of decontamination spray system is adequate.
- Measure the weights of SMMS components.

1.2.2 Testing Objectives at FMEF

- Verify basic equipment functions and mechanical interfaces.
- Verify the positioning accuracy of the SMMS deployment hardware/software.
- Demonstrate that sustained, repeated execution of the deployment sequence does not have adverse effects on the mechanical operability of the system.
- Verify that probe placement using the deployment device can be performed using only the view from an "in-tank" camera that is located up to 30 feet away (the operator controlling the winches will only be able to see the camera view on a remote video monitor).
- Train Operations personnel to prepare for field deployment in tank farms and verify that Operations personnel can easily operate the deployment device.
- OPTIONAL: perform overall "loop check" on the system by measuring moisture concentration in moisture standards (barrels full of sand and hydrated alumina with known moisture concentrations) to verify that the neutron probe and supporting electronics are functioning satisfactorily.

The last objective listed above is optional. The Light Duty Utility Arm (LDUA) program requires the use of FMEF on March 1, 1996. The neutron probe may not be available for testing at FMEF by this date and therefore the overall loop check may be performed at 306E as part of probe calibration. In this case, the deployment device will be shipped back to 306E after testing at FMEF. It is not necessary to perform this loop check with the deployment device in the vertical position as it would be at FMEF.

1.3 GENERAL EQUIPMENT DESCRIPTION

A more complete description of the SMMS, including detailed operating instructions, is provided in WHC-SD-WM-OMM-024, *Surface Moisture Measurement System Operation and Maintenance Manual* (Ritter et al. 1995).

1.3.1 Surface Moisture Measurement System

The SMMS is shown in Figure 1-1 and consists of the following components:

- A sensor (surface neutron probe) that consists of a neutron source, three neutron detectors, high voltage power transformer, temperature sensors, and supporting electronics.
- A deployment device that consists of a support mast, an arm, and winch systems to lower and raise the arm and probe.
- A data acquisition van (DAV) that is equipped with the following:
  - Control console with flat panel computer system
  - Video monitor and video cassette recorder (VCR)
  - Generator to power the batteries
  - Batteries to power the equipment
  - Electrical distribution system
  - Data processing electronics
  - Electric-powered cable reel with remote controller (for LOWMMS only)
  - Rotating boom with guide pulley (for LOWMMS only).
- A decontamination system that consists of a high pressure spray ring that mounts on the riser, a gas-powered pressure washer, a gas-powered feed pump, a water tank, totalizers, and various hoses and fittings.

The surface sensor package is a neutron probe that infers the moisture content of the top layers of the waste surface by measuring the neutron moderating properties. These properties are a strong function of the hydrogen concentration of the waste which is related primarily to the water content. The probe obtains penetrating moisture data up to a maximum depth of about 16 cm for very dry waste. The penetration depth decreases for higher moisture waste. Three moisture indications are recorded: one near the surface (about 5 cm for 15 wt% moisture), at the mid-point (about 7 cm for 15 wt% moisture), and at the maximum depth (about 10 cm for 15 wt% moisture) are recorded. The probe measures moisture in the range of 0 to 40 percent by weight of water. The SMMS was designed to be operated in a National Electric Code (NEC) hazardous area classified as Class 1, Division 1, Group B. The neutron source used with the SMMS probe is an encapsulated 16-μg, 9.1 mCi, californium-252 (^{252}Cf) source.

The deployment device consists of a vertical support mast with a rotating arm, which can be vertically rotated through a controlled angle to position the probe at a radius between 0 and 2 m (6 ft) from the riser centerline. A deployment cable, guided over the arm, mechanically lowers the probe to the waste surface. The arm also houses an inclinometer and associated cable.

The deployment device, which weighs approximately 590 kg (1300 lb), will be installed in a 4-inch or larger waste tank riser using a crane. The deployment device interfaces with a DAV that controls the sensor operation and records pertinent data. The DAV is a standalone system and connections to existing tank farms utilities are not required. Electrical power for the SMMS components is provided from one of three sources: the DAV's batteries, the DAV's generator, or a site service receptacle. Interconnecting cables will be placed above ground and routed between the van and the deployment device. The SMMS and supporting equipment are portable and only temporarily installed in a waste tank. The deployment device will be packaged in a weather-tight container for storage and transportation. The SMMS neutron source will be stored and transported in U.S. Department of Transportation (DOT) 7A Type A shipping container located inside of the DAV. The source will be stored in a locked, shielded cask when not in use.

During measurement sequences, the arm will be raised to a specified angle and the deployment device will be rotated to a specified orientation. The probe then will be mechanically lowered until it makes contact with the waste surface. The probe is not intended to penetrate the waste. A separate in-tank camera installed in an adjacent riser will provide visual feedback for all in-tank operations including probe deployment and placement. This in-tank camera is mandatory for successful SMMS operation. A video monitor will be located next to the riser to help the operator position the probe. Approximately 36 percent of the surface area within a 4 m (12 ft) diameter region will be scanned per the tank-specific test plan. Each probe measurement interrogates a region of approximately 40 cm (16 in.) in diameter. Measurements will be made in such a way as to avoid large gaps in the data. The system allows any measurement to be repeated and allows for a higher spatial resolution to fill in missing gaps.

2.0 REFERENCES

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Gimera, M., 1996, *Software Acceptance Test Procedure for the Surface Moisture Monitor*, WHC-SD-WM-ATP-158, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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Stokes, T. I. W. T. Watson, M. Gimera, J. H. Bussell, A. Dabiri, D. T. Holslin, F. Johansen, 1995, *Design Requirements Document (DRD) for the Surface Moisture Measurement System*, WHC-SD-WM-DRD-002, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

TF-95-0089, *Surface Moisture Monitoring of Hanford Tank Waste by Neutron Activation*, Westinghouse Hanford Company, Richland, Washington.

TO-020-141, *In-Tank Video Procedure*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-6-1, *Standard Engineering Practices*, latest revision, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-2-14, *Hazardous Material Packaging and Shipping*, latest revision, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-1-6, *WHC Radiological Control Manual*, latest revision, Westinghouse Hanford Company, Richland, Washington.

WHC-IP-0972, Rev. 1, *Source Movement Procedure*, Westinghouse Hanford Company, Richland, Washington.

WHC-IP-1019, latest revision, *Material Control and Accountability Plan*, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-QAPP-001, latest revision, *Quality Assurance Program Plan for Source Control*, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996a, *Surface Moisture Monitoring System Installation Assembly*, drawing H-14-100458, draft, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996b, *Surface Moisture Monitoring System Deployment Enclosure*, drawing H-14-100459, draft, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996c, *Surface Moisture Monitoring System Deployment Arm*, drawing H-14-100460, draft, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996d, *Surface Moisture Monitoring System Neutron Detector Assembly*, drawing H-14-100461, draft, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996e, *Surface Moisture Monitoring System Decon System Assembly*, drawing H-14-100462, draft, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996f, *Surface Moisture Monitoring System Impact Limiter Assembly*, drawing H-14-100463, draft, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996g, *Surface Moisture Monitoring System Vehicle Modifications*, drawing H-14-100464, draft, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996h, *Surface Moisture Monitoring System Block Diagram*, drawing H-14-100467, draft, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996i, *Operator Control Enclosure Surface Moisture Measurement System Wiring*, drawing H-14-100469, draft, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996j, *Driver Side Electronics Enclosure Surface Moisture Measurement System Wiring*, drawing H-14-100471, draft, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996k, *Passenger Side Electronics Surface Moisture Measurement System Wiring*, drawing H-14-100473, draft, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996l, *Surface Moisture Measurement System Loop Diagram*, drawing H-14-100475, draft, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996m, *Surface Moisture Measurement System Schematic Diagram*, drawing H-14-100475, draft, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996n, *Surface Moisture Monitoring System Cable Assemblies*, drawing H-14-100477, draft, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996o, *Surface Moisture Measurement System Deployment Enclosure Wiring*, drawing H-14-100485, draft, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996p, *Liquid Observation Well Deployment Device Wiring Diagram*, drawing H-14-100486, draft, Westinghouse Hanford Company, Richland, Washington.

3.0 TEST CONTROLS

3.1 RESPONSIBILITIES ASSOCIATED WITH TESTING AT 306E

3.1.1 306E Facility Management

D. G. Panther, J. R. Thielges

- Approve the ATP.
- Provide space in the 306E high bay for performing testing.
- Provide personnel to perform testing.

3.1.2 WHC SMMS Project Engineer

G. F. Vargo Jr.

- Identify and specify testing requirements for the SMMS.
- Approve the ATP and acceptance test report (ATR).
- Provide technical expertise during testing of the SMMS.
- Approve acceptability of test activities and results.

3.1.3 SMMS Design Authority

Representative: P. R. Deichelbohrer

- Approve the ATP and acceptance test report (ATR).

3.1.4 Responsible Engineers

Overall System Engineer: T. I. Stokes
Mechanical (ME): D. B. Graves and/or G. A. Ritter
Probe Electrical (EE): J. H. Bussell
DAV Electrical (EE): M. Gimera

NOTE: The responsible engineer may perform test performer activities.

- Act as the person in charge for test preparation and performance.
- Identify equipment and facilities for testing.
- Ensure informal testing and inspection is complete.
- Act as a liaison with the Quality Assurance Engineer (QE) and other participants for testing activities, as required.

- Ensure Hanford Job Hazards Analysis checklist is complete.
- Conduct prejob briefing/readiness review prior to initiating test.
- Provide overall responsibility for maintaining and controlling testing to ensure compliance with the ATP.
- Approve field changes to the ATP.
- Take necessary action to resolve exceptions to the ATP.
- Approve acceptability of test activities and results.

3.1.5 Test Performer [As Approved by the Responsible Engineer(s)]

- Perform testing in accordance with the ATP.
- Record test data and observations as specified in the ATP.
- Record authorized field changes to the ATP.
- Record exceptions to the ATP on "Exception to SMMS Acceptance Test" sheets (provided with the ATP).
- Prepare/issue the ATR.

3.1.6 Quality Assurance Engineer (QE)

M. L. McElroy

- Review and approve the ATP and ATR.
- Ensure that quality requirements are defined and satisfied for the test.
- Witness conductance of acceptance testing as required. Testing may proceed per the ATP without a QE present.

3.1.7 Quality Control Inspectors (QC)

- Monitor test activities and provide signature verification, as required by the ATP. The QE or the responsible engineer may request QC witness of testing not specifically requested in the ATP.

The names of the test performers and responsible engineers for this ATP shall be documented in the ATR.

3.2 RESPONSIBILITIES ASSOCIATED WITH TESTING AT FMEF

The responsibilities and additional test controls associated with testing at FMEF are defined in WHC-SD-WM-WP-318, *Surface Moisture Measurement System Acceptance Testing Work Plan* (Ritter 1996). This work plan also provides information on the organizations responsible for supplying test equipment including the camera system.

3.3 TEST DATA

- All test data, pertinent observations, and off-normal events shall be recorded in Section 6.0 (306E) and Section 7.0 (FMEF) of this ATP. If additional space is required, the data shall be recorded on an observation/results data sheet (provided in Appendix A) or equivalent.

- An ATR shall be prepared by SMMS personnel to publish all data gathered during testing activities.

3.4 TEST CONFIGURATION

- The drawings and engineering documents that establish the equipment test configuration are listed in Section 2.0.

- Additional documents required to perform, document, or validate a test (sketches, calibration sheets, etc.) will be referenced in or attached to the ATR.

3.5 PROCEDURE CONTROL

A controlled test procedure package shall be used for testing and shall include as a minimum single copies of the following:

- This ATP.

- Software ATP, WHC-SD-WM-ATP-158.

- Operation and maintenance manual, WHC-SD-WM-OMM-024.

- Critical lift procedure (for uprighting SMMS deployment device at FMEF, to be provided under JCS work package #4M-96-009/W).

- H-14-100458, *Surface Moisture Monitoring System Installation Assembly* (WHC 1996a*).

- H-14-100459, *Surface Moisture Monitoring System Deployment Enclosure* (WHC 1996b*).

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*To be issued.

- H-14-100460, *Surface Moisture Monitoring System Deployment Arm* (WHC 1996c*).
- H-14-100461, *Surface Moisture Monitoring System Neutron Detector Assembly* (WHC 1996d*).
- H-14-100462, *Surface Moisture Monitoring System Decon System Assembly* (WHC 1996e*).
- H-14-100463, *Surface Moisture Monitoring System Impact Limiter Assembly* (WHC 1996f*).
- H-14-100464, *Surface Moisture Monitoring System Vehicle Modifications* (WHC 1996g*).
- H-14-100467, *Surface Moisture Monitoring System Block Diagram* (WHC 1996h*).
- H-14-100469, *Operator Control Enclosure Surface Moisture Measurement System Wiring* (WHC 1996i*).
- H-14-100471, *Driver Side Electronics Enclosure Surface Moisture Measurement System Wiring* (WHC 1996j*).
- H-14-100473, *Passenger Side Electronics Surface Moisture Measurement System Wiring* (WHC 1996k*).
- H-14-100475, *Surface Moisture Measurement System Loop Diagram* (WHC 1996l*).
- H-14-100476, *Surface Moisture Measurement System Schematic Diagram* (WHC 1996m*).
- H-14-100477, *Surface Moisture Monitoring System Cable Assemblies* (WHC 1996n*).
- H-14-100485, *Surface Moisture Measurement System Deployment Enclosure Wiring* (WHC 1996o*).
- H-14-100486, *Liquid Observation Well Deployment Device Wiring Diagram* (WHC 1996p*).

The package may also include other information that is directly applicable to testing.

Changes to the test procedure are permitted. Minor procedure changes such as editorial changes to a step, clarification of a step or steps, elimination or addition of a step, or limited sequential changes of steps, shall be noted in the procedure by redline entries and noted in the test procedure package giving the reason for the change. Redlined changes shall be documented in the ATR. The test performer shall red-ink changes with the

*To be issued.

concurrence of the responsible engineer. Approvals will be documented by the responsible engineer's initials on the redlined item. Lack of immediate redline approval does not constitute a test hold. Continued test progress is at the discretion of the responsible engineer.

3.6 RETEST PROCEDURE CONTROL

- If a retest is required, then data sheets, additional procedures, or additional copies of the applicable procedure sections of this ATP may be used.

- The addition of procedure sections to be used for retest shall be added to the test procedure package, concurred with by the WHC QE representative, and formally released in the ATR.

3.7 EXCEPTIONS TO ACCEPTANCE TEST SECTION

Exceptions to the test are dispositioned and agreed to by all witnesses. Actions taken regarding disposition are noted on the "Exception to SMMS Acceptance Test" (Appendix B) sheet. If "reject" is selected for a particular test item, then an exception sheet shall be completed and dispositioned. Typical dispositions are:

- Test approved with exception (i.e., rerun of the acceptance test unnecessary).

- ATP step(s) affected to be repeated after the discrepancy has been corrected.

- Entire acceptance test to be repeated after the discrepancy has been corrected.

Note that all changes to the ATP, including redline changes and test exceptions, will be documented in the ATR, which will be reviewed and approved by all who approved the ATP.

4.0 TEST CONDITIONS AND EQUIPMENT REQUIRED

4.1 TEST FACILITY

Acceptance testing of the SMMS will be conducted at two separate facilities: the 306E Facility in the 300 area and FMEF in the 400 area. The bulk of testing will be performed at the 306E Facility, in the building high bay or area adjacent to the facility. A full scale mock-up of the SMMS deployment device as it would be operated in the field will be performed at FMEF.

4.2 EQUIPMENT REQUIRED FOR TESTING AT 306E

The following equipment will be required for testing at 306E. Readily available tools, such as standard wrenches and screwdrivers, are not included.

- SMMS deployment device
- SMMS decontamination system (including spray ring, feed pump, high pressure pump, water tank, totalizers, and hoses)
- Data acquisition van
- SMMS interconnecting cables
- SMMS neutron probe (source not required)
- Test weight for SMMS neutron probe
- SMMS source handling tool
- LOWMMS spider assembly
- LOWMMS neutron probes (source not required)
- LOWMMS interconnecting cables
- Electrician's hand tools and multimeter for continuity testing and troubleshooting of electrical system
- electronic level with a minimum precision of ± 5°
- ohmmeter with a minimum range of 1 to 10 megaohms
- 1-ton (minimum), 3 ft (minimum) spreader bar (supplied with deployment device) and rigging accessories for lifting deployment device
- Vacuum pump with a minimum capacity of 1250 Pa vacuum (5 in. H_2O vacuum)
- Differential pressure gage with a minimum range of 0 to 1250 Pa (0 to 5 in. H_2O) and a minimum precision of ± 25 Pa (0.1 in. H_2O)
- Flow meter with a minimum range of 0 to 4.7×10^{-4} m^3/s (0 to 1 ft^3/min) and a minimum precision of $\pm 4.7 \times 10^{-5}$ m^3/s (0.1 ft^3/min)
- Load cell/scale with a minimum range of 0 to 910 kg and a minimum accuracy of ± 5%
- Thermocouples and a readout unit with a minimum range of 0 to 200 °C and a minimum precision of ± 5 °C
- Calibrated torque wrench with a minimum range of 0 to 50 N-m and a minimum accuracy of ± 5%

4.3 EQUIPMENT REQUIRED FOR TESTING AT FMEF

The following equipment will be required for testing at FMEF.

- SMMS deployment device
- Data acquisition van
- SMMS interconnecting cables
- SMMS neutron probe (optional--see Section 1.2.2)
- 1-ton (minimum), 3 ft (minimum) spreader bar (supplied with deployment device) and rigging accessories for lifting deployment device
- tape measurer with a minimum range of 0 to 9.1 m (0 to 30 ft)
- electronic level with a minimum precision of ± 5°
- dial calipers with minimum range of 0 to 2.5 cm (0 to 1 in.), and a minimum precision of ± 0.025 cm (± 0.01 in.)
- Vitus II camera system including two video monitors, video cassette recorder, and interconnecting cables (see Section 3.2)

5.0 SAFETY PRECAUTIONS AND CONTROLS

Only the responsible engineers and/or their approved personnel shall operate the SMMS during performance of this ATP. A Hanford Job Hazards Analysis (JHA) Checklist will be completed under the guidance of a representative from Industrial Health and Safety. This representative will be from the FFTF & Fuel Facility Safety group, which has responsibility for the 300 and 400 areas. A pre-job meeting will be held prior to the test performance to brief test personnel on the hazards unique to the SMMS equipment and to review all procedures, drawings, and other engineering documents required to complete the test. Safety precautions for operation of the SMMS are identified in WHC-SD-WM-OMM-024. Safety precautions applicable to this ATP have been repeated here and are listed in the sections below. THESE PRECAUTIONS SHALL BE FOLLOWED FOR THE PERFORMANCE OF THIS ATP.

5.1 PERSONNEL PRECAUTIONS

5.1.1 In case of fire or other emergency in the van, all power shall be secured (if this operation can be done quickly and safely) by moving circuit breaker CB-1 to the OFF position (the main circuit breaker located on the power distribution panel, see Figure 6-1).

5.1.2 A carbon monoxide (CO) monitor is located in the DAV. If the CO monitor warning signal occurs, turn off the van engine, and exit the van leaving the doors open. Wait for a minimum of 5 minutes for the CO to dissipate. The CO monitor warning signal will automatically stop and reset when the unsafe CO level no longer exists.

5.1.3 Exhaust piping becomes hot during operation and remains hot for a while after stopping an engine (e.g., van, generator, decon pumps). Be careful not to touch a muffler while or exhaust piping it is hot.

5.1.4 The cables routed from the van to the SMMS deployment device equipment present a personnel trip/fall hazard. The cables shall be isolated by barricades to the extent possible to alleviate the trip hazards.

5.1.5 Electrical test equipment shall only be used by qualified personnel who are trained on the operation and limitation of the equipment.

5.2 EQUIPMENT PRECAUTIONS

5.2.1 Supply power to a subsystem must be OFF when connecting or disconnecting any electrical equipment or cables to that subsystem.

5.2.2 Failure to hook up or remove the power and interconnecting cables in the sequence prescribed in this manual could result in generation of unacceptable equipment voltages and in electrical arcing or sparking.

5.2.3 The SMMS deployment device could be bent if not supported and/or lifted correctly when in the horizontal position.

5.2.4 The generator is a potential source of electrical shock if misused. Do not expose the generator to moisture, rain, or snow. Do not operate the generator if it is wet, or if the operator is wet.

5.2.5 The exhaust systems get hot enough to ignite some materials. Keep the generator at least 1 m away from buildings and other equipment during operation. The generator is mounted to a platform on the front of the DAV. Do not enclose the generator in any structure and keep flammable materials away from the exhausts. Refer to the specific operation manual (e.g., generator, feed pump, high pressure pump) for operating and refueling precautions.

5.3 ADMINISTRATIVE CONTROLS FOR THE SOURCE AND VEHICLE

If the neutron source is to be used with testing at FMEF, then the applicable controls specified in section 3.3 of WHC-SD-WM-OMM-024 shall be followed.

6.0 306E TEST PROCEDURE

6.1 PREREQUISITES

6.1.1 Prejob Meeting

Conduct a "prejob meeting" of operations including a review of all procedures, drawings, safety hazards, and other engineering documents required to complete the test. Personnel who have attended the prejob meeting shall sign the attendance form given in Appendix C.

6.1.2 Stage Equipment

Verify that the equipment listed in Section 4.2 is staged in the test area. Verify that no interconnections have been made.

Test Engineer's signature _____ Date _____

6.2 ELECTRICAL CONTINUITY CHECKS

Electrical continuity measurements of all SMMS and LOWMMS wiring shall be performed in this section. The following wiring diagrams shall be used to check electrical continuity.

- H-14-100469, *Operator Control Enclosure Surface Moisture Measurement System Wiring.*
- H-14-100471, *Driver Side Electronics Enclosure Surface Moisture Measurement System Wiring.*

- H-14-100473, *Passenger Side Electronics Surface Moisture Measurement System Wiring.*
- H-14-100475, *Surface Moisture Measurement System Loop Diagram.*
- H-14-100485, *Surface Moisture Measurement System Deployment Enclosure Wiring.*
- H-14-100486, *Liquid Observation Well Deployment Device Wiring Diagram.*

For each drawing listed above, a test control copy shall be identified by clearly marking in red ink "TEST CONTROL COPY" above the title block on the drawing. Using a multimeter set up to measure resistance, the responsible EE and an independent electrical reviewer will verify continuity (maximum 1 ohm resistance) of each conductor from end to end on each drawing. The responsible EE or independent electrical reviewer will initial and date next to each termination point verified on the test control copy of the drawing. The test control copies of the drawings shall be saved in project files. Record instrument# for continuity tester below.

Instrument #: _____

Calibration expiration date: _____

WARNING

Verify that circuits are de-energized before performing continuity checks.

Electrical continuity checks on the drawings listed above have been completed. Discrepancies, if any, have been listed on exception sheets (Appendix B).

Accept/Reject (circle one)

Responsible EE's signature _____ Date _____

Independent Reviewer signature _____ Date _____

6.3 ELECTRICAL SYSTEMS OPERATIONAL CHECKOUT

The SMMS is a stand-alone system with no connections to existing tank farm utilities required. Power for the system operation is supplied as part of the data acquisition van, but can also be supplied by a site service receptacle. The van has a 120 VAC power generation system with a battery-backed UPS to stabilize and provide uninterrupted power. The SMMS must be able to operate for at least 6 hours on battery power. If site electrical power is to be used instead of the generator or batteries, the SMMS requires a 120 VAC, 20 amp site service receptacle. This ATP will verify adequate system

operation from all three power supplies. The decontamination system feed pump and high-pressure pump are gasoline engine powered and will be tested in Section 6.7.

6.3.1 SMMS Electrical Cable Connections

Set the mode selector switch on the power distribution panel to SMMS. This switch directs the appropriate position encoder signal (SMMS or LOWMMS probe) to the computer and the appropriate probe signal to the NIM bin.

Verify that the following circuit breakers and disconnect switches are in the OFF position:

- Van power distribution panel: all circuit breakers, CB-1 through CB-15 (see Figure 6-1)
- Van generator: AC circuit breaker.

Connect the electrical cables to the equipment as follows.

- W1 to DAV J1 and to SMMS electrical junction box J11 (probe signals)
- W7 to DAV J7 and to SMMS electrical junction box J17 (auxiliary instrument signals)
- W8 to DAV J8 and to SMMS electrical junction box J18 (auxiliary instrument signals)
- W9 to DAV J9 and to SMMS electrical junction box J19 (probe signals)

NOTE: Electrical cabling interconnections are shown in Figure 6-2. Depending on whether a SMMS or LOWMMS scan is being performed some cables will not be connected, as identified above.

Test Engineer's signature _____ Date _____

6.3.2 Test Battery Power Supply for SMMS

6.3.2.1 Move the van power distribution panel circuit breaker switches CB-1, CB-2, CB-4, CB-5, CB-7, CB-8, CB-10, CB-11, and CB-13 (Figure 6-1) to the ON position.

NOTE: The uninterruptible power supply (UPS) will beep when the batteries are low.

6.3.2.2 Verify that power is available for the following components:

- computer and flat panel computer display
- NIM bin
- probe

- deployment device instrumentation (compass, encoders, inclinometer)
- video monitor and video cassette recorder.
- van service receptacle

Accept/Reject (circle one)

Responsible EE's signature _____ Date _____

6.3.2.3 Leave the power turned on to the above electrical components for a minimum of 6 hours to verify the battery power is available and the equipment functions satisfactorily for this length of time.

ACCEPTANCE CRITERIA: 6 hours of available battery power (minimum)

Accept/Reject (circle one)

Responsible EE's signature _____ Date _____

6.3.2.4 With the power turned on to the above electrical components, disconnect and reconnect (see Figure 6-2 for cabling interconnections) each of the SMMS cables and verify that this causes no damage to the components.

ACCEPTANCE CRITERIA: no damage to electrical components

Accept/Reject (circle one)

Responsible EE's signature _____ Date _____

6.3.2.5 Move the van power distribution panel circuit breaker switches CB-1, CB-2, CB-4, CB-5, CB-7, CB-8, CB-10, CB-11, and CB-13 (Figure 6-1) to the OFF position.

6.3.3 Test Site Service Receptacle Supply for SMMS

6.3.3.1 The SMMS requires a 120 VAC three-prong receptacle with 20 amp service. To prevent damage to SMMS hardware, verify the selected site service receptacle is the correct type specified per the responsible EE's direction. Using a multimeter, verify that the voltage across hot and neutral on the site service receptacle is 120 VAC. Verify that the voltage across neutral and ground is approximately zero.

6.3.3.2 Plug the extension cord into the van receptacle (connect W2 to DAV P3 per Figure 6-2).

NOTE: The van line voltage receptacle is located at the front of the van near the generator.

6.3.3.3 Plug the extension cord into the site service receptacle.

6.3.3.4 Move the van power distribution panel circuit breaker switches CB-1, CB-2, CB-4, CB-5, CB-7, CB-8, CB-10, CB-11, and CB-13 (Figure 6-1) to the ON position.

6.3.3.5 Verify that power is available for the following components:

- computer and flat panel computer display
- NIM bin
- probe
- deployment device instrumentation (compass, encoders, inclinometer)
- video monitor and video cassette recorder
- van service receptacle.

Accept/Reject (circle one)

Responsible EE's signature _____ Date _____

6.3.3.6 Move the van power distribution panel circuit breaker switches CB-1, CB-2, CB-4, CB-5, CB-7, CB-8, CB-10, CB-11, and CB-13 (Figure 6-1) to the OFF position.

6.3.4 Test Generator Power Supply for SMMS

Testing of the generator must be performed outside of the 306E Facility or the generator must be temporarily plumbed such that the exhaust is outside of the building. The number of hours of generator power available from one tank of gas will also be measured as part of this test.

WARNING

Generator exhaust piping becomes hot during operation and remains hot for a while after it is turned off. Do not touch the muffler while it is hot.

WARNING

The generator is a potential source of electrical shock if misused. Do not expose the generator to moisture, rain, or snow. Do not operate the generator if it is wet, or if the operator is wet.

WARNING

If the CO monitor warning signal occurs, turn off the van engine and/or generator, exit the van, and ventilate the van. Wait for a minimum of 5 minutes for the CO to dissipate. The CO monitor warning signal will automatically stop and reset when the unsafe CO level no longer exists.

6.3.4.1 Perform preoperation check.

NOTE: Engine oil is a major factor affecting engine performance and service life. Nondetergent and 2-stroke engine oils will damage the engine and are NOT to be used.

1. Check the oil level BEFORE EACH USE with the generator on a level surface with the engine stopped. If the level is low, add SAE 30W SF/SG or equivalent oil to the upper mark on the dipstick.

2. Check the fuel level gauge. Refill the tank so that the fuel tank is full. Do not fill above the shoulder or the fuel strainer, and never refuel if the generator is running or is hot.

6.3.4.2 Plug one end of the extension cord into the AC receptacle on the generator and the other end into the van receptacle (connect W3 to generator J3 according to Figure 6-2).

NOTE: The van line voltage receptacle is located at the front of the van near the generator.

6.3.4.3 Make sure that the generator AC circuit breaker is in the OFF position. The generator may be hard to start if a load is connected.

6.3.4.4 Turn the fuel valve to the ON position, turn the choke lever to the CLOSE position, and turn the engine switch to the ON position.

6.3.4.5 Pull the starter grip until compression is felt, then pull briskly.

NOTE: Do not allow the starter grip to snap back. Return it slowly by hand to prevent damage to the starter.

6.3.4.6 Turn the choke lever to the OPEN position as the engine warms up.

6.3.4.7 Switch ON the generator AC circuit breaker and continue to run the generator per the responsible EE's direction.

6.3.4.8 Move the van power distribution panel circuit breaker switches CB-1, CB-2, CB-4, CB-5, CB-7, CB-8, CB-10, CB-11, and CB-13 (Figure 6-1) to the ON position.

6.3.4.9 Verify that power is available for the following components:

- computer and flat panel computer display
- NIM bin
- probe
- deployment device instrumentation (compass, encoders, inclinometer)
- video monitor and video cassette recorder
- van service receptacle.

Accept/Reject (circle one)

Responsible EE's signature _____ Date _____

6.3.4.10 Move the van power distribution panel circuit breaker switches CB-1, CB-2, CB-4, CB-5, CB-7, CB-8, CB-10, CB-11, and CB-13 (Figure 6-1) to the OFF position.

6.3.5 LOWMMS Electrical Cable Connections

Set the mode selector switch on the power distribution panel to LOWMMS. Verify that the following circuit breakers and disconnect switches are in the OFF position:

- Van power distribution panel: all circuit breakers, CB-1 through CB-15 (see Figure 6-1)
- Van generator: AC circuit breaker.

Connect the electrical cables as follows.

- W4 to spider box J4 (remote pendant controller)
- W5 to DAV J5 and to spider box J15 (probe cable)
- W6 to DAV J6 and to spider box J16 (spider cable)

NOTE: Electrical cabling interconnections are shown in Figure 6-2. Depending on whether a SMMS or LOWMMS scan is being performed some cables will not be connected, as identified above.

Test Engineer's signature _____ Date _____

6.3.6 Test Battery Power Supply for LOWMMS

6.3.6.1 Move the van power distribution panel circuit breaker switches CB-1, CB-4, CB-6, CB-7, CB-9, CB-10, and CB-13 (Figure 6-1) to the ON position.

6.3.6.2 Verify that power is available for the following LOWMMS components:

- probe
- cable reel
- spider assembly instrumentation
- computer and flat panel computer display
- NIM bin.

6.3.6.3 Verify that battery power is available (without recharging) to lower and raise the LOWMMS probe 30 ft (minimum) a minimum of 5 times.

Accept/Reject (circle one)

Responsible EE's signature _____ Date _____

6.3.6.4 With the power turned on to the above electrical components, disconnect and reconnect (see Figure 6-2 for cabling interconnections) each of the LOWMMS cables and verify that this causes no damage to the components.

ACCEPTANCE CRITERIA: no damage to electrical components

Accept/Reject (circle one)

Responsible EE's signature _____ Date _____

6.3.6.5 Move the van power distribution panel circuit breaker switches CB-1, CB-4, CB-6, CB-7, CB-9, CB-10, and CB-13 (Figure 6-1) to the OFF position.

6.3.7 Test Site Service Receptacle Supply for LOWMMS

6.3.7.1 Plug the extension cord into the van receptacle (connect W2 to DAV P3 per Figure 6-2).

6.3.7.2 Plug the extension cord into the site service receptacle.

6.3.7.3 Move the van power distribution panel circuit breaker switches CB-1, CB-4, CB-6, CB-7, CB-9, CB-10, and CB-13 (Figure 6-1) to the ON position.

6.3.7.4 Verify that power is available for the following LOWMMS components:

- probe
- cable reel
- spider assembly instrumentation
- computer and flat panel computer display
- NIM bin.

Accept/Reject (circle one)

Responsible EE's signature _____ Date _____

6.3.7.5 Move the van power distribution panel circuit breaker switches CB-1, CB-4, CB-6, CB-7, CB-9, CB-10, and CB-13 (Figure 6-1) to the OFF position.

6.3.8 Test Generator Power Supply for LOWMMS

6.3.8.1 Start up generator by performing steps 6.3.4.1 through 6.3.4.7.

6.3.8.2 Move the van power distribution panel circuit breaker switches CB-1, CB-4, CB-6, CB-7, CB-9, CB-10, and CB-13 (Figure 6-1) to the ON position.

6.3.8.3 Verify that power is available for the following LOWMMS components:

- probe
- cable reel
- spider assembly instrumentation
- computer and flat panel computer display
- NIM bin.

Accept/Reject (circle one)

Responsible EE's signature _____ Date _____

6.3.8.4 Move the van power distribution panel circuit breaker switches CB-1, CB-4, CB-6, CB-7, CB-9, CB-10, and CB-13 (Figure 6-1) to the OFF position.

6.3.9 Intrinsic Safety Barrier

6.3.9.1 Measure the resistance between the intrinsic safety barriers mounting bus bar (DIN rail) and the SMMS deployment device winch enclosure box. Record equipment calibration information. QC verify reading.

Instrument #: _____ QC Initial/Date _____

Calibration expiration date: _____

Reading _____ QC Initial/Date _____

ACCEPTANCE CRITERIA: 1 ohm (maximum)

6.3.9.2 For the two Stahl model 9002/77-150-300-00 barriers, measure the resistance from pin 1 to pin 3 and from pin 2 to pin 4. Record the readings below and verify that they are within the range of the acceptance criteria (manufacturer's specifications).

Barrier#1: pin 1 to pin 3 reading _____

Barrier#1: pin 2 to pin 4 reading _____

Barrier#2: pin 1 to pin 3 reading _____

Barrier#2: pin 2 to pin 4 reading _____

ACCEPTANCE CRITERIA: 118 ± 12 ohms

Accept/Reject (circle one)

Responsible EE's signature _____ Date _____

6.3.9.3 For the two Stahl model 9351/10-14-10 barriers, connect a 100 ohm resistor across the output (pin 7 to pin 8). Apply 24 VDC across pin L+ and pin 3. Using an ammeter, measure the current that flows through the resistor for each barrier. Record the readings below and verify that they are within the range of the acceptance criteria (manufacturer's specifications).

Barrier#1 reading _____

Barrier#2 reading _____

ACCEPTANCE CRITERIA: 80 - 110 mA

Accept/Reject (circle one)

Responsible EE's signature _____ Date _____

6.3.9.4 For the one Elcon model 1072 barrier, apply 24 VDC across the 24 V supply bus and the 0 V supply bus. Measure the open circuit voltage and the short circuit from pin A to pin B, pin A to pin C, pin B to pin C, pin D to pin E, pin D to pin F, and pin E to pin F. Record the readings below and verify that they are within the range of the acceptance criteria (manufacturer's specifications).

Pin A to pin B: open circuit voltage _____
short circuit current _____

Pin A to pin C: open circuit voltage _____
short circuit current _____

Pin B to pin C: open circuit voltage _____
short circuit current _____

Pin D to pin E: open circuit voltage _____
short circuit current _____

Pin D to pin F: open circuit voltage _____
short circuit current _____

Pin E to pin F: open circuit voltage _____
short circuit current _____

ACCEPTANCE CRITERIA: open circuit voltage < 13.1 V
short circuit current < 96 mA

Accept/Reject (circle one)

Responsible EE's signature _____ Date _____

6.3.9.5 Visually inspect the intrinsic barriers and verify that they are adequately installed per H-14-100476* and the manufacturer's installation instructions.

Responsible EE's signature _____ Date _____

Fire Protection Engineer's signature _____ Date _____

6.3.10 Grounded and Bonded Equipment

All in-tank hardware (deployment device and neutron probe) must be grounded and bonded when the equipment is installed in a waste tank. Grounding is the assurance that a given component has very little to no potential voltage difference with respect to earth ground. Bonding is the assurance that individual components have little to no potential with respect to each other. The following section will perform loop checks to verify that all in-tank hardware is bonded to the deployment device winch box. When the equipment is installed in a waste tank, the deployment device winch box will be grounded to the tank riser.

6.3.10.1 Using an ohmmeter (with a minimum range of 0 - 10 megaohms), measure the resistance between the end of the arm and the deployment device winch enclosure box. Verify the resistance is less than 25 ohms. Record equipment calibration information.

Instrument #: _____

Calibration expiration date: _____

Reading _____

ACCEPTANCE CRITERIA: 25 ohms (maximum)

Accept/Reject (circle one)

Responsible EE's signature _____ Date _____

6.3.10.2 Measure the resistance between the neutron probe housing and the deployment device winch enclosure box. Verify the resistance is less than 25 ohms.

Reading _____

ACCEPTANCE CRITERIA: 25 ohms (maximum)

Accept/Reject (circle one)

Responsible EE's signature _____ Date _____

*To be issued.

6.3.10.3 Measure the resistance between the neutron probe cable (outside) and the deployment device winch enclosure box. Verify the resistance is less than 1 megaohm.

Reading _____

ACCEPTANCE CRITERIA: 1 megaohm (maximum)

Accept/Reject (circle one)

Responsible EE's signature _____ Date _____

6.3.10.4 Measure the resistance between the arm cable and the deployment device winch enclosure box. Verify the resistance is less than 1 megaohm.

Reading _____

ACCEPTANCE CRITERIA: 1 megaohm (maximum)

Accept/Reject (circle one)

Responsible EE's signature _____ Date _____

6.4 DATA ACQUISITION VAN HVAC SYSTEM TEST

This section will verify that the DAV's HVAC system will allow vehicle idling for several hours without overheating.

6.4.1 Equipment Setup

6.4.1.1 Park the DAV outside the 306E Facility in a location where there is adequate ventilation.

6.4.1.2 Set up to measure the radiator temperature, by attaching a thermocouple to the outside of the radiator, and insulating the back side of the thermocouple. Connect the thermocouple to the readout unit. Record instrument calibration information below.

Instrument #: _____

Calibration expiration date: _____

6.4.1.3 Set up a heater(s) to heat the ambient air in front of the radiator.

6.4.2 Functional Test

6.4.2.1 Turn on the van engine, and allow it to warm up for several minutes. Turn on the heater(s) and allow the air in front of the

radiator (within 15 cm) to warm up to at least 46°C (120°F). Record air temperature in front of the radiator and the ambient temperature below.

Air in front of radiator temperature reading _____

Ambient temperature reading _____

6.4.2.2 Turn the air conditioning on to the MAX position, turn the fan to the MAX position, turn on all instrumentation, and close the vehicle doors.

6.4.2.3 Allow the DAV to idle until a steady radiator temperature is reached. Record this temperature below. If a steady temperature is reached without the engine overheating, then the HVAC system is functioning adequately.

Steady state temperature reading _____

ACCEPTANCE CRITERIA: engine idles without overheating

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

6.5 DEPLOYMENT DEVICE PREOPERATIONAL TEST

The following sections are intended to perform an initial checkout of the mechanical operability of the deployment device before it is shipped to FMEF for extensive testing. Specific measurements will also be obtained to provide information for field procedures.

6.5.1 Weight Measurements

Weigh the SMMS deployment device assembly (winch housing, rotation bearing, mast, arm, neutron probe), neutron probe (by itself), decontamination spray washer (including wiper and impact plate), and impact limiters. Heavy equipment may be weighed using a load cell and suspending the item from a crane. The minimum accuracy of weight measurements shall be ± 5%. Record results and instrument calibration information below.

Instrument #: _____

Calibration expiration date: _____

(Acceptance Criteria are shown in bold)

SMMS Deployment Device Assembly: _____ kg (lbs.)

[614 kg (1350 lbs.) maximum]

Neutron Probe: _____ kg (lbs.)

[11.4 kg (25 lbs.) maximum]

Decontamination Spray Washer: _____ kg (lbs.)

[45.5 kg (100 lbs.) maximum]

Short Impact Limiter: _____ kg (lbs.)

[22.7 kg (50 lbs.) maximum]

Tall Impact Limiter: _____ kg (lbs.)

[22.7 kg (50 lbs.) maximum]

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

6.5.2 Torque Limiter Test

The deployment device winch handles have torque limiters to prevent overloading the arm and probe cables. This section is intended to verify that the torque limiters are functioning satisfactorily. The torque limiters consist of a friction plate (similar to a brake or clutch) and a pressure plate. If the torque limit is exceeded, the pressure plate will slip on the friction plate and the winch will not rotate. The torque limit can be adjusted by tightening/loosening a nut to increase/decrease the force between the pressure plate and the friction plate.

6.5.2.1 Secure the probe winch handle in a vise such that the handle is fixed but the extension (that connects the handle to the winch) is free to rotate.

6.5.2.2 Attach a calibrated torque wrench to the probe winch handle extension using an adapter per the responsible ME's direction. Record calibration information below.

Instrument #: _____

Calibration expiration date: _____

6.5.2.3 Using the torque wrench, apply an increasing amount of torque to the probe winch handle extension and observe the torque at which the extension slips/rotates--the breakaway torque. Record the breakaway torque below.

Breakaway torque: _____ N-m (ft-lbf)

6.5.2.4 If the breakaway torque is not within the range of the acceptance criteria, adjust the nut per the responsible ME's direction and repeat steps 6.5.2.2 and 6.5.2.3 until the breakaway torque meets the acceptance criteria. NA below if no adjustment is required.

Breakaway torque (after adjustment): _____ N-m (ft-lbf)

ACCEPTANCE CRITERIA: 8.1 - 13.6 N-m (6 - 10 ft-lbf)

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

6.5.2.5 Secure the arm winch handle in a vise such that the handle is fixed but the extension (that connects the handle to the winch) is free to rotate.

6.5.2.6 Attach the calibrated torque wrench to the arm winch handle extension using an adapter.

6.5.2.7 Using the torque wrench, apply an increasing amount of torque to the probe winch handle extension and observe the torque at which the extension slips/rotates--the breakaway torque. Record the breakaway torque below.

Breakaway torque: _____ N-m (ft-lbf)

6.5.2.8 If the breakaway torque is not within the range of the acceptance criteria, adjust the nut per the responsible ME's direction and repeat steps 6.5.2.6 and 6.5.2.7 until the breakaway torque meets the acceptance criteria. NA below if no adjustment is required.

Breakaway torque (after adjustment): _____ N-m (ft-lbf)

ACCEPTANCE CRITERIA: 12.2 - 19.0 N-m (9 - 14 ft-lbf)

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

6.5.2.9 Attach the winch handles to the winches and lift the deployment device from horizontal to vertical with the appropriate rigging and suspend the device from the crane in the 306E penthouse per a 306E Building Certified Crane Operator's direction. Uprighting the deployment device requires two cranes/hoists with a minimum 910 kg (1 ton) capacity. See Figure 6-3 for lift points and required rigging.

6.5.2.10 Secure the deployment device in place by strapping the mast to the stand next to the test pit to prevent movement when the arm is lifted per the Responsible ME's direction. Position the deployment device winches such that winch handles can be reached by test personnel on the lower catwalk in the penthouse.

6.5.2.11 306E Certified Crane Operator and Responsible ME sign below to indicate that the deployment device has been safely secured.

Certified Crane Operator signature _____ Date _____

Responsible ME's signature _____ Date _____

6.5.2.12 With test personnel positioned on the lower catwalk of the penthouse, perform the following to verify the probe winch torque limiter is functioning satisfactorily. With the probe fully secured in the arm socket, turn the probe winch handle clockwise to try to raise the probe and verify that the probe winch handle turns but the probe winch does not rotate.

6.5.2.13 Verify that no damage to the deployment device occurred. In particular, visually inspect the probe cable and cable head to verify no damage occurred.

ACCEPTANCE CRITERIA: no damage to deployment device

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

6.5.2.14 The following will test the effect of raising the arm before the probe has been released from the arm socket (operating procedure violation). With the probe fully secured in the arm socket, perform the following to verify the arm winch torque limiter is functioning satisfactorily. Turn the arm winch handle clockwise to raise the arm. After the arm has been raised to the horizontal position, verify that the arm winch handle turns but the arm winch does not rotate.

6.5.2.15 Verify that no damage to the deployment device occurred. In particular, visually inspect the arm cable, bell crank, probe cable, and probe cable head to verify no damage occurred.

ACCEPTANCE CRITERIA: no damage to deployment device

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

6.5.2.16 Determine the following for the arm winch and probe winch. Note that too many turns of the winches indicates that the torque limiters are set too low and significant slippage is occurring.

(Acceptance Criteria are shown in bold)

arm winch--number of turns from vertical to horizontal: _____

(30 turns maximum)

probe winch--number of turns per foot of deployment (average):. _____

(15 turns maximum)

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

6.5.3 Load Tests

The winches were designed to be self-locking to prevent unintentional spooling. This section will verify that the winches will hold a load of at least 2 times the weight of the probe. An electronic level may be used to determine the angle of the arm if the inclinometer is not available.

6.5.3.1 With the deployment device suspended from the crane in the 306E penthouse, lower the probe (or mock-up probe) to the floor level and attach a test weight such that the combined weight of the probe and test weight is at least 22.7 kg (50 lb). Record the applied load below.

6.5.3.2 Using the arm winch, raise and lower the arm and verify that it remains stationary after releasing the arm winch handle for the following angles of the arm: 10, 20, 30, 45, 60, and 90 degrees with respect to vertical (the arm winch handle should not rotate more than 1/20 of a revolution after releasing).

6.5.3.3 Using the probe winch, raise and lower the probe several feet and verify the probe remains stationary after releasing the probe winch handle (the probe winch handle should not rotate more than 1/20 of a revolution after releasing).

Applied Load: _____ kg (lbs.)

ACCEPTANCE CRITERIA: no unintentional spooling of cable

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

6.5.4 **Bell Crank Retraction Test**

This test will verify that the bell crank on the arm retracts reliably without damaging the probe cable. The configuration for this test is intended to be the worst case scenario for which the probe cable has the highest probability of interfering with the bell crank.

6.5.4.1 With the deployment device suspended from the crane in the 306E penthouse, lower the deployment device such that it is approximately 30 cm (1 ft) from the floor level.

6.5.4.2 Verify that the arm is in the vertical position (aligned with the mast). Raise the bell crank out of the arm by turning the arm winch handle clockwise.

6.5.4.3 Lower the probe (or mock-up probe) to the floor by turning the probe winch handle counterclockwise. Continue to turn the probe winch handle counterclockwise to pay out several inches of slack cable. Note any interference between the probe cable and bell crank on Observation/Results sheets (Appendix A).

6.5.4.4 Retract the bell crank by turning the arm winch handle counterclockwise. Closely observe whether the bell crank retracts reliably without becoming tangled with or damaging the probe cable.

6.5.4.5 Raise the probe by turning the probe winch handle clockwise and verify that it seats reliably in the arm socket.

6.5.4.6 Repeat steps 6.5.4.2 through 6.5.4.5 a minimum of 20 times as directed by the responsible ME to verify that the bell crank retracts reliably each time. Indicate acceptance below.

ACCEPTANCE CRITERIA: **no damage to probe cable**
no interference between bell crank and probe cable

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

6.5.5 Operational Test with Reduced Arm Length

The arm on the deployment device has extensions that can be removed to shorten the arm length. A reduced arm length will allow the deployment device to be installed in tanks with limited headspace, because the overall length of the device is reduced. This test will verify that the deployment device functions satisfactorily with the extensions removed from the arm.

6.5.5.1 Remove the extensions from the arm by removing the screws at the extension joints and reattaching the end piece per the responsible ME's direction.

6.5.5.2 With the deployment device suspended from the crane in the 306E penthouse and personnel positioned on the lower catwalk of the penthouse, lower the probe approximately 6 inches to allow raising the arm.

6.5.5.3 Raise and lower the arm several times as directed by the responsible ME. Verify that the motion is smooth and that the shortened arm functions satisfactorily. Indicate acceptance below.

ACCEPTANCE CRITERIA: rotational motion is smooth
no binding, pinching, or jamming
no damage or excessive wear

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

6.5.6 Deployment Device Insertion into Shipping Container

The deployment device will be contaminated after the first in-tank deployment. It will therefore be shipped from tank farm to tank farm in an approved shipping container. This test will verify that the deployment device can be inserted into the shipping container when bagged with plastic sleeving as it would be after being removed from a waste tank.

6.5.6.1 Wrap the deployment device with the plastic sleeving material in accordance with the responsible ME's and Operations representative's direction.

6.5.6.2 Using two cranes, lift the deployment device in the horizontal position and carefully insert it into the shipping container in accordance with the responsibe ME's direction.

6.5.6.3 Observe the plastic sleeving as the device is inserted to verify that the sleeving does not tear. Record comments on the Observation/Results sheets (Appendix A). Indicate acceptance below.

ACCEPTANCE CRITERIA: device fits inside container
no tearing of plastic sleeving

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

Ops representative's signature _____ Date _____

6.5.7 Winch Enclosure Box Leak Test

The SMMS deployment device winch enclosure box is open to the tank environment through the mast section. Therefore, this box must be leak tested to verify that it is sufficiently leak tight and will provide adequate containment. This leak test will also verify that the assembly is sufficiently weatherproof. Excessive leaks, as determined by the responsible ME, shall be repaired and the assembly shall be retested.

6.5.7.1 Isolate the winch box assembly by disconnecting the mast at the extension joint nearest the winch box. Place and seal a plug to the mast opening. The plug must have pass throughs for the cables.

6.5.7.2 Connect the differential pressure gage (range: 0 to 1250 Pa [0 to 5 in. H_2O]) to a tee fitting that is connected to the port on the winch box. Connect the flow meter (minimum range: 0 to 4.7 x 10^{-4} m^3/s [0 to 1 ft^3/min]), valve, and nitrogen source to the tee fitting as shown in Figure 6-4.

Instrument #: _____ (pressure gage)

Calibration expiration date: _____

Instrument #: _____ (flow meter)

Calibration expiration date: _____

Test Engineer's signature _____ Date _____

6.5.7.3 Slowly open the valve from the building air supply and fill the winch box with air until the internal gage pressure reaches 250 Pa (1.0 in. H_2O).

6.5.7.4 Allow the internal pressure to stabilize. Adjust the control valve until a steady-state condition is obtained, i.e., the flow rate into the system equals the leak rate out of the system such that the internal gage pressure is maintained at a minimum of 250 Pa (1.0 in. H_2O). Record the steady state flow rate (leak rate) and pressure below.

Flow/leak rate: _____

Pressure reading: _____

6.5.7.5 Repair leaks and retest as required. Verify the winch box remains structurally intact. Indicate acceptance below.

ACCEPTANCE CRITERIA: leak rate < 4.7 x 10^{-4} m^3/s (< 1.0 ft^3/min)

Accept/Reject _____

Responsible ME's signature _____ Date _____

6.5.7.6 Connect a vacuum pump to the tee fitting (in place of the nitrogen supply) and slowly pull 1250 Pa (5.0 in. H_2O) vacuum (minimum) on the winch box and verify that the enclosure remains structurally intact. Indicate acceptance below.

ACCEPTANCE CRITERIA: no damage to winch box

Accept/Reject _____

Responsible ME's signature _____ Date _____

6.6 MISCELLANEOUS PROBE HARDWARE TESTS

The following tests are intended to test features of the probe that are not tested as part of the software ATP or probe calibration.

6.6.1 Probe Housing Leak Test

The probe housing must be water tight to survive decontamination and to ensure that no damage occurs if the probe is accidently lowered too far into liquid waste.

6.6.1.1 Verify that the probe housing has been properly sealed.

6.6.1.2 Lower the probe into a barrel full of water such that there is a minimum of 30 cm (12 in.) of water above the top of the probe. Keep the probe under water for a minimum of 5 minutes.

6.6.1.3 Remove the probe from the water and dry the outside thoroughly. Remove the cable head from the probe and visually verify that no water has leaked into the probe housing. Indicate acceptance below.

ACCEPTANCE CRITERIA: no leakage

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

6.6.2 Probe Shock Test

The probe housing and electronics inside the housing must be rugged enough to withstand small impact/shocks during an in-tank deployment. The following test will verify that an impact (typical of what would be expected during normal operation) on the probe housing will not damage the probe.

WARNING

Failure to handle the probe and source carefully or keep it at a maximum distance can result in severe neutron overexposure. Approximate dose rate at 1 m (3 ft) is 6 mrem/h.

CAUTION

Thread damage may occur without proper care in handling of the probe.

6.6.2.1 Verify the probe is functioning satisfactorily by placing the probe (with neutron source installed) into the two calibration fixtures and counting for 2 minutes. Record the count rates (CR) for the three detectors and the two temperature readings in Table 6-1.

6.6.2.2 Drop the probe housing (axis horizontal to drop surface) from a height of 30 cm (1 ft) onto a minimum 1.3 cm (1/2 in.) thick steel plate (uniformly supported on a concrete floor) in the 4 orientations described below. Perform the drops with the spare source holder inserted in the bottom of the probe. After each drop, thoroughly inspect the probe for damage and repeat the probe calibration check as outlined in steps 6.6.2.3 through 6.6.2.6. Also after each drop, remove and reinstall the spare source holder from the bottom of the probe to verify that the source holder can still be easily removed. Record comments on the Observation/Results sheets (Appendix A).

1. Along the axis of detector #1 on the anode side.
2. Perpendicular to the axis of detector #1, on the side closest to detector #2 (rotated 90 degrees from orientation 1)
3. Along the axis of detector #1 on the side opposite the anode side (rotated 180 degrees from orientation 1)
4. Perpendicular to the axis of detector #1, on the side opposite of detector #2 (rotated 270 degrees from orientation 1)

NOTE: The spare source holder must be removed after each drop so that the actual source can be installed for checking probe calibration. After the probe calibration check, remove the actual source and reinstall the spare source holder for the next drop. Verify that the source holder can still be easily removed/installed after each drop.

6.6.2.3 Drop the probe onto the surface in orientation 1. Inspect the probe for damage, install the actual source, place the probe into each of the calibration fixtures, and count for 2 minutes. Remove the source and reinstall the spare source holder. Record count rates and temperature readings in Table 6-1.

6.6.2.4 Drop the probe onto the surface in orientation 2. Inspect the probe for damage, install the actual source, place the probe into each of the calibration fixtures, and count for 2 minutes. Remove the source and reinstall the spare source holder. Record count rates and temperature readings in Table 6-1.

6.6.2.5 Drop the probe onto the surface in orientation 3. Inspect the probe for damage, install the actual source, place the probe into each of the calibration fixtures, and count for 2 minutes. Remove the source and reinstall the spare source holder. Record count rates and temperature readings in Table 6-1.

6.6.2.6 Drop the probe onto the surface in orientation 4. Inspect the probe for damage, install the actual source, place the probe into each of the calibration fixtures, and count for 2 minutes. Remove the source and reinstall the spare source holder. Record count rates and temperature readings in Table 6-1.

6.6.2.7 Drop the probe oriented vertically such that the probe bottom impacts the surface (with the probe bottom parallel to the drop surface). Use the same drop height and impact surface described in 6.6.2.2. Inspect the probe for damage, install the actual source, place the probe into each of the calibration fixtures, and count for 2 minutes. Remove the source and reinstall the spare source holder. Record count rates and temperature readings in Table 6-1.

6.6.2.8 Calculate the statistical standard deviation (SD) of each count rate by dividing the square root of the total number of counts by the time interval. Record the standard deviations in Table 6-1.

6.6.2.9 Compare the count rates and temperature readings after the drops to the count rates and temperature readings before the drops to verify that the readings did not change significantly. A significant change in the count rate is defined as more than 3 standard deviations difference. Verify that no significant damage to the probe occurred and indicate acceptance below.

ACCEPTANCE CRITERIA: count rate < 3 standard deviations difference
no damage to probe

Accept/Reject (circle one)

Responsible EE's signature _____ Date _____

Responsible ME's signature _____ Date _____

6.6.3 Source Handling Tool Test

The following test will verify that the source handling tool cannot damage the source holder when the source is removed from the bottom of the probe.

6.6.3.1 With the deployment device in the horizontal position and the neutron probe attached inside the arm socket, screw the spare source holder (with no source inside) into the probe bottom.

6.6.3.2 Attach the source handling tool to the nut on the source holder by turning the center handle clockwise.

6.6.3.3 Carefully let go of the source handling tool and verify that the tool's weight causes the probe to rotate without damaging the source holder. Record comments on the Observation/Results sheets (Appendix A). Remove the source holder from the probe bottom and visually inspect to verify that it was not damaged.

ACCEPTANCE CRITERIA: no damage to source holder

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

6.7 DECONTAMINATION SYSTEM TEST

The decontamination system provides cold water for washing the SMMS deployment device assembly (mast, arm, and neutron probe). A rubber wiper is used during withdrawal of the in-tank hardware. The nozzles on the spray ring are angled downward. Therefore, because of the Venturi effect, high velocity water flow through the nozzles causes a suction at the top of the spray ring. The approximate suction created by the operation of the spray ring will also be measured as part of this test.

6.7.1 Equipment Setup

6.7.1.1 Prepare a testing area on the concrete pad outside the 306E building.

6.7.1.2 Connect the decontamination equipment hoses to the water supply tank, feed pump, high pressure washer, and decontamination spool piece as specified in H-14-100462*. Figure 6-5 shows the basic layout of the decontamination system.

6.7.1.3 Verify the detergent valve on the high pressure pump is in the closed position.

6.7.1.4 Verify by visual inspection that the tank is filled with clean water.

6.7.1.5 Verify that the hoses are secure from movement.

Test Engineer's signature _____ Date _____

6.7.2 Functional Test

6.7.2.1 Open valves HV-1 and HV-2.

WARNING

The feed pump and high pressure pump exhaust piping becomes hot during operation and remains hot for a while after it is turned off. Do not touch a muffler while it is hot.

*To be issued.

CAUTION

Do not run the feed pump for more than 5 minutes with water flowing through HV-1. Never run the high-pressure pump without adequate water supply. Pump and system overheating can occur.

6.7.2.2 Start up the feed pump and the high pressure pump.

6.7.2.3 Visually observe the spray patterns of the nozzles to verify that water distribution is uniform. A non-uniform water spray may indicate a plugged nozzle. If a nozzle appears to be plugged, shut down the pumps, clean the nozzle, and repeat steps 6.6.2.1 through 6.6.2.3 as required.

6.7.2.4 Carefully inspect the decontamination spool piece, hoses, and fittings for leakage. Repair leaks as required.

ACCEPTANCE CRITERIA: uniform spray pattern, no leakage

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

6.7.2.5 Determine the approximate flow rate (gpm) by recording the change in the totalizer reading over a 5 minute period. The flow rate is calculated by dividing the change in the totalizer reading by the time interval. Indicate acceptance below.

Start time: _____ Totalizer reading: _____

Stop time: _____ Totalizer reading: _____

Calculated flow rate: _____

ACCEPTANCE CRITERIA: 2 - 5 gpm flow rate

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

6.7.2.6 Shut down the pumps, and close valve HV-2.

6.7.2.7 Seal up the top opening of the decontamination spool piece (with a blind flange or equivalent). Verify that a small hole has been threaded through the center of the blind flange for installing a pressure gage.

6.7.2.8 Connect one port of a differential pressure gage (minimum range: 0 to 1250 Pa [0 to 5 in. H_2O]) to the small opening on the top of the spool piece and leave the other port open to atmosphere. Record instrument calibration information below.

Instrument #: _____

Calibration expiration date: _____

6.7.2.9 Open valve HV-2, and start up the feed pump and the high pressure pump.

6.7.2.10 Record the reading on the differential pressure gage. Indicate acceptance below.

Reading _____

ACCEPTANCE CRITERIA: < 0 Pa (vacuum required)

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

6.7.2.11 Shut down the pumps, close valves HV-1 and HV-2, and disassemble equipment.

6.7.3 Full-Scale Test

This test will verify that the deployment device can be easily removed and decontaminated through the decontamination spool piece. It will also verify that all of the surfaces of the deployment device are self-draining and that the cables will not be damaged from the high pressure spray.

6.7.3.1 Install an adapter plate across the top of the 306E test pit to mock-up a 4-inch riser flange. Install the decontamination spool piece, rubber wiper, and impact plate on top of the adapter plate.

6.7.3.2 Position a 55-gallon drum at the bottom of the test pit directly below the adapter plate. Attach a plastic sleeve to the adapter plate and place the other end inside the drum to catch water draining from the spool piece.

6.7.3.3 Lift the deployment device from horizontal to vertical with the appropriate rigging and lower the device through the spool piece per a 306E Building Certified Crane Operator's direction. Uprighting the deployment device requires two cranes/hoists with a minimum 910 kg (1 ton) capacity. See Figure 6-3 for lift points and required rigging. Note that setting the deployment device down onto the impact plate/spool piece assembly is optional.

6.7.3.4 Set up the decontamination system in accordance with Section 5.2.8 of WHC-SD-WM-OMM-024.

6.7.3.5 Slowly lift/remove the deployment device while operating the decontamination system in accordance with WHC-SD-WM-OMM-024.

6.7.3.6 Verify that the deployment device can be removed easily through the spool piece and that the rubber wiper is functioning satisfactorily. Verify that all surfaces of the deployment device are self-draining and that there are no "traps" or "pockets" of water.

6.7.3.7 After the deployment device has been removed from the spool piece, lower the deployment device back to the horizontal position per a 306E Building Certified Crane Operator's direction. Perform a thorough visual inspection of the cables to verify that no damage occurred. Indicate acceptance below.

ACCEPTANCE CRITERIA: **deployment device self-draining**
no damage to cables

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

As the last step for the 306E Test Procedure, review the test and verify that all steps in Section 6.0 have been completed.

Test Engineer's signature _____ Date _____

7.0 FMEF TEST PROCEDURE

7.1 PREREQUISITES

7.1.1 Prejob Meeting

Conduct a "prejob meeting" of operations including a review of all procedures, drawings, safety hazards, and other engineering documents required to complete the test. Personnel who have attended the prejob meeting shall sign the attendance form given in Appendix C.

Test Engineer's signature _____ Date _____

7.1.2 Equipment Staging and Test Setup

Verify that the equipment listed in Section 4.3 is staged in the test area per the responsible ME's and FMEF representative's direction. Verify that no interconnections have been made. Note that only the deployment device and rigging accessories are required for starting testing. If not all of the equipment in Section 4.3 is available at the start of testing, record below when the rest of the equipment is delivered. The DAV will be delivered and setup at FMEF after testing has begun. The DAV will only be used for training Operations personnel.

The test area in room 351 must be prepared for the probe placement test (Section 7.3). The following steps can be performed before or after the deployment device is installed. Prepare and locate targets for the probe placement test as follows.

7.1.2.1 Prepare 29 targets by cutting out circular pieces of colored paper 15 cm (6 in.) in diameter.

7.1.2.2 Lower a plumb bob (or mock-up probe if deployment device is installed) through the center of the mock-up riser to the ground level in room 351 and mark the center of the riser (location for Target 1).

7.1.2.3 Place and secure (using tape) the targets on the floor of room 351 below the mock-up riser (in which the deployment device is installed) as shown in Figure 7-1. This figure represents the recommended sampling point grid for in-tank moisture measurements. Table 7-1 lists the locations for the targets.

NOTE: The specified positions for the targets are approximate. The required accuracy for placing the targets is ± 7.6 cm (3 in.). The furthest targets are exceptions, they cannot be located more than 1.8 m (6 ft) away or the arm will not reach it.

7.1.2.4 Sign below to indicate that the equipment has been staged and is ready to be installed.

Test Engineer's signature _____ Date _____

7.2 DEPLOYMENT DEVICE TEST

7.2.1 Install Deployment Device and Camera

7.2.1.1 Lift the deployment device from horizontal to vertical and install in the selected mock-up riser in room 500 per the critical lift procedure provided in the work package. Bolt the deployment device bearing plate to the mock-up riser using the bolts provided with the deployment device.

7.2.1.2 Install the camera system in the selected adjacent mock-up riser in room 500 per TO-020-141, *In-Tank Video Procedure* (disregard steps related to contamination control and HPT surveys). Set up two video monitors: one next to the camera controls, and one next to the deployment device winch enclosure.

7.2.1.3 Connect the cables between the camera, camera controls, and video monitors and supply power to the camera system.

NOTE: Power to all components will be disabled at the end of testing each day. The cables should be reinspected at the beginning of each day to verify that they are connected correctly before resupplying power to the components.

Test Engineer's signature _____ Date _____

7.2.2 Deployment Device Arm Operability and Reliability Test

This section will demonstrate that sustained, repeated execution of the deployment sequence (raising and lowering the arm) does not have adverse effects on the mechanical operability and reliability of the deployment device.

7.2.2.1 Repeat steps 7.2.2.2 through 7.2.2.6 a minimum of 50 times as directed by the responsible ME. Using the camera, zoom in on the deployment device as directed by the responsible ME and observe whether the following conditions are met.

1. The rotational motion is smooth.
2. The arm winch mechanism does not jam.
3. No binding or pinching of the cables occurs.
4. The mechanical parts are not damaged or galled and the cables do not show excessive wear.
5. The probe seats reliably in the arm's probe socket.
6. The arm and probe cables seat reliably in the mast's channel shaped cut-out when the arm is returned to the vertical position.

7. The arm and probe do not exhibit a significant amount of oscillation or "bouncing" during deployment.
8. The bell crank retracts reliably without interfering with or damaging the probe cable.

7.2.2.2 Lower the probe approximately 15 cm (6 in.) by rotating the probe winch counterclockwise. The probe needs to clear the arm's probe socket before the arm can be lifted.

7.2.2.3 Confirm that the clearance between the probe and the arm can be verified with the camera.

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

7.2.2.4 Raise the arm to the horizontal position by rotating the arm winch clockwise.

7.2.2.5 Lower the arm to the vertical position by rotating the arm winch counterclockwise.

7.2.2.6 Raise the probe by rotating the probe winch clockwise until it is secured in the arm's probe socket.

7.2.2.7 After the deployment device is removed from the mock-up riser (after section 7.3 is performed) and placed in the horizontal position, perform a thorough inspection of the deployment device. In particular, inspect the cables, connectors, and winches to verify that they are not damaged and do not show excessive wear. Indicate acceptance below.

ACCEPTANCE CRITERIA: items 1 through 8 of 7.2.2.1

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

7.2.3 Probe Cable Wear Test

This section will demonstrate that raising and lowering the probe does not have adverse effects on the probe cable or cause excessive wear.

7.2.3.1 Using the dial calipers, measure the diameter of a new 3 m (10 ft) section of probe cable in 20 locations, approximately 15 cm (6 in.) apart. Record diameters in Table 7-2. Calculate the average diameter and the standard deviation below.

Average new cable diameter: _____

Standard deviation of average new cable diameter: _____

7.2.3.2 Lower the probe to the ground and mark off a 60 cm (2 ft) section of probe cable near the probe using tape or some other means of clearly identifying the section of cable.

7.2.3.3 Using the dial calipers, measure the diameter of a the marked section of probe cable in 20 locations, approximately 2.5 cm (1 in.) apart. Clearly identify the locations on the cable at which the measurements were made. Record diameters in Table 7-2. Calculate the average diameter and the standard deviation below.

Average pre-test cable diameter: _____

Standard deviation of pre-test cable diameter: _____

7.2.3.4 Raise the arm to the horizontal position by turning the arm winch handle clockwise.

7.2.3.5 Raise the probe by turning the arm winch clockwise until the lower tape mark is approximately lined up with the rounded surface on the end of the arm.

7.2.3.6 Raise and lower the probe 60 cm (2 ft) 50 times as directed by the responsible ME such that the probe cable section between the tape marks slides repeatedly over the rounded surface on the end of the arm.

7.2.3.7 Lower the probe to the ground. Using the dial calipers, measure the diameter of the marked section of probe cable in the same 20 locations as before. Record diameters in Table 7-2. Calculate the average diameter and the standard deviation below.

Average mid-test cable diameter: _____

Standard deviation of mid-test cable diameter: _____

7.2.3.8 Raise the probe again until the lower tape mark is lined up with the rounded surface on the end of the arm.

7.2.3.9 Raise and lower the probe 60 cm (2 ft) 50 more times (100 cycles total) as directed by the responsible ME such that the probe cable section between the tape marks slides repeatedly over the rounded surface on the end of the arm.

7.2.3.10 Lower the probe to the ground. Using the dial calipers, measure the diameter of a the marked section of probe cable in the same 20 locations as before. Record diameters in Table 7-2. Calculate the average diameter and the standard deviation below.

Average post-test cable diameter: _____

Standard deviation of post-test cable diameter: _____

7.2.3.11 Compare the post-test cable average diameter to the pre-test cable average diameter. Calculate the number of standard deviations that the post-test cable diameter differs from the pre-test cable diameter and record below. If the post-test cable diameter is more than six standard deviations (based on the pre-test average cable diameter) different than the pre-test cable, then the results are not acceptable.

Number of standard deviations difference: _____

ACCEPTANCE CRITERIA: less than 6 standard deviations difference

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

7.2.4 Stop Clamps Functional Test

With the deployment device installed in the mock-up riser, perform the following steps to verify that the stop clamps are functioning correctly.

7.2.4.1 Set the stop clamps such that the deployment device mast can only rotate approximately 45 degrees. Rotate the box until it reaches the stops. Apply approximately 450 N (100 lbf) by pushing on the box to verify that the stops prevent further rotation such that rotation is restricted to 45 degrees.

7.2.4.2 Repeat step 7.2.4.1 for angles of 90, 180, and 270 degrees. Also verify that not setting the stop clamps will allow full 360 degree rotation. Indicate acceptance below.

ACCEPTANCE CRITERIA: stop clamps limit the specified rotation

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

7.3 PROBE PLACEMENT TEST

The deployment device is equipped with an electronic compass, inclinometer, and encoders for positioning the probe on the waste surface. However, a relatively flat surface is required for positioning the probe to perform an accurate moisture measurement. For an in-tank deployment, it will not be known exactly where the preferred measurement positions are located. Therefore, given an approximate sampling position, the deployment device operator must be able to adjust the probe position using only the view from the camera, such that the probe is positioned on a good surface for moisture measurement. This section will test the ability of an operator to position the probe on selected targets using the deployment device and view from a camera located up to 9.1 m (30 ft) from the targets. The acceptance criteria will be based on the time it takes the operator to place the probe on 29 targets (one riser deployment).

Two separate camera locations will be used for this test. The first camera location will be in an adjacent mock-up riser located near the deployment device. Because this riser is relatively close to the deployment device, a second test will be performed with the camera on the ground floor positioned 9.1 m (30 ft) from the deployment device (FMEF does not have a mock-up riser that is 9.1 m away from the riser in which the deployment device will be installed).

In addition, the following test must be performed at least once by a representative from Operations. Once the deployment device is installed in a waste tank, operators will control the deployment device for placing the probe on the waste surface. The operator will be wearing anti-contamination clothing and possibly a mask. The Operations representative will determine the acceptability of ease of operation for the deployment device.

7.3.1 Equipment Setup

7.3.1.1 Measure the center to center distance from the mock-up riser (in which the deployment device is installed) and the mock-up riser (in which the camera is installed) using a tape measurer with a minimum accuracy of ± 1.3 cm (0.5 in.). Record below.

Distance _____

Test Engineer's signature _____ Date _____

7.3.1.2 Verify that the deployment device arm and probe are aligned in the vertical position as it would be installed in the riser.

7.3.1.3 Verify that the cables are connected between the camera, camera controls, and video monitors and supply power to the camera system. Power up the camera lights.

7.3.1.4 Turn off the lights in room 351 such that the only light available in room 351 is from the camera lights.

Test Engineer's signature _____ Date _____

7.3.2 Functional Test for Camera Located in Adjacent Riser

Steps 7.3.2.1 through 7.3.2.5 are intended to provide guidance for placing the probe on a target. These steps may be deviated from as needed if a better method for placing the probe is determined. Note that the probe placement operation must also be videotaped. Record comments on the Observation/Results sheets (Appendix A).

In addition, the locations of the targets are not to be given to the winch operator. This test is intended to show that the probe can be placed in a good sampling location using only the view from the camera.

7.3.2.1 Record the start time below.

Start time: _____

NOTE: When tracking the time it takes to place the probe on targets, be sure to note any breaks that were taken. Subtract the total time for breaks from the time interval below.

7.3.2.2 Lower the probe onto Target 1 by rotating the probe winch counterclockwise. Place the probe as close as possible to the center of the target. Follow the probe with the camera as it is lowered to the floor.

7.3.2.3 After the winch operator is satisfied with the probe placement, verify that the probe is on the target from the lower level (room 351). Also verify that the probe is flat on the target surface. Measure the minimum distance from the probe housing to the edge of the target and record in Table 7-3.

7.3.2.4 Measure the radial distance from the center of the riser to the center of the probe and the azimuthal angle and record in Table 7-3. Also record the radial distance and azimuthal angle indicated on the DAV's computer display (from the compass and inclinometer).

7.3.2.5 Rotate the deployment device so that the arm is in position for placing the probe on the next target.

7.3.2.6 Raise the arm a few degrees by rotating the arm winch clockwise.

7.3.2.7 Lower the probe by rotating the probe winch counterclockwise until it is near the target.

7.3.2.8 Rotate the deployment device, and raise or lower the arm and probe as required to position the probe on the center of the target.

7.3.2.9 Raise the probe as required and repeat steps 7.3.2.3 through 7.3.2.6 for the rest of the targets (29 total). Record comments and observations on the Observation/Results sheets (Appendix A). Record the stop time, calculate the time interval, and record below. Indicate acceptance for the probe placement accuracy.

7.3.2.10 For the "repeat" sample points/targets indicated in Table 7-3, return the probe to the previous position according to the compass and inclinometer readings. Measure the radial distance from the center of the riser to the center of the probe and the azimuthal angle and record in Table 7-3. Compare to the previous values. Record comments and observations on the Observation/Results sheets (Appendix A).

Stop time: _____

Time interval (with breaks subtracted): _____

ACCEPTANCE CRITERIA: time interval of 8 hours (maximum)

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

7.3.3 Remove Camera and Setup in Room 351

7.3.3.1 Disable power to the camera system and disconnect the cables between the camera, camera controls, and video monitors.

7.3.3.2 Remove the camera system from the selected mock-up riser in room 500 per TO-020-141, *In-Tank Video Procedure* (disregard steps related to contamination control and HPT surveys).

7.3.3.3 Position the camera on the ground level 9.1 m (30 ft) ± 15 cm (6 in.) away from the center of the riser in which the deployment device is installed. Note that the camera may need to be located outside of room 351 and view the probe through one of the windows to obtain the specified distance.

7.3.3.4 Reconnect the cables between the camera, camera controls, and video monitors and supply power to the camera system. Turn on the camera lights.

7.3.3.5 Turn off the lights in room 351 such that the only light available in room 351 is from the camera lights.

Test Engineer's signature _____ Date _____

7.3.4 Functional Test for Camera Located in Room 351

Repeat the steps specified in Section 7.3.2 for the second camera location, placing the probe on each of the 29 targets. Record measurements in Table 7-4. Record comments on the Observation/Results sheets (Appendix A). Record the start time, stop time, calculate the time interval, and record below. Indicate acceptance for the probe placement accuracy at this camera location.

Start time: _____

NOTE: When tracking the time it takes to place the probe on targets, be sure to note any breaks that were taken. Subtract the total time for breaks from the time interval below.

Stop time: _____

Time interval (with breaks subtracted): _____

ACCEPTANCE CRITERIA: time interval of 8 hours (maximum)

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

7.3.5 Probe Placement on Irregular Surfaces

The tank waste surface that the probe will be positioned on is not flat or smooth like the targets in the previous tests. For the tests in this section, position the probe on selected surfaces per the responsible ME's and/or Operations Representative's direction. For each surface, record a description of the surface in Table 7-5. Videotape the surface and probe placement operation. After the winch operator is satisfied with the probe placement, measure the probe offset from the surface (if any), the probe inclination, and any other parameters to describe the placement accuracy. Record the measurements and comments in Table 7-5. Indicate acceptance for the probe placement accuracy below.

Accept/Reject (circle one)

Responsible ME's signature _____ Date _____

Operations Representative signature _____ Date _____

7.3.6 Operations Representative Approval

A representative from Operations shall perform the tests in Section 7.3.2 and Section 7.3.4 at least once to determine the ease of operation of the deployment device. In addition, this representative will attach and remove the brackets that prevent azimuthal rotation to verify that this operation can be performed in the field. Using the following criteria (as a minimum), indicate acceptability of deployment device operation.

7.3.6.1 Verify that the probe can be easily placed on a target using the deployment device winches and only the view from the camera.

Accept/Reject (circle one)

Operations Representative signature _____ Date _____

7.3.6.2 Verify that the deployment device can be easily rotated around the azimuth such that the smallest operator can perform this task.

Accept/Reject (circle one)

Operations Representative signature _____ Date _____

7.3.6.3 Verify that the arm and probe cranks can be easily turned such that this operation is not exhausting to the smallest operator.

Accept/Reject (circle one)

Operations Representative signature _____ Date _____

7.3.6.4 Verify that brackets that prevent azimuthal rotation of the deployment device during tank installation/removal can be attached/removed by an operator wearing clothing per the RWP.

Accept/Reject (circle one)

Operations Representative signature _____ Date _____

7.3.7 Remove Deployment Device

7.3.7.1 Disable power to the deployment device and disconnect cables.

7.3.7.2 Lift the deployment device from the mock-up riser and place in the horizontal position on pipe stands (or sawhorses) per the critical lift procedure.

7.3.7.3 With the deployment device in the horizontal position, perform a thorough inspection of the device as described in Step 7.2.2.7. Indicate acceptance at the end of Section 7.2.2.

7.3.7.4 Disassemble and secure equipment for transport.

As the last step for the FMEF Test Procedure, review the test and verify that all steps in Section 7.0 have been completed.

Test Engineer's signature _____ Date _____

Figure 1-1. Surface Moisture Measurement System.

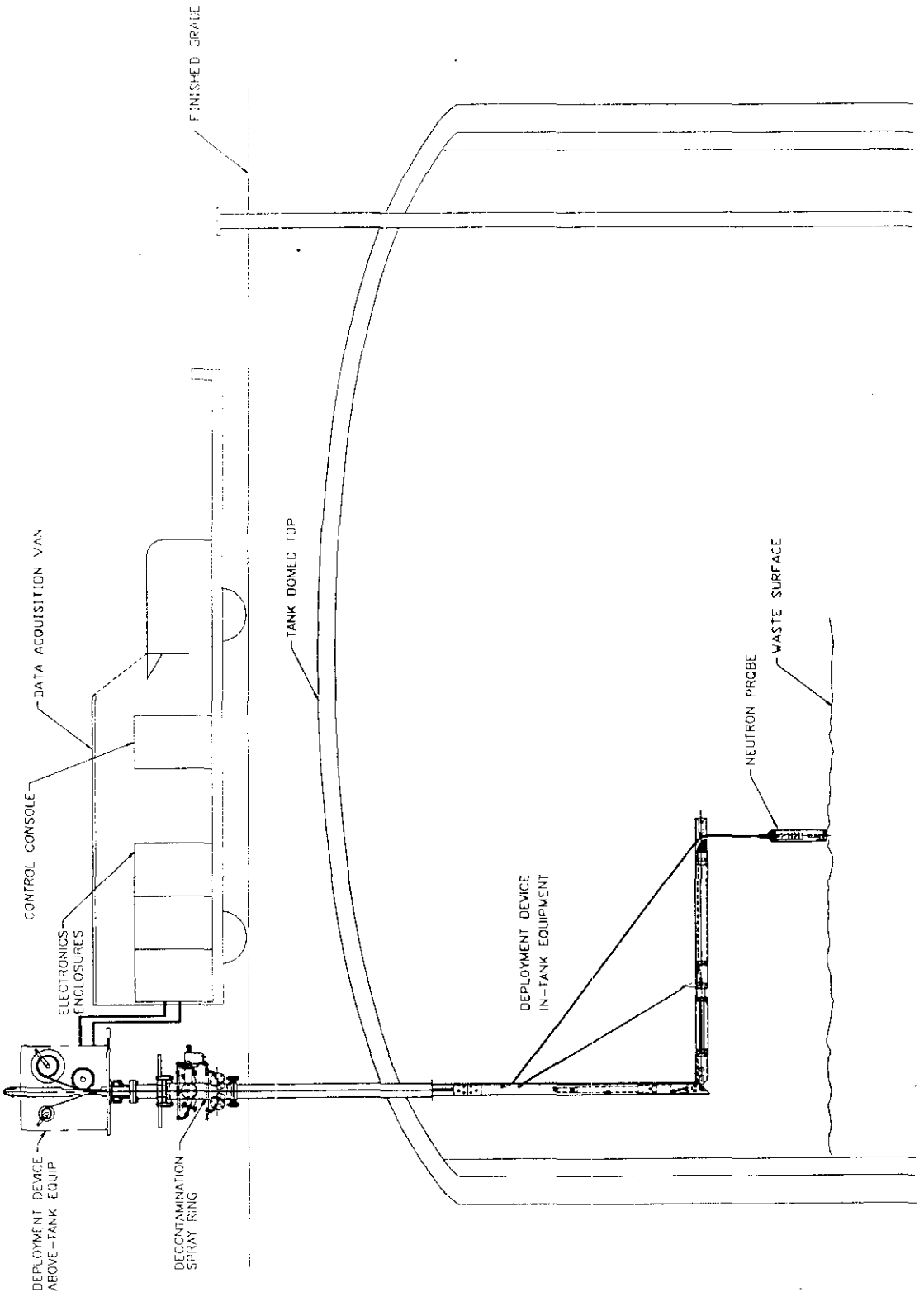


Figure 6-1. Circuit Breaker Panel Layout.

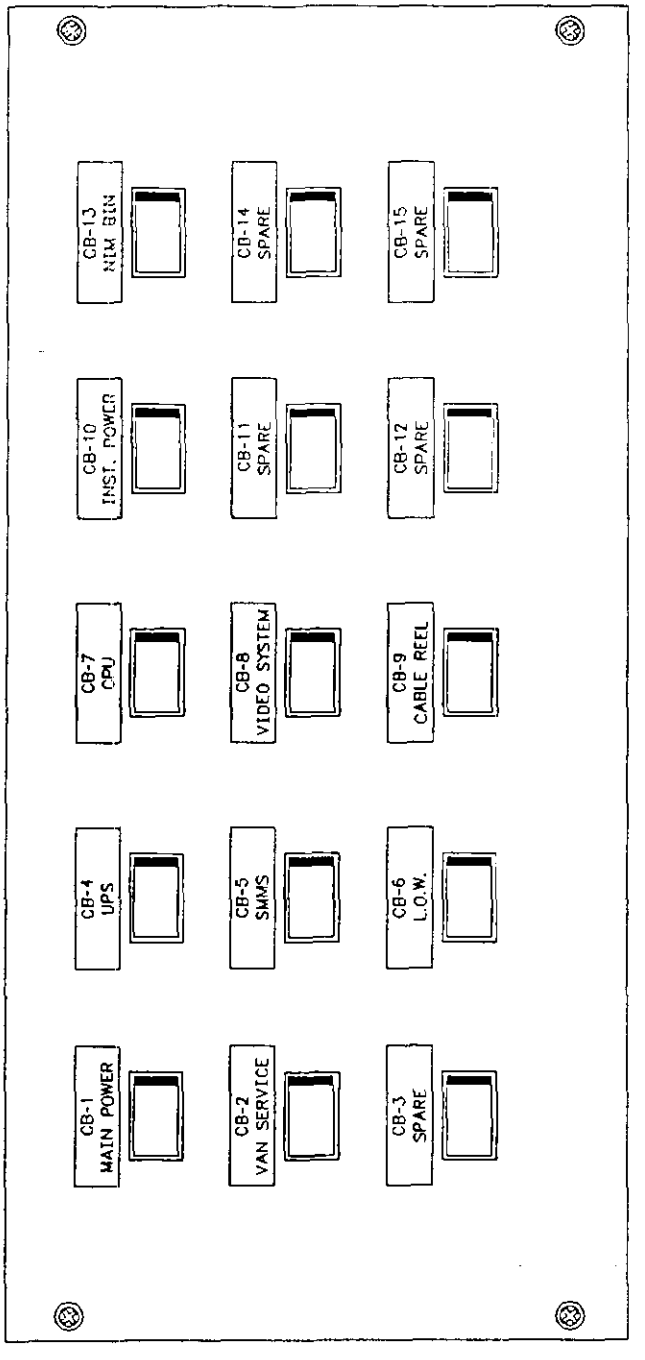
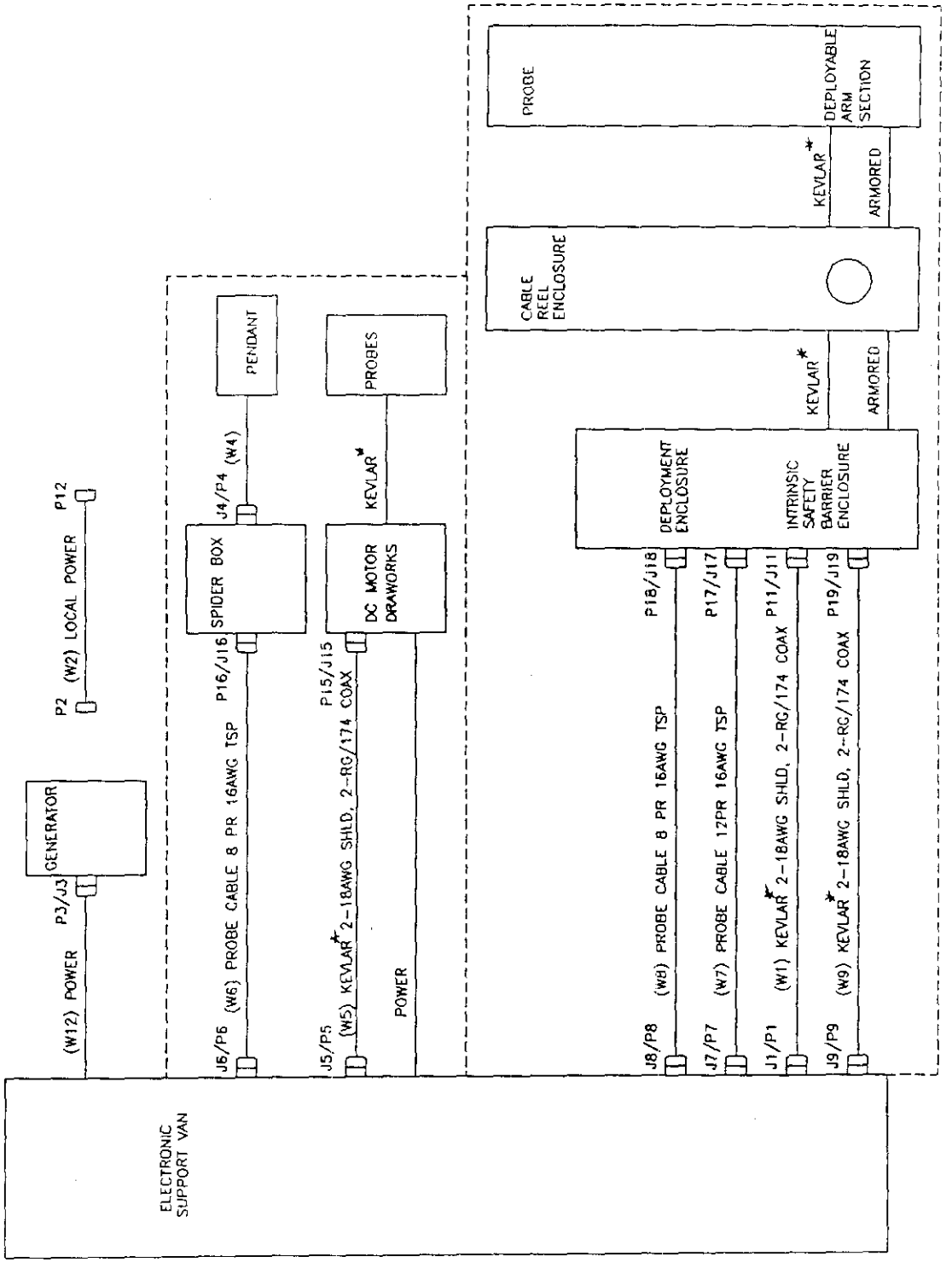


Figure 6-2. SMMS and LOWMMS Instrument Cable Connections.



*Kevlar is a trademark of E.I. du Pont de Nemours and Company, Wilmington, DE.

Figure 6-3. SMMS Deployment Device Lift Points and Required Rigging.

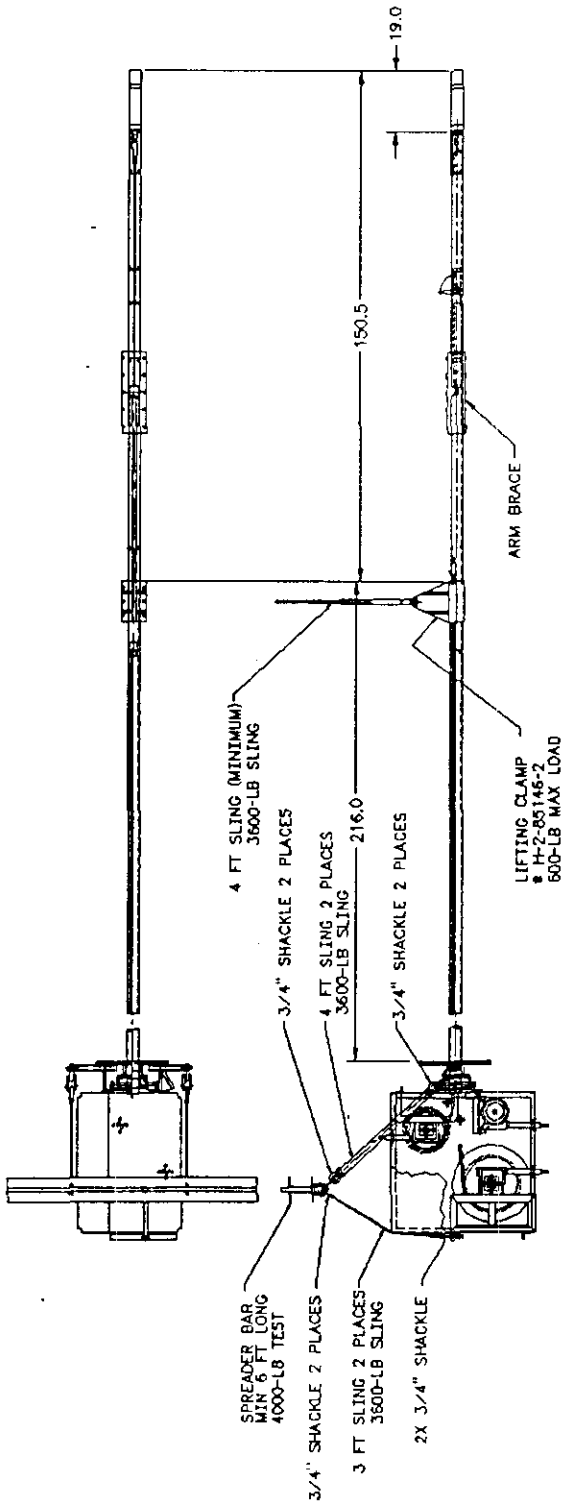


Figure 6-4. Winch Enclosure Box Leak Test Setup.

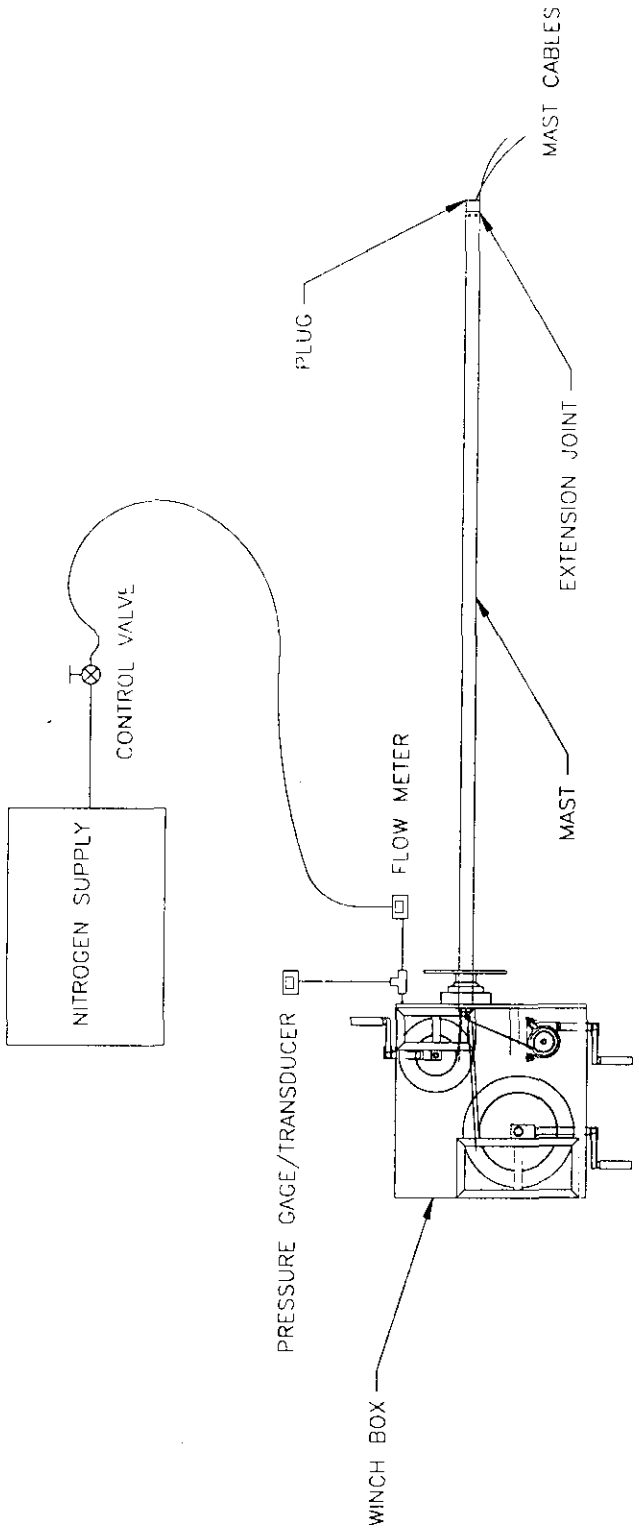


Figure 6-5. SMMS Decontamination System Block Diagram.

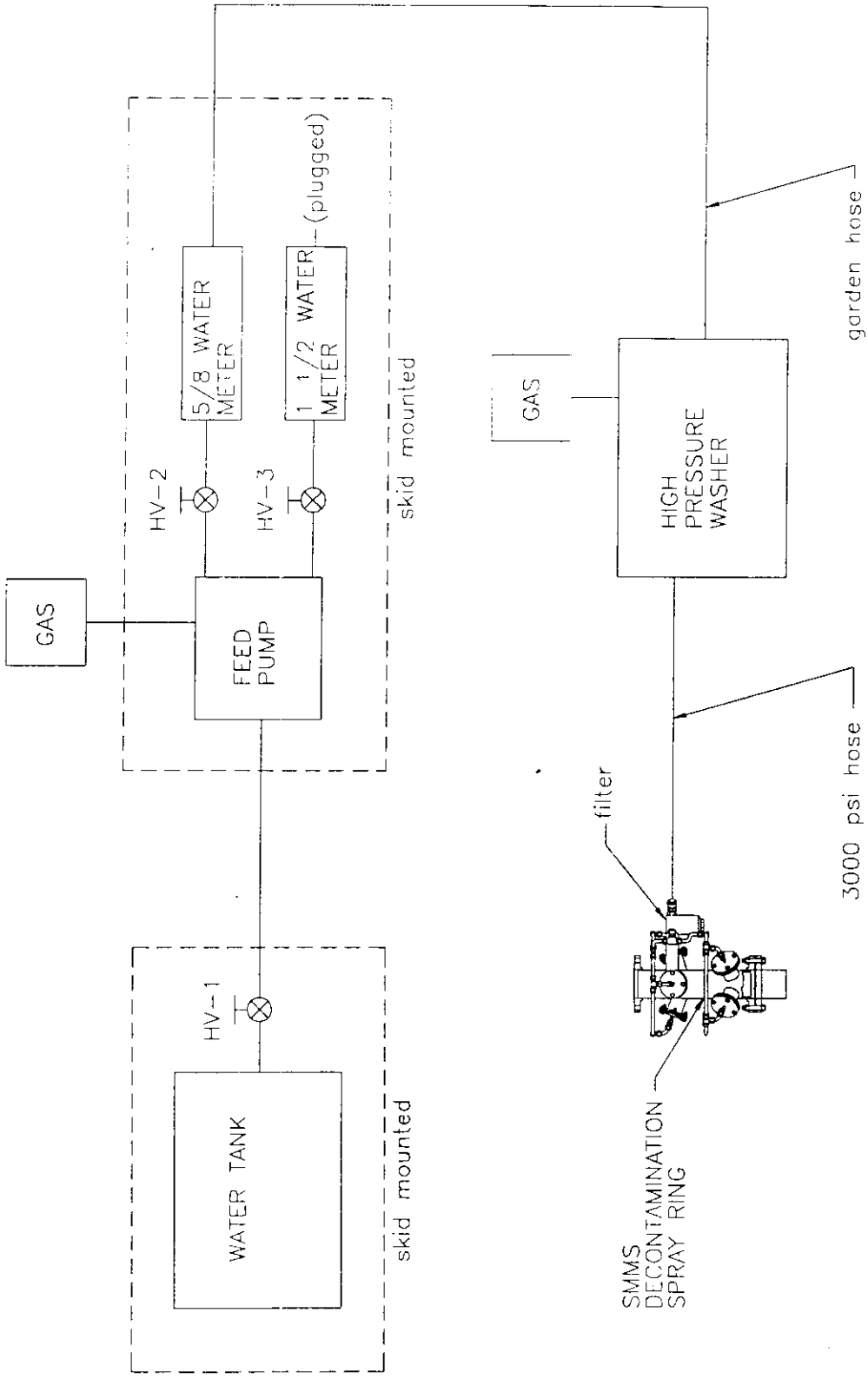


Figure 7-1. Sampling Point/Target Layout.

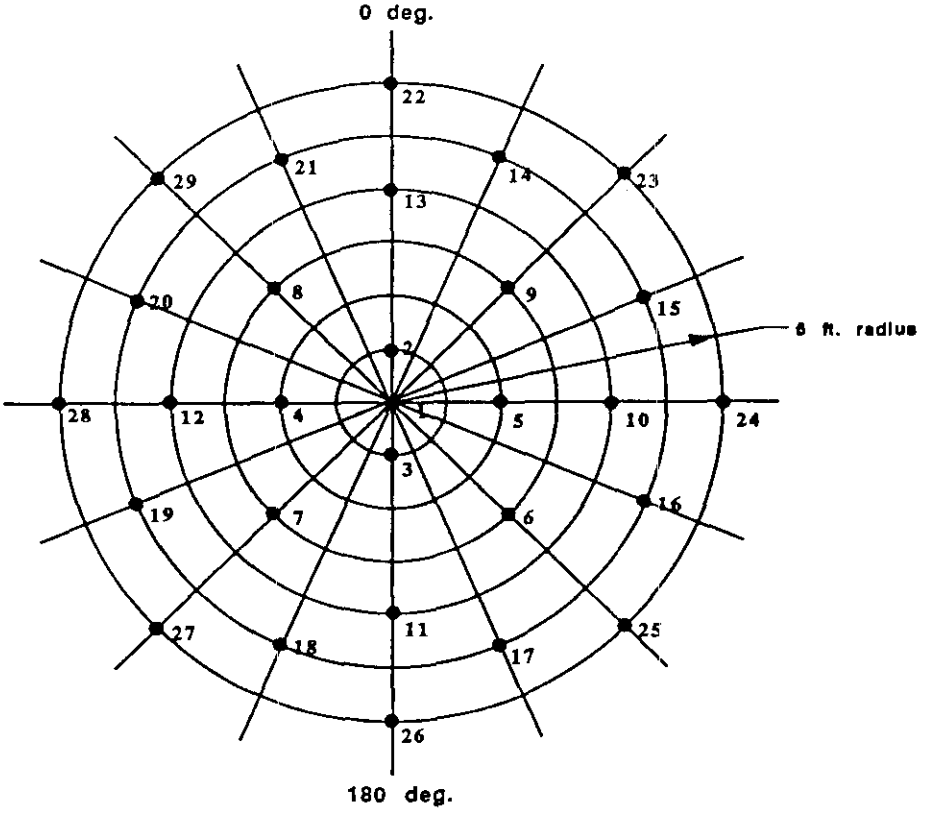


Table 6-1. Probe Drop Test Measurements (Section 6.6.2).

	Calibration Fixture #1					Calibration Fixture #2				
Drop Test #	Det. #1	Det. #2	Det. #3	Temp #1	Temp #2	Det. #1	Det. #2	Det. #3	Temp #1	Temp #2
Pre-Test (6.6.2.1)	CR SD	CR SD	CR SD			CR SD	CR SD	CR SD		
1 (6.6.2.3)	CR SD	CR SD	CR SD			CR SD	CR SD	CR SD		
2 (6.6.2.4)	CR SD	CR SD	CR SD			CR SD	CR SD	CR SD		
3 (6.6.2.5)	CR SD	CR SD	CR SD			CR SD	CR SD	CR SD		
4 (6.6.2.6)	CR SD	CR SD	CR SD			CR SD	CR SD	CR SD		
5 (6.6.2.7)	CR SD	CR SD	CR SD			CR SD	CR SD	CR SD		

Table 7-1. Sampling Point/Target Locations.

Sample Point#	Radius (m [ft])	Azimuthal Angle (degrees)
1	0	NA
2	0.3 [1]	0
3	0.3 [1]	180
4	0.6 [2]	90
5	0.6 [2]	270
6	0.9 [3]	135
7	0.9 [3]	225
8	0.9 [3]	315
9	0.9 [3]	45
10	1.2 [4]	90
11	1.2 [4]	180
12	1.2 [4]	270
13	1.2 [4]	0
14	1.5 [5]	22.5
15	1.5 [5]	67.5
16	1.5 [5]	112.5
17	1.5 [5]	157.2
18	1.5 [5]	202.5
19	1.5 [5]	247.5
20	1.5 [5]	292.5
21	1.5 [5]	337.5
22	1.8 [6]	0
23	1.8 [6]	45
24	1.8 [6]	90
25	1.8 [6]	135
26	1.8 [6]	180
27	1.8 [6]	225
28	1.8 [6]	270
29	1.8 [6]	315

Table 7-2. Probe Cable Diameter Measurements (Section 7.2.3).

Measurement#	New Cable Measurements	Pre-test Measurements	Mid-Test Measurements (after 50 cycles)	Post-Test Measurements (after 100 cycles)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Table 7-3. Probe Placement Measurements (Section 7.3.2).

Target #	Distance to Target Edge	Measured radius/angle	Computed radius/angle	Measured radius/angle (repeats*)
1*				
2*				
3				
4				
5*				
6				
7*				
8				
9				
10				
11				
12				
13*				
14				
15				
16				
17*				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29*				

Table 7-4. Probe Placement Measurements (Section 7.3.4).

Target #	Distance to Target Edge	Measured radius/angle	Computed radius/angle	Measured radius/angle (repeats*)
1*				
2*				
3				
4				
5*				
6				
7*				
8				
9				
10				
11				
12				
13*				
14				
15				
16				
17*				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29*				

Table 7-5. Probe Placement on Irregular Surfaces (Section 7.3.5).

Surface Description	Probe Offset	Probe Inclin. Angle	Comments

APPENDIX A

SURFACE MOISTURE MEASUREMENT SYSTEM FUNCTIONAL TESTING OBSERVATION/RESULTS SHEET

SURFACE MOISTURE MEASUREMENT SYSTEM
FUNCTIONAL TESTING
OBSERVATION/RESULTS SHEET

TEST STEP	OBSERVATION/RESULTS	INITIALS	DATE

TEST STEP	OBSERVATION/RESULTS	INITIALS	DATE

APPENDIX B

EXCEPTION TO SMMS ACCEPTANCE TEST

EXCEPTION TO SMMS ACCEPTANCE TEST

Title of Test: Surface Moisture Measurement System Test

EXCEPTIONS			CORRECTION APPROVAL		
PARAGRAPH NO.	DATE	DESCRIPTION	ORGANIZATION	INITIALS	DATE

TEST APPROVED - NO EXCEPTIONS:	TEST APPROVED - WITH EXCEPTIONS:
Responsible Engineer _____ Date _____	Responsible Engineer _____ Date _____
Quality Assurance _____ Date _____	Quality Assurance _____ Date _____
Test Witness _____ Date _____	Test Witness _____ Date _____

APPENDIX C

PREJOB SAFETY MEETING FORM AND ATTENDANCE ROSTER

PREJOB SAFETY MEETING FORM
AND ATTENDANCE ROSTER

PRE-JOB SAFETY MEETING FORM

Page 1 of 2

Job Description/Title
Surface Moisture Measurement System Acceptance Test

Date

Work Package No.: WHC-SD-WM-ATP-153

Person in Charge (PIC):

First Aid Qualified Person:

Check Items Discussed

[X]	Procedures/Plans to be Used	No.	WHC-SD-WM-ATP-153
[ ]	Applicable OSR's	No.	
[ ]	Radiation Work Permit	No.	
[X]	Job Hazard Analysis	No.	
[ ]	Construction Permit (as needed)	No.	
[ ]	Additional Permits (i.e., confined space, excavation, etc.)	No.	

[X] Review All Applicable Safety Precautions and Prestart Conditions per Procedures/Plans to be used

[ ] Components Locked and Tagged

[X] ALARA Considerations (applicable MSDS's)

[ ] Respiratory Protection (fresh air, PAPR's, chemical filters, etc.)

[ ] Radioactive Contamination Containment Device

[X] Emergency Response and Actions

[X] Summary of Job Sequence (or steps)

[ ] Work Area Conditions (high/low temperatures, lighting, etc.)

[X] All Equipment Functionally Checked and at Work Site

Special Circumstances or COMMENTS:

Chairman Signature:

Operations _____

Maintenance _____

Other _____

Pre-Job Safety Meeting Form **ATTENDANCE ROSTER**		Page 2 of 2
Name	Org. Code	Payroll No.

BD-6000-696.2 (4/91) (EF) GEF121

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	G. A. Ritter	Date 2/1/96
Project Title Work Order		EDT No. 604983
Surface Moisture Measurement System Hardware Acceptance Test Procedure		ECN No. NA

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
J. M. Bates	K7-15	X			
K. L. Bennett	N1-21	X			
D. R. Burstad	N2-50	X			
J. H. Bussell	L6-38	X			
R. D. Crowe	H0-38	X			
P. R. Deichelbohrer	S7-12	X			
G. T. Dukelow	S7-15	X			
M. Gimera	L6-37	X			
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C. E. Hanson	H5-09	X			
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G. F. Vargo Jr.	H5-09	X			
A. E. Waltar	H0-32	X			
W. T. Watson	H0-38	X			
Project Files	H5-09	X			
Central Files (orig + 2)	A3-88	X			

*ADVANCED COPY