AUG 13 1996

ENGINEERING DATA TRANSMITTAL

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1	1	PROJ. Eng. GF Vargo, Jr.	<i>GF Vargo</i>	7/29/96	09	RJ Blanchard	<i>RJ Blanchard</i>	8/9/96	S7-12	1	1
1	1	PROJ. Mgr. CE Hanson	<i>CE Hanson</i>	7/29/96	09						
		QA									
1	1	Safety LS Krogsrud	<i>LS Krogsrud</i>	7/29/96	14-07						
1	1	TI Stokes	<i>TI Stokes</i>	7-29-96	HiLine						
1	1	CM Monasmith	<i>CM Monasmith</i>	7-29-96	E6-27	(*Signature represents H.E.C.B. approval)					
1	1	SD Tomich	<i>SD Tomich</i>	7-29-96	HiLine						

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NFPA HAZARDOUS CLASSIFICATIONS AND COMPLIANCE REGARDING THE ELECTROMAGNETIC INDUCTION PROBE

TI STOKES, HiLine Engineering
Westinghouse Hanford Company, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-87RL10930

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Abstract: This document discusses how the ElectroMagnetic Induction probe complies with the hazardous locations discussed for the Surface Moisture Measurement System (SMMS). The EMI probe head was designed to interchange with the neutron probe of the SMMS.

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**NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) HAZARDOUS CLASSIFICATIONS
AND COMPLIANCE REGARDING
THE
ELECTROMAGNETIC INDUCTION PROBE**

AUTHOR LIST

**T. I. STOKES
S. D. TOMICH**

**Dated
July 1996**

TABLE OF CONTENTS

1.0	EXECUTIVE SUMMARY	2
2.0	SYSTEM OVERVIEW	2
3.0	EQUIPMENT COMPLIANCE WITH HAZARD CLASSIFICATION	3
3.1	DEPLOYMENT DEVICE UPPER ENCLOSURE(S)	3
3.2	DEPLOYMENT DEVICE MAST & ARM	4
3.3	EMI PROBE	4
3.4	MISCELLANEOUS EQUIPMENT ADJACENT TO DEPLOYMENT DEVICE	4
4.0	REFERENCES	5
	Appendix A	6
	Introduction	7
	Table A1	8
	Grounding and Bonding	9

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) HAZARDOUS CLASSIFICATIONS
AND COMPLIANCE REGARDING THE
ELECTROMAGNETIC INDUCTION PROBE

1.0 EXECUTIVE SUMMARY

This document discusses how the ElectroMagnetic Induction (EMI) probe complies with the hazardous locations discussed for the Surface Moisture Measurement System (SMMS), document WHC-SD-WM-DA-202 Rev. 0. The EMI probe head was designed to interchange with the neutron probe of the SMMS.

Interchanging an EMI Probe with the neutron probe of the SMMS has very little SMMS hardware impact. Therefore, this document relies primarily on the "NEC HAZARDOUS CLASSIFICATIONS AND COMPLIANCE REGARDING THE SURFACE MOISTURE MEASUREMENT SYSTEM", WHC-SD-WM-DA-202 REV 0, J. H. BusseII and T. I. Stokes, dated May 9, 1996. See the SMMS engineering work plan (WHC-SD-WM-WP-200 Rev. 1) for the background of the SMMS project, which includes EMI and neutron probes.

Signature on this document's EDT indicates concurrence by the technical community and the Hanford Electrical Codes Board (HECB), the Hanford Site "Authority Having Jurisdiction" (AHJ), that the EMI Probe may be interchanged with the neutron probe, according to the design drawings and procedures, and when thus configured, is approved for use in any of Hanford's waste tanks, including those classified as Class 1, Division 1, Group B Hazardous locations as defined by the National Fire Protection Association (NFPA).

2.0 SYSTEM OVERVIEW

The EMI probe head is designed to measure the moisture in the near surface layers of tank waste using the eddy current technology. The depth of interrogation depends on the moisture level encountered and the probe must be placed on the surface of the waste to make these measurements.

The EMI Probe screws directly onto the neutron probe interface cable head. The EMI Probe has two internal pancake coils. These coils are routed through coaxial cables to a connector, which mates with the cable head connector used for the neutron probe. The coils and connectors are mechanically housed within a probe housing, comprised of stainless steel and semi-conductive polypropylene. See Figure 1 for a drawing of the EMI probe as a stand alone entity.

The coaxial cables had routed from the cable head connector, through the SMMS winch box, through a set of mercury wetted slip rings, and terminated on a set of intrinsic barriers specially selected to protect the neutron probe. However, EMI signals could not be passed through the existing barriers. Therefore, a new set of barriers were added inside the SMMS deployment device electrical enclosure. These barriers are specially selected to not only function with EMI signals, but to provide an intrinsically safe EMI circuit within the tank. See appendix A for a detailed circuit schematic, and

calculations showing the circuit inductance, capacitance, and barrier ratings.

The coaxial cables had BNC connectors installed after the slip rings, but prior to the intrinsic barriers. Each pair of barriers has BNC pigtails on the output side, which allow field operations to configure the electrical circuit for either EMI probe or neutron probe. This document does not discuss the EMI system once the coaxial wires are terminated on the correct barriers.

3.0 EQUIPMENT COMPLIANCE WITH HAZARD CLASSIFICATION

This section has been made to match with the neutron probe document, WHC-SD-WM-DA-202, to provide confirmation that modifications have not been made by EMI probe options that invalidate previous design bases.

3.1 DEPLOYMENT DEVICE UPPER ENCLOSURE(S)

3.1.1 Winch Enclosure

There are no electrical components besides cabling that passes through this space. All electrical cabling passing through this space is intrinsically safe, with the neutron or EMI barriers using the BNC connectors in the electrical enclosure.

Connecting the wrong barrier pair is possible because the neutron probe and the EMI probe utilize BNC connectors for hookup. The neutron probe utilizes intrinsic barriers WST-EB-2201 and WST-EB-2202 (drawing H-14 100485, page 1 of 2, Rev 0). These barriers are Stahl barriers part number 9002/77-150-300-00. The EMI probe utilizes intrinsic barriers WST-EB-2205 and WST-EB-2206 (drawing H-14 100485, page 1 of 2, Rev 0). These barriers are Stahl barriers part number 9002/22-240-160-00.

Specifications from the Stahl catalog:

TABLE 1

<u>Barrier</u>	<u>Vmax</u>	<u>R</u>	<u>Voc</u>	<u>Isc</u>	<u>Pt</u>	<u>Ca(uf)</u>	<u>La(mh)</u>
9002/77-150-300-00 (Neutron probe)	<u>±12</u>	118	14.5	138	.500	.85	1.6
9002/22-240-160-00 (EMI probe)	<u>±9.5</u>	167	11.3	74	.207	2.0	6.5

There are two cases for misconnection:

CASE 1: EMI Probe connected to Neutron Probe Barriers.

The neutron probe barrier protects a system with up to .85 Ca and 1.6 La. As shown in table 1 above, the protected portion of the EMI system only has .016 Ct and .075 Lt, refer to the intrinsic barrier table A1 in Appendix A. Also, under faulted conditions, the neutron probe barrier would allow up to 14.5 Voc on the

EMI probe, which would not cause shield breach or any circuit breakdown. The EMI probe can operate safely at 14.5 Voc and 138 Isc, therefore, the EMI probe would remain intrinsically safe.

CASE 2: Neutron Probe connected to the EMI Probe Barriers.

The EMI probe barrier protects a system with up to 2.0 Ca and 6.5 La. As shown in table 1 above, the protected portion of the Neutron system only has .026 Ct and .020 Lt. Also, under faulted conditions, the EMI probe barrier would allow up to 9.5 Voc on the Neutron probe, which is not enough voltage to operate it or cause any circuit breakdown. The Neutron probe can be powered safely at 9.5 Voc and 74 Isc, therefore, the Neutron probe would remain intrinsically safe.

SUMMARY

The main effect of the EMI probe when used with the neutron barriers would be a change in the resonant frequencies caused by the barriers own resistance, capacitance, and inductance values. This change would result in misinterpretation of the data and inaccurate moisture readings.

Both the neutron probe and the EMI probe can use the same barriers and remain intrinsically safe. The performance and measuring capabilities of each system is affected by the difference in barriers which necessitates their choice for each probe system.

3.1.2 Electrical Enclosure

This box is considered a non-classified location. This box contains intrinsic safety barriers for the EMI probe, the neutron probe, and the inclinometer. None of the electrical equipment in this box must comply with requirements of any classified location.

3.2 DEPLOYMENT DEVICE MAST & ARM

There are no electrical components besides the EMI probe and the cabling that reside in this space. All electrical cabling passing through this space is intrinsically safe.

3.3 EMI PROBE

The EMI probe consists of two eddy current coils spaced 5 inches apart within a semi-conductive plastic housing which is attached to the previously approved SMMS deployment arm, enclosure, and data acquisition van. The eddy current coils are connected to approximately 50 feet of RG-174U coax which is terminated on the safe side of an intrinsic barrier. The intrinsic barrier provides for the operation of the EMI probe in a Class I, Division 1, Group B location. See Appendix A for a more detailed discussion.

3.4 MISCELLANEOUS EQUIPMENT ADJACENT TO DEPLOYMENT DEVICE

This space is considered a non-classified location, once the deployment device is fully installed and the riser bolts have been torqued. Electrical equipment in the immediate vicinity of a riser should not be energized until tank containment is reestablished/sealed.

4.0 REFERENCES

WHC-SD-WM-DA-202 Rev. 0, "NEC Hazardous Classification and Compliance Regarding the Surface Moisture Measurement System"

WHC-SD-WM-WP-300 Rev. 0, Engineering Work Plan for Surface Moisture Measurement

ANSI/NFPA 70, "National Electrical Code - 1993"

ANSI/ISA-RP12.6-1987, "Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations."

Class Number 3610, "Approval Standard - Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1 Hazardous (Classified) Locations", October 1988

SMMS Drawing Tree - H-14-100457

APPENDIX A

INTRODUCTION

Drawing set 9605-HEF-006 (attached) shows the EMI system and the demarcation between intrinsically safe portion of the system and the non-intrinsically safe portion of the system. The EMI has two electrical coils which are operated through an intrinsic barrier. Therefore the EMI probe is a simple device and is intrinsically safe with the appropriately chosen intrinsic safety barrier.

Intrinsic safety parameters were selected for the EMI on the basis of their entity safety parameters. Entity safety parameters are those parameters that define the maximum open circuit voltage, maximum short circuit current, maximum allowed capacitance, and maximum allowed inductance in the intrinsically safe apparatus, e.g. the eddy current coils.

Manufacturers seek approval for their intrinsic safety barriers using entity approval concept. Listing by entity parameters allows interchangeability between manufacturers and permits intrinsically safe systems to be easily qualified by verifying the correct relationship between entity safety parameters of a intrinsically safe apparatus and a intrinsic safety barrier. Table A1 shows the relationship between entity safety parameters between the intrinsically safe apparatus, e.g. eddy current coils, and the associated intrinsic safety barrier and attached instrumentation.

The EMI probe consists of a probe housing which contains an eddy current coil, a nylon spacer, a second eddy current coil, a polyethylene spacer, and the appropriate stainless steel connectors necessary to attach the probe to the SMMS deployment arm system. The signal supplied to the probe is provided through two intrinsically safe circuits contained in one intrinsic barrier. Each intrinsically safe circuit can provide 74 mA of current at ± 9 V for the operation of the eddy current coils.

Table A1
Entity Safety Parameters for Intrinsic Safety Barrier for EMI Probe Coils
Stahl 9002/22-240-160-00

C	V_{oc} Maximum Open Circuit Voltage from IS Barrier (V)	V_{max} Intrinsically Safe Apparatus Maximum Allowed Voltage (V)	I_{sc} Maximum Short Circuit from IS Barrier (mA)	I_{max} Intrinsically Safe Apparatus Maximum Allowed Current (mA)	C_{IS} IS Barrier Maximum Allowed Circuit Capacitance (μ F)	C_{total} Circuit Total Capacitance (μ F)	C_{cable} Cable Capacitance (100 ft x 60 pF/ft) (μ F)	C_i Intrinsically Safe Apparatus Capacitance (μ F)	L_{IS} IS Barrier Maximum Allowed Circuit Inductance (mH)	L_{total} Circuit Total Inductance (mH)	L_{cable} Cable Inductance (100 ft x 0.2 μ H/ft) (mH)	L_i Intrinsically Safe Apparatus Inductance (mH)
I	11.3	9.5	74	< 160	2.0	< 0.016	0.006	< 0.01	6.5	0.075	0.02	0
II	11.3	9.5	74	< 160	2.0	< 0.016	0.006	< 0.01	6.5	0.075	0.02	0

Notes:

¹The intrinsic safety barrier is dual channel passive barrier. One channel is terminals 1 to 3 and the other channel is terminals 2 to 4.

²Inductance and capacitance per foot are conservatively set as 60 pF/ft and 0.2 μ H/ft per ANSI/ISA-RP12.6-1995.

³Eddy Current Coils are Zetec's D#3804-3-C, see attached data.

GROUNDING AND BONDING

The probe housing is bonded to the shield wires of the two 18 AWG wires as well as the shields of the two RG-174 coax wires. The shield wires are bonded to the ground bus of the intrinsic safety barrier located in the mast head. The resistance of the two shield wires is less than 2 ohms.

The probe cable is the exact same cable as used by the neutron probe. The jacket is comprised of semiconductive plastic that will drain the electrostatic charge induced as a result of being rolled off of the winch, passing down through the mast, and rolling over the shoe assemblies at the end of the arm. The semiconductive plastic is LNP Engineering Plastics Stat-Kon-ME¹. The surface resistivity is 10^2 to 10^6 ohms/square and 10^2 to 10^6 ohms-cm. The EMI Probe body is constructed of the same plastic from the same vendor.

¹LNP Engineering Plastics and Stat-Kon-ME are trademarks of LNP Engineering Plastics.

HiLine Engineering & Fabrication, Inc.

Revisions		
No.	Date	By
0	4/5/96	sdt
1	5/9/96	sdt
2		
3		

Electromagnetic Induction Surface Moisture Monitor

Drawn by
Stan D. Tomich

Date
4/5/96

Drawing No.
9605-HEF-006

Sht
1

GENERAL NOTES: (UNLESS OTHERWISE SPECIFIED)

1. DECIMAL DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-82. DIMENSIONS ARE IN INCHES.
TOLERANCES: .X .XX .XXX ANGULAR
+ or - .10 .003 .001 1 DEGREE
2. ALL MACHINED SURFACES SHALL BE 125 RMS OR BETTER IN ACCORDANCE WITH ANSI B46.1 (LATEST REVISION).
3. BREAK ALL SHARP EDGES AND REMOVE ALL BURRS.

PARTS/MATERIAL LIST

QUANTITY	DESCRIPTION	SPECIFICATION	10
1	EMI PROBE ASSEMBLY		1
1			2
1			3
1			4
AR	STATKON-FE SEMICONDUCTIVE	POLYETHYLENE	5
AR	TUNGSTEN ALLOY (.62 LB/IN ³)	MI-TECH HD-17	6
AR	METAL CASE	304 OR 304L SST	7
8	FLAT & ALLEN HEAD CAPSCREW	304 OR 304L SST	8
1	JANMS-27467T15B97S	MIL-SPEC	9
2	400 KHz COILS, ZETEC	3804-3-C	10
			11
			12
			13
			14
			15
			16
			17
			18
			19

REVISIONS 1. 9605-REF-006 2. 9605-REF-006		DATE 9/1/96
DESCRIPTION EMI PROBE HOUSING		
DESIGNED BY J. J. J.		
CHECKED BY J. J. J.		
APPROVED BY J. J. J.		

ZETEC

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TELEFAX

PAGE 1 OF 4

FAX NO.:	(509) 372-3777	FAX LOG :	96-PS1286	DATE:	06/04/96
COMPANY:	Westinghouse Hanford Co.	REF. NO.:	PS6F1520.DOC		
LOCATION:	Richland, WA	FROM:	Tom Zistatsis		
ATTENTION	Mr. Warren Wittekind	DEPT.:	Probe		

Reference: Coil Winding Specifications

Warren,

Following is the chart that correlates the probe winding information requested:

Probe P/N	Probe OD	Groove Depth	Groove Width	AWG #	# of Turns	Inductance	Resistance
D#3804-1-A	3.000"	.675"	.100"	23	95	675μH	1.33Ω
D#3804-2-B	3.000"	.700"	.090"	20	45	151μH	.43Ω
D#3804-3-C	3.000"	.450"	.075"	20	23	55μH	.31Ω

The material specifications for the Polypenco® Nylon 101 are attached. I do not have any specifications for its radiation limits.

The insulation material on the magnet wire is Therm-Amid (see attached).

If you have any further questions or if you need any other information, please call.

Best regards,

ZETEC, INC.

Tom Zistatsis
Probe Design Specialist

TZ/tz

Post-It® Fax Note	7671	Date	JUN 96	# of Pages	4/1
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DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	Characterization Equipment Development	Date 08/09/96
Project Title/Work Order		EDT No. 158628
NFPA Haz Classifications And Compliance Regarding The Electromagnetic Induction Probe		ECN No.

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
RJ Blanchard	S7-12	X			
CE Hanson	H5-09	X			
LS Krogsrud	T4-07	X			
CM Monasmith	E6-27	X			
GF Vargo (3)	H5-09	X			
Central Files	A3-88	X			
Project Files	H5-09	X			