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3		Design Authority	LF Hill			1	/	Proj. Mgr. CE Hanson	H5-09	9/18/96	
		Design Agent				3		TI Stokes		9/18/96	
3		Cog. Eng.	CA Esvelt		S7-12			Central Files		A3-88	
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18. GF Vargo, Jr. Signature of ED Originator 9-18-96 Date	19. CE Hanson Authorized Representative Date 9/18/96	20. CE Hanson Design Authority/ Cognizant Manager Date 9/18/96	21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments
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SYSTEM DESIGN DESCRIPTION OF THE SURFACE MOISTURE MEASUREMENT SYSTEM (SMMS)

TI Stokes HiLine Engineering

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

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Abstract: The SMMS has been developed to measure moisture in the top few centimeters of tank waste. The SMMS development was initiated by the preliminary findings of SAR-033, and does not necessarily fulfill any established DQO. After the SAR-033 is released, if no significant changes are made, moisture measurements in the organic waste tanks will rapidly become a DQO.

The SMMS was designed to be installed in any 4 inch or larger riser, and to allow maximum adjustability for riser lengths, and is used to deploy a sensor package on the waste surface within a 6 foot radius about the azimuth. The first sensor package will be a neutron probe.

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James Bishop 9-23-96
Release Approval Date
Release Stamp

Approved for Public Release

SYSTEM DESIGN DESCRIPTION
OF THE
SURFACE MOISTURE MONITORING SYSTEM (SMMS)

REVISION 0
(WHC-SD-WM-SDD-070)
(ETN 96-0026)

Authors: T. I. Stokes and G. F. Vargo, Jr.
for Westinghouse Hanford Company
September 1996

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SYSTEM DESIGN DESCRIPTION
OF THE
SURFACE MOISTURE
MEASUREMENT SYSTEM (SMMS)

1.0 INTRODUCTION

The Hanford Site contains over 100 underground tanks containing millions of gallons of radioactive and chemical wastes. None of the tanks are exactly the same, considering riser access, above tank equipment, and the unique waste form(s) inside the tanks themselves.

The primary mission of the Hanford Site is to safely store the tank waste until it can be permanently entombed by processes not yet developed and stored in locations not yet selected. Westinghouse Hanford Company (WHC) is currently working to define several safety bases which will provide guidance on how to control each tank to assure continued waste storage safety. Until these bases are established, WHC is pursuing an aggressive characterization campaign, to know better what they are facing as far as actual waste content.

Systems approaches have been receiving considerable focus over the last two years, as the U.S. Department of Energy (DOE) insists WHC have a master plan concerning Hanford Site management. Data Quality Objectives (DQOs) are a portion of the systems process, and in theory, equipment is developed to satisfy preselected DQOs. Unfortunately, the DQO process is not fully up to speed or implemented, and safety problems persist.

The Surface Moisture Measurement Systems (SMMS) has been developed to measure moisture in the top few centimeters of tank waste. The SMMS development was initiated by the preliminary findings of SAR-033, and does not necessarily fulfill any established DQO. After the SAR-033 is released, if no significant changes are made, moisture measurements in the organic waste tanks will rapidly become a DQO.

The SMMS was designed to be installed in any 4 inch or larger riser, and to allow maximum adjustability for riser lengths, and is used to deploy a sensor package on the waste surface within a 6 foot radius about the azimuth. The first sensor package will be a neutron probe.

2.0 DOCUMENT OVERVIEW

WHC teamed with Science Applications International Corporation (SAIC), HiLine Engineering & Fabrication Inc. (HiLine) and ICF-Kaiser to develop the SMMS. Development included the research and development (R&D) of the neutron probe (optimized for surface geometry) and the design, fabrication, assembly,

and testing of every SMMS component.

This system design description document, WHC-SD-WM-SDD-070, Rev. 0 is intended as an overall reference document for the equipment. In essence, this document was developed to "tie" the SMMS project together. All important memos and other information of interest to the SMMS has been appended to this document. As new information is developed that is pertinent to the SMMS system, this information will also be appended or referenced within this document via an ECN.

Final decontamination and decommissioning of the SMMS is outside the scope of this document at this time.

3.0 FUNCTIONAL AND DESIGN REQUIREMENTS

As stated previously, there are no documented DQOs to be answered by the SMMS at this time. However, a detailed "Design Requirements Document" (DRD) was prepared and issued early in the project (Refer to WHC-SD-WM-DRD-002 Rev. 0).

The acceptance test plans (ATPs) were written against the DRD, to assure the SMMS complies with the requirements and guidance provided in the DRD. The test procedures (WHC-SD-WM-ATP-153 Rev. 0 and WHC-SD-WM-ATP-158 Rev. 1) were both successfully performed, and the results documented in the respective acceptance test reports (ATRs).

Where the DRD did not provide accuracy requirements, the performance of the respective system was quantified during testing, and documented in the ATR.

3.1 SAFETY

An Unreviewed Safety Question (USQ) screening against existing safety bases was performed for this activity, and is documented in USQ-TF-0098 Rev. 4, which has been attached to this document. (Revisions were required to catch the original USQ up to the final hardware configuration.)

The requirements specified by this USQ were implemented into the work procedures and hardware, where required.

4.0 DESIGN DESCRIPTION

This section presents a detailed description of the SMMS. A complete drawing list is attached to the design verification appendix.

drawing list is attached to the design verification appendix.

4.1 GENERAL DESIGN DESCRIPTION

The SMMS is "portable" equipment, which when installed and connected properly, can obtain in situ waste moisture data. Several "probes" can be conceived to be deployed by the SMMS deployment device, however, at this time, only a neutron probe has been developed.

The SMMS is comprised of 5 major systems.

- Deployment Device
- Neutron Probe
- Decontamination System
- Data Acquisition Van
- Transport/Storage Equipment

NOTE: At one time, the SMMS was also going to contain an internal camera, which would lower out of the deployment device elbow area. Technical challenges caused excessive funding and schedule impacts, and the integral camera system was terminated, and all camera related systems in the deployment device were removed.

4.2 DEPLOYMENT DEVICE

The deployment device provides the mechanism to lower a probe into a waste tank, and place the probe in optimum measurement locations within a 12 foot diameter under a 4 inch or larger riser.

4.2.1 Enclosures

The deployment device has two large enclosures on the top, which remain outside the tank space. The electrical enclosure houses the electronics and safety barriers, and is sealed from the winch box enclosure. The winch box enclosure houses 2 winches, an arm winch and a probe winch.

The probe elevation is important, so the probe cable has been encoded in the winch box. A wheel is spring loaded against the cable and an idler pulley, and a drive shaft routes from the wheel to outside the box, where the encoder is located.

4.2.2 Bearing System

Under the enclosures is a bearing system, which mounts the enclosures to the riser flange. The enclosures and mast rest on this bearing system, and are free to rotate 360 degrees.

During testing, the bearing system worked so well, the mast would self rotate. This is unacceptable for placing a probe which must remain in place

for over 5 minutes per position, so an anti-rotation brake system was developed.

Also, during early USQ discussions, safety personnel wanted a stop clamp system installed, which could be configured to limit rotation based on in tank interferences. This system is a manual operation, based upon in tank camera feedback.

4.2.3 Support Mast

Also attached to the underside of the enclosures is a 3 inch sch. 40 SST pipe, which extends down approximately 14 feet. (The extension distance is adjustable by using different spacer pieces). This pipe is typically referred to as the support mast.

The support mast is hollow, and provides protection to the cables which pass through this zone. Three cables are routed through the mast. One cable is attached to the inclinometer, one cable is used to actuate the arm rotation, and the third cable provides the strength member, power, and communication link with the probe.

4.2.4 Elbow

An elbow joint was welded to the far end of the mast. This is a precision machined piece, with a chrome plated pin installed to prevent galling on the primary rotating surfaces. The elbow is constructed of stainless steel, and does have rotating faces exposed to non-rotating faces. This was considered acceptable as the rotation speed is slow, infrequent, and the surfaces were lubricated with antiseize at assembly.

The elbow is solid, but a fluid path relief was integrated into the assembly so that any entrapped decontaminated water could drain out.

4.2.5 Arm

The arm is attached to the elbow, and is free to pivot from vertical (in line with the mast) to approximately 110 degrees from vertical (0 to 110 degree rotation).

The arm has several sections that slip together which comprise the 6 foot reach. The sections are held to each other by the slip fit and locking screws. An inclinometer is permanently mounted in one of the arm sections, and provides accurate feedback concerning arm inclination from horizontal.

The section furthest from the elbow is specially designed as a socket, which mates with the neutron probe cable head. It also serves as a cable guide, sometimes referred to as the "shoe". This section does not allow the probe cable to come free, in essence it captures the cable and provides a shoe on all surfaces.

decisions about mitigating dry conditions.

4.5 TRANSPORT/STORAGE EQUIPMENT

Almost all SMMS related equipment can be wrapped in plastic and shipped in waste drums, if it becomes contaminated. However, the data acquisition van, deployment device, and neutron source required special consideration.

The van will be driven into a contaminated area. The van will be treated as a "controlled" vehicle, and parked in designated parking for "controlled" vehicles at the end of the day. The interior of the van is not anticipated to be contaminated.

The deployment device will be contaminated. It is too large to fit any standard package, therefore a special package was fabricated and qualified. Storage only requires leak tight integrity, but transport requires additional structural strength as well. WHC-SD-T-SEP-043 was prepared to document the container is acceptable to ship the deployment device in, as long as the shipment remains on the Hanford Site.

The source requires a special container, transport procedures, and security measures. (See WHC-SD-TP-DAP-008 for documentation approving the Frontier cask for shipment on the Hanford Site).

5.0 INSTRUMENTS & DATA

5.1 DIRECTIONAL COMPASS

The geographic position of the lower deployment mast is determined by the use of a state-of-the-art low power, high performance Electronic Compass Sensor Module, TCM2. The manufacturer is:

Precision Navigation, Inc.
1235 Pear Avenue, Suite 111
Mountain View, CA 94043
(415)962-8777

The compass is interfaced to the computer in the DAV via an analog output from the compass to an analog to digital (A/D) converter channel in the DAV computer. The DAV computer then outputs from a digital to analog (D/A) channel to a Newport Electronics, Inc. digital display meter mounted on the SMMS electronic enclosure (dog house). The meter reads in degrees from 0° to 360° (+or - 5°) repeatable to within 1°. The reading in degrees marks the direction that the lower mast arm is pointing. That is when the lower mast arm is winched up into the working position the arm will come up in the direction indicated by the compass. Furthermore, this same reading is displayed on the LabVIEW¹ computer screen.

For more information on the electronic compass and it's operation refer to the TCM2 Electronic Compass Module User's Manual Revision.011, March 17,

¹ LabVIEW is a registered trademark of National Instruments, Corp., Austin, TX.

the DAV.

5.2 CABLE ENCODER

The amount of cable that is spooled out from the probe winch is tracked via an optical absolute position encoder that is driven from an idler arm that is spring loaded against the cable as it is spooled off the winch. This signal from the encoder is a serial digitized stream that is read into a serial port in the DAV computer. The DAV computer then outputs from a digital to analog (D/A) channel to a Newport Electronics, Inc. digital display meter mounted on the SMMS electronic enclosure (dog house). The meter reads in feet from 0.0' to 400.0' ($\pm 1'$ repeatable to $.1'$). A checksum is computed by the DAV computer to ensure the accuracy of the reading. Furthermore, this same reading is displayed on the LabView computer screen.

5.3 LOWER MAST INCLINOMETER

To measure the angle that the lower mast arm is winched up, an inclinometer is used. The inclinometer is located approximately 8 cm below the elbow on the deployment arm and consists of a Humphreys, Inc. Model CP16-0102-1 liquid filled pendulum. The pendulum position is converted to an electrical signal via a potentiometer connected to the pendulum. The inclinometer has an angular span of 90° . A modified well logging cable, Schlumberger Model 4-18PSS, is used to connect the three terminals of the pendulum potentiometer to a bulkhead connector located in the SMMS upper enclosure (dog house). The outer layer of stainless steel strands was removed from the well logging cable to improve its flexibility. On the electrical equipment side of the SMMS enclosure, a cable connects to a feed through bulkhead connector. On the opposite side of the bulkhead connector a cable connects to a transformer isolated intrinsically safe potentiometer transmitter, Elcon Instruments model 1072-X-3-0581-AA. The transformer isolated, intrinsically safe, potentiometer transmitter converts the potentiometer signal to a 4 to 20 mA output signal which is processed by an analog-to-digital converter, TB5, B2A. The transformer isolated intrinsically safe potentiometer transmitter provides excitation voltage and reads the voltage between the wiper and the common connection to the potentiometer.

The inclinometer is interfaced to the computer in the DAV via the analog 4 to 20 mA signal from the intrinsically safe transmitter to an analog to digital (A/D) converter channel in the DAV computer. The DAV computer then outputs from a digital to analog (D/A) channel to a Newport Electronics, Inc. digital display meter mounted on the SMMS electronic enclosure (dog house). The meter reads in degrees from 0° to 90° ($\pm 3^\circ$ repeatable to within 1°). The reading in degrees marks the angle between the main SMMS support mast and the lower mast arm. Furthermore this same reading is displayed on the LabView computer screen. A mechanical stop prevents the arm from being winched past the 90° position. Care must be taken not to exceed the 90° position, i.e., hard mechanical jam into the stop, because the inclinometer potentiometer will be at its furthest travel and may become inoperable.

hard mechanical jam into the stop, because the inclinometer potentiometer will be at it's furthest travel and may become inoperable.

For more information on the inclinometer see references below.

References

Mechanical:

Westinghouse Hanford Co. Drawings

H-14-100459, Sheet 2 SMMS Deployment Device Assembly [shows a view of arm and location.

H-14-100459, Sheet 3, View B and Section E, SMMS Deployment Assembly [shows a detail assembly details]

H-14-100461, Sheet 1, SMMS Enclosure Assembly [list electrical panel in SMMS Enclosure]

H-14-100461, Sheet 2, Zone F5, SMMS Enclosure Assembly [show electrical panel]

H-14-100484, Sheets 1 to 4, SMMS Intrinsic Barrier Panel [shows panel assembly in enclosure]

Humphreys, Inc. Drawings

C33373, Rev D, Base Pendulum

C33374, Rev A, Cover Pendulum

6.0 DESIGN CRITERIA COMPLIANCE

6.1 NFPA CLASSIFICATION AND COMPLIANCE

This document does not set any NFPA classifications. The SMMS was designed to comply with the necessary electrical codes to allow system operation in a Class I, Division 1, Group B Hanford location. A very detailed discussion of this entire subject may be found in WHC-SD-WM-DA-202 Rev. 0

6.2 STATIC SPARKING CONTROL

All in tank equipment is made of stainless steel. Furthermore, the arm, support mast, enclosures, and bearing assemblies are all bonded together. There are three electrical cables in the tank vapor space. The probe cable

has a semi-conductive plastic jacket, made of LNP Engineered Plastics Stat-kon ME Polypropylene.

The arm actuation cable is a multi-stranded stainless steel cable, which is swaged to fittings at each end. The fittings are pinned and connected to other bonded equipment. The inclinometer cable is armored in stainless steel, and the armored cable is connected at each end via metal clips serving as strain reliefs.

6.3 STRUCTURAL REQUIREMENTS

The waste tank risers are of various designs and strengths. It is recommended each tank be considered unique, and a structural review prepared for each tank and each riser selected. The SMMS design has included aluminum I-beams that can be used to span the 42 inch risers that were capped with thin steel and buried. The structural review for tank BY-110 and the SMMS equipment is attached in Appendix E.

6.4 MATERIAL COMPLIANCE

No materials were used in this assembly that warrant special study. All materials are carbon steel, stainless steel, or a plastic compatible with the chemical(s) and radiation levels to be expected. There is no aluminum, brass, or other potentially reactive metal exposed to the tank vapor space.

6.5 PROBE PLACEMENT (MACHINE CONTROL COMPLIANCE)

Much effort was expended training field operations personnel, in placing the probe using the deployment device, in a simulated tank environment. As the operation is totally manual, with video feedback, this control was deemed acceptable as discussed in the hardware ATR.

7.0 OPERATION

7.1 QUALIFICATION TESTING

The SMMS was fully tested for system operability (Refer to the Acceptance Test Procedures, WHC-SD-WM-ATP-153 and WHC-SD-WM-ATP-158, and their ATRs).

7.2 INSTALLATION & REMOVAL

A work package has been prepared that fully describes the steps required to install the SMMS on waste tank BY-110. (Refer to work package ES-95-00662 /S Surveillance). A copy of this work package is attached.

7.3 OPERATION

Operation of the SMMS will be in accordance with the work package above, and the Operations and Maintenance Manual (OMM). The field work will be performed by trained personnel only. The data acquisition van will be operated by engineers and/or engineering technicians, as the entire SMMS is a test apparatus, in development stage. Exact probe placement will be as directed by the lead engineer based on video feedback obtained while in the field.

8.0 MAINTENANCE

An OMM has been prepared that fully describes the steps required for special maintenance of the SMMS. This document can be modified as required and as operational experience grows. Reference WHC-SD-WM-OMM-024, Rev. 1.

9.0 REFERENCES

- WHC-SD-WM-WP-300 Rev. 0, *Surface Moisture Measurement of Tank Waste Engineering Work Plan*, T. I. Stokes, April 1995.
- WHC-SD-WM-DRD-002 Rev. 0, *Design Requirements Document of the Surface Moisture Measurement System*, T. I. Stokes, September 1995.
- WHC-SD-WM-FRD-023, *Functions and Requirements for In Situ Tank Waste Moisture and Chemical Species Characterization*, B. L. Philipp, T. Lopez, F. R. Reich, June 1995.
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- WHC-SD-WM-QAPP-032, *Software Quality Assurance Plan for Moisture Monitor*, M. Gimera, November 1995.
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- WHC-SD-WM-OMM-024 Rev. 0, *Surface Moisture Measurement System Operation and Maintenance Manual*, G. A. Ritter, K. L. Pearce, December 1995.
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- WHC-SD-WM-DTR-044, *Results of Modeling and Experimental Measurements for the Design of a Neutron Surface Moisture Measurement Sensor*, W. T. Watson, M. D. Harris, A. K. Todd, et al., December 1995.
- WHC-SD-WM-ATP-158, *Software Acceptance Test Procedure for Surface Moisture Monitor*, M. Gimera, December 1995.
- WHC-SD-WM-ER-529, *Description of Double-Shell Tank Selection Criteria For Inspection*, E. B. Schwenk, K. V. Scott, January 1996.

WHC-SD-WM-ATP-153, *Surface Moisture Measurement System Hardware Acceptance Test Procedure*, G. A. Ritter, February 1996.

WHC-SD-WM-WP-318, *Surface Moisture Measurement System Acceptance Testing Work Plan*, G. A. Ritter, January 1996.

WHC-SD-WM-TI-729, *Calibration Technique for the Neutron Surface Moisture Measurement System*, W. T. Watson, D. C. Shreve, January 1996.

WHC-SD-WM-FDC-042, *Functional Design Criteria for the Self-Installing Liquid Observation Well*, S. A. Parra, January 1996.

WHC-SD-WM-ER-543, *Assessment of Chemical Vulnerabilities in the Hanford High-Level Waste Tanks*, H. K. Fauske, February 1996.

WHC-SD-WM-HIE-006, *Hazards and Operability Study for the Surface Moisture Measurement System*, B. D. Board, April 1996.

WHC-SD-WM-DA-202, *NEC Hazardous Classification and Compliance Regarding the Surface Moisture Monitor Measurement System*, J. H. Bussell, T. I. Stokes, May 1996.

WHC-SD-TP-SEP-043, *Surface Moisture Shipping Container Safety Evaluation for Packaging*, B. D. Flanagan, June 1996.

WHC-SD-TP-DAP-008, *Documentation and Analysis for Packaging for Surface Moisture Measurement System 7A Containers*, D. K. Clem, June 1996.

Appendix A
Calibration Information

MEETING MINUTES

Subject: SMMS/CONE PENETROMETER CALIBRATION STANDARDS MEETING				
TO: DISTRIBUTION			BUILDING: ETC1/10	
FROM: G. F. VARGO, JR.		CHAIRMAN: G. F. VARGO, JR. <i>G.F. Vargo Jr.</i>		
Dept-Operation-Component	Area	Shift	Meeting Date	Number Attending
SMMS/CONE PENETROMETER	RCHN	DAY	11-27-95	5

ATTENDEES

G. N. Boechler	H5-09	WHC
G. F. Vargo, Jr	H5-09	WHC
W. T. Watson	H0-38	WHC
T. I. Stokes	L6-37	HLENG

INTRODUCTION

A meeting was held to discuss the calibration standards that are being used to verify the moisture content output of the Surface Moisture Measurement System (SMMS) and the Cone Penetrometer (CP) probes. The discussion was to overview the differences in the standards, i.e., wet vs dry, elemental analysis, etc. The goal was to see if a common set of standards could be used for both probes.

DISCUSSION

WT Watson first gave the attendees an overview of the planned calibration standards to be used for the SMMS. Watson reviewed the differences in the SAIC calibration methods performed in San Diego as to what was planned for the SMMS testing in Richland. These differences are listed below:

CONE PENETROMETER	SMMS
No initial bake of sand	Plan to bake sand
No elemental analysis	Plan to perform elemental analysis
Water based	Plan to use dry compound(Aluminum Tri-hydride)
Not actual conditions, i.e., water standing on surface of tank waste	Real world interim stabilized tanks DO NOT have standing water.

Also, Watson assumed a specific gravity of 1.5g/cm^3 for a non-sampled tanks. The specific gravities of tested tanks have been measured between 1.3 and 2.5g/cm^3 . Therefore, the assumption of 1.5g/cm^3 is reasonable.

Stokes asked if the scale used to weigh the calibration standard, before and after in the SAIC testing, was properly calibrated and recorded. Boechler replied that he believes that it was. Although, he was not positive.

Boechler stated that the CP probe is being designed to a Data Quality Objective (DQO). Stokes commented that there was no DQO regarding a surface moisture measurement. And that the task for a SMMS was ordered by waste tank safety manager, GT Dukelow. Therefore, the SMMS task was being performed on order from GT Dukelow.

Boechler stated that B. Cash was trying to change the 20 wt.% moisture limit, stated in SAR 033, to 5 wt.%. The $>$ or $=$ 20 wt.% moisture content limit is the boundary for whether or not a waste tank is considered flammable.

Boechler stated that the receipts for the calibration standards, used in the San Diego test, were not included in the Phase 1 of Cone Penetrometer Moisture Probe Study, Final Report, SAIC Science Applications International Corporation, March 20, 1995.

Boechler stated that the testing that was performed in San Diego was considered to be adequate for calibration of the CP moisture probe. Furthermore, that the testing was probably documented sufficiently, i.e., to pass a QA audit.

Stokes stated that he heard in conversation with FP Johansen, program manager from SAIC for the CP and the SMMS, that the testing performed at San Diego on the CP moisture probe was more of "proof-of-principle" testing than detailed calibration testing. Furthermore, he stated that the errors introduced, by the loosely performed testing, could be significant. And that the detailed testing, proposed by Watson, was required to make the data technically defensible. Vargo and Watson agreed with Stokes. Boechler and Barnes were undecided.

Boechler stated that the calibration testing, proposed by Watson, would be costly. Stokes stated the this testing is not cost prohibitive and was proposed in the budget in the Engineering Task Plan. Vargo and Watson agreed. Boechler and Barnes were undecided.

Vargo stated that CE Hanson demands, if possible, a common set of calibration standards that can be used for the CP and the SMMS.

ACTION ITEMS

1. Another meeting is to be held to further discuss the issues and make a plan. This meeting is to have the mandatory attendance of CE Hanson.
2. The calibration standards for the SMMS will continue as planned by WT Watson. Additional tall test bed containers and Aluminum Tri-hydride material will be purchased by the SMMS project to accommodate selective additional testing of the CP.
3. Vargo will discuss the additional funding requirements of any additional testing of the CP on the SMMS test beds, with GT Dukelow.

FAX TRANSMISSION

619-458-3718

Date: Troy Stokes and Jim Bussell
To: Dec. 21, 1995
FAX: 509/376-5955
Number of Pages (including cover): 12
From: Dan Holsh
Phone: 619-458-3715

*****MESSAGE*****

Troy and Jim,
Here are the figures for the temperature/gamma-ray
sensitivity test report. Please give me a call if
they don't come over well.
Happy Holidays!
Dan

High-Temp Tests - Reuter-Stokes

Data from Nov. 15, 1995

Fig. 11

High-Temp Tests - LND

Data from Nov. 15, 1995

Fig. 10

Reuter-Stokes Long, 400 R/hr position

Data from Nov. 8, 1995

Fig. 9

Short Reuter-Stokes, 400 R/hr position

Data from Nov. 8, 1995

Fig. 8

Reuter-Stokes Long, 200 R/hr position

Data from Nov. 8, 1995

File: RSL200R.wq1

—□— 200 R/hr 35.6 C —+— 0 R/hr 93.9 C —▲— 200 R/hr 93.6 C —..... Integ Spect

Fig. 7

Short Reuter-Stokes, 200 R/hr position

Data from Nov. 8, 1995

File: RSS200R.wq1

Fig. 6

LND Large Diameter, 200 R/hr position

Data from Nov. 8, 1995

—□— 200 R/hr 25.7C —+— 0 R/hr 93.3C —▲— 200 R/hr 93.3C Integ Spect

Fig. 5

LND Small Diameter, 200 R/hr position

Data from Nov. 8, 1995

—□— 200 R/hr 25.0C
 —+— 0 R/hr 93.3C
 —▲— 200 R/hr 93.3C
 Integ Spect

Fig. 4

BEST AVAILABLE COPY

Fig. 3 The thermal test configuration using the calibrated oven. The 4 detectors are shown in the oven surrounded by the polyethylene.

BEST AVAILABLE COPY

Fig. 2 The 4 B-10 lined neutron detectors shown with the different layers used in the test configuration. From the left, the outer layer is the electric thermal blanket, the copper layer, the teflon, then the outermost polyethylene layer. The 1.5 micron 252-CF source is shown at the right.

BEST AVAILABLE COPY

Fig. 1 The gamma-ray gauging range at
SASC's MPD Division.

Appendix B

Test Strategy and Data Reduction

BATTELLE

Pacific Northwest Laboratories
Battelle Boulevard
P.O. Box 999
Richland, Washington 99352
Telephone (509) 375-2539

December 1, 1995

Mr. George F. Vargo, Jr.
Surface Moisture Measurement Project Engineer
Westinghouse Hanford Company
Mail Stop H5-09
Richland, Wa. 99352

Dear George:

Subject: Sampling Plan for Surface Moisture Measurement System Deployment in Tank 241-BY-110

Enclosed please find the draft of the subject sampling plan. For purposes of internal reference, it has been assigned the document number PNLMIT:120195. Also attached is a copy of a document review record form which may be used to record comments for formal resolution.

If you have questions regarding the subject test plan, please contact JM Bates, ph. 375-2539.

Sincerely,

A handwritten signature in dark ink, appearing to read "JM Bates".

JM Bates
Sr. Research Engineer
PNL Waste Tank Safety Program
Waste Tank Organic Safety Project

cc:
Karen Drury/SMMS record file
Dennis Bowser, DOE/RL
Glenn Ritter, WHC
Troy I. Stokes, HiLine Eng.
Todd Watson, WHC
Rich Hallen, PNL
Greg Piepel, PNL

January 18, 1996

George F. Vargo, Jr.
Project Manager
Surface Moisture Measurements Project
Westinghouse Hanford Company
Mail Stop H5-09
Richland, WA 99352

Dear George:

Subject: TRANSMITTAL OF "Sampling Plan for Surface Moisture Measurement System
Deployment in Tank 241-BY-110"

Enclosed please find the subject sampling plan as generated by the Technical Support for
Surface Moisture Measurement task of the Laboratory's Waste Tank Organics Project. For
purposes of internal reference, it has been assigned the document number PNL-MIT:120195.

If you have questions or comments regarding this report please give me a call.

Sincerely,

James M. Bates
Sr. Research Engineer
Pacific Northwest National Laboratory

JMB/

cc: Stokes, TI, HiLine Engineering
Dukelow, GT, WHC
Watson, WT, WHC
Bear, G, WHC
Ritter, GA, WHC
Redgate, PE, PNNL
Hallen, RT, PNNL
Brothers, JW, PNNL
File/lb

Appendix C

NEPA Documentation

**Westinghouse
Hanford Company**

**Internal
Memo**

From: Project Services 01810-JRR-95-044
Phone: 376-8162 95-POC-031
Date: September 1, 1995
Subject: ANALYSIS OF ENVIRONMENTAL REQUIREMENTS FOR THE TANK WASTE
CHARACTERIZATION SURFACE MOISTURE MEASUREMENT SYSTEM

To: G. A. Ritter H0-38*
~~T. I. Stokes~~ ~~H0-38*~~

cc: D. Alison R2-36* E. M. Greager H6-20*
I. J. Austin T4-01* M. J. Hall T6-12*
J. A. Bates H6-22* J. J. Luke H6-25*
J. F. Brown S5-03* K. J. Moss X0-21*
M. W. Cline H6-24* P. A. Powell R2-06*
P. R. Deichelbohrer S7-12* S. M. Price H6-23*
L. P. Diediker S3-95* R. J. Swan H6-21*
B. J. Dixon B4-20* W. E. Toebe H6-22*
R. H. Engelmann H6-26* K. S. Tollefson H6-21* *KST*
B. G. Erlandson H6-20* *H2* POC File/JRR H6-21
D. W. Fritz H6-22* *via cc:Mail
C. J. Geier R2-36*

Attached is an Analysis of Environmental Requirements Checklist for the "Surface Moisture Measurement System," (95-POC-031), being developed for in situ tank waste characterization. This letter documents Project Services' evaluation of the required environmental permits, approvals, and/or other documentation necessary for this project, and lists the contact person for each applicable requirement.

The mission of the Environmental Services organization is to provide expert, cost-effective, and innovative services that support line organizations in achieving and maintaining compliance. Environmental Services support to your project may include the following:

- Interpretation of environmental requirements;
- Preparation of NEPA documentation;
- Preparation of permitting plans, schedules, and applications;
- Negotiation of permit conditions with regulatory agencies, and;
- Technical support to assist you in achieving and maintaining environmental compliance.

This list is not meant to be all-inclusive, and support will be tailored to suit your needs. The Project Services staff can provide a single point-of-contact to coordinate these activities. Please contact me on 376-8162, at your earliest convenience.

J. R. Robertson
J. R. Robertson
Advanced Engineer

hmb

Attachment

TANK WASTE CHARACTERIZATION SURFACE MOISTURE MEASUREMENT SYSTEM SCOPE OF WORK

Radioactive wastes from defense operations have been accumulated in underground waste tanks at the Hanford Site since the 1940s. Concerns have arisen about the potential for uncontrolled chemical reactions involving ferrocyanide and various organic substances (potential fuels). The waste forms are sludges and salt cakes which contain oxidizer and various quantities of water and/or fuel. Ample amounts of fuel and oxidizer materials may exist in some of the tanks to create unsafe chemical conditions that, given an ignition source, could lead to runaway and propagating chemical reactions. The presence of a certain minimum level of water in the waste will stop the reaction.

Because the credible reaction initiators would be expected to occur at the waste surface, sufficient moisture concentration in the top layers of waste would, under current safety guidelines, provide evidence that the tank waste is in a stable and safe form for continued storage. In general, measurement of sufficient average moisture concentration in the top few centimeters of waste in a tank may allow WHC to classify the tank as conditionally safe. Additionally, measurement of sufficient moisture levels may reduce the need for some intrusive sample gathering techniques (e.g., core, auger), resulting in significant cost savings.

WHC has been developing instruments for measuring the waste moisture concentration profiles for tanks. The intent is to take direct surface moisture measurements with an in situ sensor, deployed on a custom arm, through an available tank riser. The neutron moderation moisture probe has been selected as the first sensor technology to be deployed for surface waste moisture measurements because of both its advanced state of development and its expected capability to rapidly meet the data needs. Other sensors may be deployed later, as needed, if the results of their development demonstrate their capability to obtain needed data.

The approach for deployment of the sensor instrumentation package will be to lower the deployment system and sensor package through an available tank riser to the waste surface. Some equipment will have to be removed from risers to deploy the Surface Moisture Measurement System (SMMS), but the retrieval of large equipment, the removal of weather coverings, and the use of fouled risers will be done only as a last resort. The use of open risers, observation port risers, and breather filter risers is the baseline approach.

The deployment device is expected to consist of a jointed arm that will be lowered through the riser into the tank airspace. The arm will then be rotated through a controlled angle, positioning the probe (suspended from the end of the arm). The arm will be manually operated from the surface and will allow for probe deployment anywhere within about a two-meter radius circle under a typical riser. The probe will rest on the surface of the waste and is not designed to penetrate into the waste. The deployment will be monitored by an in-tank camera to determine the physical conditions and configuration of the sensor deployment. An integral camera will be incorporated into the deployment arm, or an existing in-tank camera will be used. The deployment system will interface with a portable field data acquisition system that will control sensor operation and record data.

The deployment system will have an integrated decontamination system for any needed cleaning of the sensor or deployment apparatus. Decontamination is to occur before equipment movement from riser to riser and before removal for storage (i.e., before hardware is removed from the tank). The decontamination system will use water to reduce radiation levels of the system to less than 100 millirem per hour at contact, maximum. Ideally, only the probe will touch the waste, and the probe will be protected in a disposable membrane.

The development of a carbon dioxide (CO₂) (instead of water) decontamination system is being considered for use with the deployment system. This system would also be deployed within the tank/tank riser. As with the water decontamination system, the waste removed from equipment by the CO₂ system would fall back into the tank, and no secondary waste would be generated.

The primary tanks of interest are 20 tanks on the organics watch list. These are tanks judged to have the fuel potential to burn, given an ignition source. An additional eight organic tanks have been judged as conditionally safe. The priority of tanks to be characterized was established considering tank total organic carbon estimates and tank physical locations. Also, supernate tanks will not be tested until they are stabilized. Saltcake tanks have priority over sludge tanks. A moisture monitoring program may be established for certain tanks based on the initial determined moisture content and estimated moisture loss rates. At this time, to help guide general design decisions, monitoring of one tank on a bi-yearly basis is considered adequate.

The proposed action will not release liquid effluent to the ground or surface water, nor will it involve excavation of earthen material. Actual increases in emissions to the atmosphere are not expected as a result of this action, so long as water is used to decontaminate equipment. However, if a CO₂ decontamination system is employed, gases in the tank head space will be displaced by CO₂, and permitting of increased emissions of regulated air pollutants may be required.

The following form identifies areas of environmental concern that may be impacted by this activity. Any "Yes" answer in the applicability column will be further described in the narrative that follows the table. Some "No" answers may require special explanation and will have narrative associated with them. If this is the case, the words "See Text" will be stated in the applicability column. Compliance with NEPA and other requirements not specifically addressed as part of the form must be attained in accordance with WHC guidance.

The accompanying narrative identifies environmental permits, approvals, and/or requirements applicable to the activity, including NEPA documentation. A contact is identified at the end of each evaluation to answer questions and/or provide additional information regarding the specific regulation in question. If the contact cannot be reached, Project Services may be contacted to obtain answers to questions or to coordinate meetings with appropriate personnel within Environmental Services.

AREAS OF ENVIRONMENTAL CONCERN

NOTE: NEPA documentation, Ecological Compliance Reviews, and Preoperational Surveys shall be requested in accordance with WHC-CM-7-5. Excavation Permits and Cultural Resource Review clearances shall be obtained in accordance with WHC-CM-8-7 and WHC-CM-7-5.

AIR	Applicability (Y/N)
New Activity - Is this (1) a new process, (2) newly installed equipment, OR (3) a "new" activity (ie, an activity that has NOT been conducted in the last two years at this location, using existing procedures and equipment); AND will (1), (2), or (3) above involve potential emissions of any regulated air pollutant (assuming no controls were in place)?	See text
New Source - Will the planned activity provide emissions of a regulated air pollutant from a newly constructed point of emissions?	No
Modification - Will the activity involve a physical or operational change at an existing source of air emissions, which could result in an increased challenge to the emissions control system?	See text
Will the activity involve any open burning or training fires?	No
WATER	
Will the activity involve a new or existing liquid discharge to the ground or to the river (e.g., process effluent, stormwater)?	No
Will the activity modify an existing, approved wastewater treatment system?	No
Will the activity modify an existing drinking water system or install a new one?	No
Will the activity require any work over, in, or adjacent to a surface water body?	No
Will the activity include installation of a new septic system or modification of an existing one?	No
DANGEROUS WASTE	
Will the activity include treatment, storage, and/or disposal of dangerous waste?	No
Will the activity generate or manage contaminated equipment, environmental media (e.g., dirt), or debris?	Yes
MISCELLANEOUS	
Will the activity involve disposal of inert waste at a non-approved disposal site?	No
Will the activity include construction of a solid waste facility?	No
Will the activity install, remove, or modify an underground storage tank?	No
Will the activity include demolition and/or renovation involving asbestos?	No

J.R. Robertson 9/6/95
Approval by ECO or designated representative

If any questions result in a response of "yes," an analysis of applicable environmental requirements shall be completed in accordance with Section 9 of WHC-CM-7-5. Terms used on this form are consistent with definitions provided in the applicable state and federal regulations.

ABBREVIATIONS and ACRONYMS

CFC	Chlorofluorocarbons
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DOH	State of Washington Department of Health
Ecology	State of Washington Department of Ecology
EPA	U.S. Environmental Protection Agency
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NOC	Notice of Construction
NSR	New Source Review
PSD	Prevention of Significant Deterioration
RCRA	Resource Conservation and Recovery Act
SEPA	State Environmental Policy Act
TAPs	Toxic Air Pollutants
WAC	Washington Administrative Code

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS

NEPA; SEPA

NEPA Documentation - Title 10, CFR 1021

SEPA Documentation - WAC 197-11

Note: All cultural resource surveys and ecological survey/reviews must be completed before any NEPA documentation is submitted to RL.

The proposed action is covered under two existing NEPA documents, the "Environmental Assessment: Waste Tank Safety Program" (DOE/EA-0915, February 1994) and the "Final Environmental Impact Statement: Disposal of Hanford Defense High-Level, Transuranic and Tank Wastes" (DOE/EIS-0113, 1987). Preparation of new NEPA documentation will not be required.

Submission of a SEPA Environmental Requirements Checklist to Ecology will not be necessary if water is used for decontamination. However, preparation and submission of a SEPA checklist may be required if the option of using in-tank CO₂ decontamination is pursued. The Ecology response to a submitted SEPA checklist may take the form of a Determination of Nonsignificance, preparation of a state environmental impact statement, or adoption of existing NEPA documentation.

CONTACTS: Mr. R. H. Engelmann (376-7485)

ALL MEDIA

Ecological Compliance Review - 10 CFR 1021; 50 CFR 402.6; DOE Order 5484.1

A blanket biological review of the 200 West and 200 East tank farms is conducted on an annual basis. Results of the 1995 review (#95-200-073), which is valid through April 15, 1996, indicate that no plant or animal species of concern were found in the 200 Area tank farms. The proposed action may proceed before April 15, 1996, without additional review, and it is likely that the following year's annual review will result in a similar determination.

CONTACTS: Mr. C. A. Brandt, Ph.D. (376-5345) for questions regarding site assessments.

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Cultural Resource Review - 36 CFR 800

The proposed action will be conducted entirely within the 200 Area tank farms and will not involve removal of existing tanks or the modification or demolition of any permanent structures within or in the immediate vicinity of the tank farms. Hence, the proposed action is covered by an exemption from further review, as documented in a letter from Ms. M. E. Crist (PNL) to Mr. W. B. Bancroft (WHC), "Cultural Resources Exemption of the Tank Farm Areas," dated August 16, 1994. The proposed action may proceed without additional review.

CONTACTS: Ms. N. A. Cadoret (376-8107) to request a cultural resource review.

Preoperational Monitoring of Facilities, Sites, and Operations -
DOE Order 5400.1

NOTE: For more information see the Environmental Compliance Manual WHC-CM-7-5, Section 5.0, 5.4.2.1.g & h, Section 8.0, 8.5.1.7, and Section 9.0, 9.3.1.3.

A determination is being sought regarding whether air, soil, or vegetation sampling will be required before, during set up, and/or during operation of the SMMS and/or CO₂ decontamination system at the selected waste tanks. (It is unlikely that such sampling will be required for work within the tank farms.)

CONTACTS: Mr. A. R. Johnson (372-3056) for questions regarding preoperational monitoring requirements.

Radiation Protection Standards - DOE Order 5400.5

Environmental monitoring for the proposed action shall be in compliance with DOE/RL-91-50, "Environmental Monitoring Plan" and DOE/EH-0173T, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance," which provide specific guidance regarding environmental monitoring activities. Actions conducted in compliance with the Hanford Site Radiation Control Manual satisfy this requirement.

CONTACTS: Mr. D. W. Fritz (372-2066)

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NONRADIOACTIVE AIR EMISSIONS

General Regulations for Air Pollution Sources - WAC 173-400
NSR Applicability - WAC 173-400-110
PSD - WAC 173-400-141
Ozone Depleting Substances/CFCs - 40 CFR 82
Controls for New Sources of TAPs - WAC 173-460

Permitting of nonradioactive air pollutants will not be necessary if water is used to decontaminate equipment. However, if the option of using a CO₂ decontamination system is pursued, the action would likely result in increased emissions of toxic air pollutants, which would require obtaining Ecology approval of the proposed action under WAC 173-460. Ms. N. A. Homan (372-1644) of Air & Water Permitting is currently reviewing the proposed action to make this determination.

CONTACTS: Mr. J. A. Bates (376-2088) for assistance with determining the applicability of environmental requirements, Mr. L. P. Diediker (373-1716) for questions on how to meet annual PSD reporting requirements, and Mr. J. J. Luke (376-8629) for permitting questions and assignment of permitting personnel.

RADIOACTIVE AIR EMISSIONS

NESHAPs - 40 CFR 61, Subpart H

Radiation Protection - Air Emissions - WAC 246-247

Registration of Source - WAC 246-247-060

NOC - WAC 246-247-060

Use of the SMMS without the CO₂ decontamination system will result in very limited disturbance of the tank waste and tank head space gases. Efforts will be taken to control any potential radioactive emissions. No actual increase in emissions is expected as a result of the proposed activity. However, a courtesy notification will be provided to the DOH during a routine monthly meeting with the agency. DOH concurrence that this activity may be added to the list of "routine" activities at tank farms (those activities that may be conducted without further review by DOH) will be requested. The concurrence will be documented in signed meeting minutes, and these minutes will be incorporated into the project file. Ms. N. A. Homan (372-1644) of Air & Water Permitting will aid in preparing the presentation to DOH. No other air permitting documentation is expected to be necessary for this activity, assuming water is used for decontamination.

If the option of using a CO₂ decontamination system is pursued, the action would likely result in increased emissions of radioactive air pollutants. If this were the case, it would be necessary to obtain DOH approval of the proposed action under WAC 246-247 and EPA approval under 40 CFR 61, Subpart H. Ms. N. A. Homan (372-1644) of Air & Water Permitting is currently reviewing the proposed action to make this determination.

CONTACTS: Mr. J. A. Bates (376-2088) for assistance with determining the applicability of environmental requirements, Mr. L. P. Diediker (373-1716) for questions on how to meet annual NESHAPs reporting requirements, and Mr. J. J. Luke (376-8629) for permitting questions and assignment of permitting personnel.

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ALL AIR EMISSIONS

Air Operating Permit - WAC 173-401

If use of a CO₂ decontamination system is pursued, an emissions inventory (type and quantity of emissions) is to be maintained on file for inclusion in the Site Operating Permit. No action is necessary pursuant to this requirement if water is used to decontaminate equipment.

CONTACTS: Mr. J. A. Bates (376-2088) should be contacted for assistance with determining the applicable regulatory requirements, the list of categorically exempt/list of insignificant activities that must be listed in the permit application, and identification of any required air permits or formal notifications. Mr. J. J. Luke (376-8629) should be contacted for assistance with preparation of the permit(s) or NOC applications, or written notifications, and Mr. B. L. Curn (372-0840) for questions on the Air Operating Permit.

DANGEROUS WASTE

Dangerous Waste Permit - WAC 173-303; 40 CFR 264, 265, 270

Hanford Site waste tanks contain mixed waste. Equipment that comes in contact with tank waste during the proposed action may be impacted by RCRA requirements and/or the contaminated equipment policy (as documented in a letter from Mr. J. E. Rasmussen (RL) to Mr. M. Gearheard (EPA) and Mr. M. Wilson (Ecology), "Management of Contaminated Equipment at the Hanford Site," dated June 9, 1995). Any waste that is generated will need to be further evaluated for proper treatment, storage, transportation, or disposal.

CONTACTS: Mr. W. E. Toebe (372-2359) for regulatory interpretations; Mr. E. M. Greager (376-3132) for compliance questions, compliance assessments, or compliance assistance; and Mr. R. C. Bowman (376-4876) for permitting questions or assignment of permitting personnel.

**Westinghouse
Hanford Company**

**Internal
Memo**

From: Air & Water Permitting 01830-95-087
Phone: 376-8629 H6-25
Date: September 26, 1995
Subject: ESTIMATED RADIONUCLIDE AIR EMISSIONS FROM CO₂ DECONTAMINATION OF
THE SURFACE MOISTURE MEASUREMENT SYSTEM PROBE

To: T. I. Stokes H5-09

cc: N. A. Homan H6-25
J. J. Luke H6-25
G. A. Ritter H0-38
J. R. Robertson H6-21
NAH File/LB H6-25

The purpose of this memo is to transmit and discuss the preliminary emissions calculations for use of CO₂ decontamination with the Surface Moisture Measurement System. The calculations were performed to help determine if using CO₂ would be a feasible option, with respect to air permitting restraints, for decontaminating the probe. These preliminary estimates were limited to single shelled tanks (SSTs). A discussion of the source term, results and conclusions follows. The data sheets are provided in the enclosure. An electronic copy of the spread sheet will be provided through cc:mail, it is in the Excel 5.0 format.

SOURCE TERM

The source term used in the estimation comes from "Tank Vapor Mitigation Requirements for Hanford Tank Farms," WHC-SD-W314-DA-002 Rev.2. Originally it was thought that the source term calculations generated by the Safety Organization for worst case accident scenarios could be used. However, after review of their calculations, and results, performed for this project (consequences of Neutron Probe CO₂ decontamination), it was determined that the basis for their method of calculation was not equivalent to what is required by the Clean Air Act (CAA) for estimating off-site doses. Different locations for the maximally exposed individual (MEI) were used, and different scenarios for the MEI were used (acute vs chronic exposure). Also, their use of the super tank concept (creating a worst case tank source term from all the tanks) proved to be too conservative. It was thought that CAA emissions estimated from that source term would not realistically reflect the emissions expected from this CO₂ decontamination effort.

The Tank Vapor Mitigation Requirements document estimates the vapor space composition for all 177 waste tanks by using partition fractions. Partition fractions are a ratio of the concentration of a radionuclide in the waste to the concentration of the same radionuclide in the vapor space. They were developed using data from the aging waste tanks. Individual tank vapor space estimates were based on liquid waste samples of those tanks and then multiplied by the appropriate partition fractions. The data was combined into a fictitious worst case tank made up of the highest concentrations of each constituent throughout a tank farm. This single worst case tank per tank farm was the basis for the CO₂ decontamination estimates.

T. I. Stokes
Page 2
September 26, 1995

01830-95-087

ASSUMPTIONS/RESULTS

The estimation assumes that an exhauster would run for one hour per tank, this was believed to be a conservative time frame for decontamination. Also, an assumption was made that the contamination on the probe itself would be insignificant when compared to the quantities being exhausted from the vapor space. Therefore, contamination contributed by the probe was not included in the estimation.

The results are enclosed in spread sheet form. The first sheet a is high level summary for the SST Farms. The remaining sheets are broken down by tank farm and show the constituents, the emissions and the off-site dose for one, worst case, tank. Calculations were performed with two different flow rates for comparison, 200 cubic feet per minute (cfm) and 50 cfm. This was done to find out if reducing the flow rate would lower the emissions enough to preclude National Emissions Standards for Hazardous Air Pollutants (NESHAPs) monitoring requirements on an exhauster. Reducing the flow rate from 200 cfm to 50 cfm correspondingly reduced the emissions, per tank, by a factor of four. This, in general, was not enough to be exempt from NESHAPs monitoring requirements.

CONCLUSIONS

The results showed that continuous monitoring would be required for the exhaust generated by CO₂ decontamination of the moisture probe. However, they were close enough to the 0.1 millirem per year threshold that refining the estimates may prove to be beneficial. The worst case tank may be too conservative since all the tanks in a farm will not be sampled in the same year. It may be worth recalculating emissions based on the individual tanks that will be sampled in the same year. This would spread the "heavy hitters" out among other tanks (which may not be sampled that year) and bring the estimated emissions closer to their real quantity.

J. J. Luke, Manager
Air & Water Permitting
Environmental Division

ikt

Enclosure

Page 1

WORST CASE TANK FROM 241-A TANK FARM						
	ESTIMATED TANK VAPOR CONCENTRATION *	UNABATED EMISSIONS (at 200 cfm)	CAP-88 ** (mrem/Ci)	UNABATED DOSE (at 200 cfm)	UNABATED EMISSIONS (at 50 cfm)	UNABATED DOSE (at 50 cfm)
RADIONUCLIDE	(uCi/L)	(curies)	(mrem/Ci)	(mrem/yr)	(curies)	(mrem/yr)
C14	3.00E-01	1.02E-01	2.62E-03	2.87E-04	2.55E-02	6.68E-05
Co60	9.30E-01	3.16E-01	2.90E-02	9.16E-03	7.90E-02	2.29E-03
Se79 (see note 1)		0.00E+00	6.00E-02	0.00E+00	0.00E+00	0.00E+00
Sr89/90	1.20E+03	4.08E+02	4.38E-02	1.79E+01	1.02E+02	4.46E+00
Y90		0.00E+00	3.77E-04	0.00E+00	0.00E+00	0.00E+00
Tc99	1.00E-02	3.40E-03	1.09E-03	3.70E-06	8.50E-04	9.26E-07
Ru106		0.00E+00	2.09E-02	0.00E+00	0.00E+00	0.00E+00
I129		0.00E+00	2.91E-01	0.00E+00	0.00E+00	0.00E+00
Cs134		0.00E+00	3.13E-02	0.00E+00	0.00E+00	0.00E+00
Cs137	3.40E+01	1.16E+01	2.39E-02	2.76E-01	2.89E+00	6.90E-02
Eu154 (see note 4)	1.90E+00	6.46E-01	3.64E-01	2.35E-01	1.81E-01	5.88E-02
Eu155 (see note 4)	5.90E-01	2.00E-01	3.68E-02	7.38E-03	5.01E-02	1.84E-03
Np237 (see note 2)		0.00E+00	1.19E+01	0.00E+00	0.00E+00	0.00E+00
U238		0.00E+00	2.84E+00	0.00E+00	0.00E+00	0.00E+00
Pu238		0.00E+00	8.02E+00	0.00E+00	0.00E+00	0.00E+00
Pu239/240	3.00E-01	1.02E-01	8.67E+00	8.84E-01	2.55E-02	2.21E-01
Pu241	3.50E-01	1.19E-01	1.38E-01	1.64E-02	2.97E-02	4.10E-03
Am241	3.40E-01	1.16E-01	1.31E+01	1.51E+00	2.89E-02	3.78E-01
Am243		0.00E+00	1.31E+01	0.00E+00	0.00E+00	0.00E+00
Cm242 (see note 3)		0.00E+00	6.94E+00	0.00E+00	0.00E+00	0.00E+00
Cm244		0.00E+00	6.94E+00	0.00E+00	0.00E+00	0.00E+00
NOTES:			TOTAL =	2.1E+01 mrem/yr		5.2E+00 mrem/yr
1. CAP-88 was not available for Se79, used GENII for Se79.						
2. CAP-88 was not available for Np237, used CAP-88 for Np238.						
3. CAP-88 was not available for Cm242, used CAP-88 for Cm244.						
4. CAP-88 was not available for 200E Area, used CAP-88 for 300 Area.						
* WHC-SD-W314B-DA-002-0						
** WHC-EP-0498						

WORST CASE TANK FROM 241-AX TANK FARM									
	ESTIMATED TANK VAPOR CONCENTRATION *	UNABATED EMISSIONS (at 200 cfm)	CAP-88 **	UNABATED OFFSITE DOSE	UNABATED EMISSIONS (curies)	UNABATED OFFSITE DOSE	UNABATED EMISSIONS (curies)	UNABATED OFFSITE DOSE	
	(uCi/L)	(at 200 cfm)	(mrem/Ci)	(at 200 cfm)	(curies)	(at 200 cfm)	(curies)	(at 50 cfm)	
				(mrem/yr)		(mrem/yr)		(mrem/yr)	
C14	1.60E-02	5.44E-03	2.62E-03	1.42E-05	1.36E-03		3.56E-06		
Co60	1.10E-02	3.74E-03	2.90E-02	1.08E-04	9.34E-04		2.71E-05		
Se79 (see note 1)		0.00E+00	6.60E-02	0.00E+00	0.00E+00		0.00E+00		
Sr89/90	5.00E+00	1.70E+00	4.38E-02	7.44E-02	4.25E-01		1.86E-02		
Y90		0.00E+00	3.77E-04	0.00E+00	0.00E+00		0.00E+00		
Tc99	5.20E-03	1.77E-03	1.09E-03	1.93E-06	4.42E-04		4.81E-07		
Ru106		0.00E+00	2.09E-02	0.00E+00	0.00E+00		0.00E+00		
I129		0.00E+00	2.91E-01	0.00E+00	0.00E+00		0.00E+00		
Cs134		0.00E+00	3.13E-02	0.00E+00	0.00E+00		0.00E+00		
Cs137	2.00E+01	6.80E+00	2.39E-02	1.62E-01	1.70E+00		4.06E-02		
Eu154 (see note 4)	1.40E-01	4.76E-02	3.64E-01	1.73E-02	1.19E-02		4.33E-03		
Eu155 (see note 4)	6.80E-02	2.31E-02	3.68E-02	8.50E-04	5.78E-03		2.13E-04		
Np237 (see note 2)		0.00E+00	1.19E+01	0.00E+00	0.00E+00		0.00E+00		
U238		0.00E+00	2.84E+00	0.00E+00	0.00E+00		0.00E+00		
Pu238		0.00E+00	8.02E+00	0.00E+00	0.00E+00		0.00E+00		
Pu239/240	4.30E-02	1.46E-02	8.67E+00	1.27E-01	3.65E-03		3.17E-02		
Pu241	1.50E-01	5.10E-02	1.38E-01	7.03E-03	1.27E-02		1.76E-03		
Am241	1.90E-02	6.46E-03	1.31E+01	8.46E-02	1.61E-03		2.11E-02		
Am243		0.00E+00	1.31E+01	0.00E+00	0.00E+00		0.00E+00		
Cm242 (see note 3)		0.00E+00	6.94E+00	0.00E+00	0.00E+00		0.00E+00		
Cm244		0.00E+00	6.94E+00	0.00E+00	0.00E+00		0.00E+00		
			TOTAL =	4.7E-01	mrem/yr		1.2E-01	mrem/yr	
NOTES:									
1. CAP-88 was not available for Se79, used GENII for Se79.									
2. CAP-88 was not available for Np237, used CAP-88 for Np238.									
3. CAP-88 was not available for Cm242, used CAP-88 for Cm244.									
4. CAP-88 was not available for 200E Area, used CAP-88 for 300 Area.									
* WHC-SD-W314B-DA-002-0									
** WHC-EP-0498									

WORST CASE TANK FROM 241-B TANK FARM									
	ESTIMATED TANK VAPOR CONCENTRATION *	UNABATED EMISSIONS (at 200 cfm)	CAP-88 ** (mrem/CI)	UNABATED DOSE (at 200 cfm)	UNABATED EMISSIONS (at 50 cfm)	UNABATED DOSE (at 50 cfm)	UNABATED OFFSITE DOSE (mrem/yr)		
RADIONUCLIDE	(uCi/L)	(curies)		(mrem/yr)	(curies)	(mrem/yr)			
C-14	9.50E-02	3.23E-02	2.62E-03	8.48E-05	8.07E-03	2.11E-05			
Co60		0.00E+00	2.90E-02	0.00E+00	0.00E+00	0.00E+00			
Sr79 (see note 1)		0.00E+00	6.60E-02	0.00E+00	0.00E+00	0.00E+00			
Sr89/90	4.10E+01	1.39E+01	4.38E-02	6.10E-01	3.48E+00	1.53E-01			
Y90		0.00E+00	3.77E-04	0.00E+00	0.00E+00	0.00E+00			
Tc99	1.30E-01	4.42E-02	1.09E-03	4.81E-05	1.10E-02	1.20E-05			
Ru106		0.00E+00	2.09E-02	0.00E+00	0.00E+00	0.00E+00			
I129	2.30E-04	7.82E-05	2.91E-01	2.27E-05	1.95E-05	5.68E-08			
Cs134		0.00E+00	3.13E-02	0.00E+00	0.00E+00	0.00E+00			
Cs137	3.70E+01	1.26E+01	2.39E-02	3.00E-01	3.14E+00	7.51E-02			
Eu154 (see note 4)	7.90E-03	2.68E-03	3.64E-01	9.77E-04	6.71E-04	2.44E-04			
Eu155 (see note 4)	2.00E-03	6.80E-04	3.68E-02	2.50E-05	1.70E-04	6.25E-06			
Np237 (see note 2)		0.00E+00	1.19E+01	0.00E+00	0.00E+00	0.00E+00			
U238		0.00E+00	2.84E+00	0.00E+00	0.00E+00	0.00E+00			
Pu238		0.00E+00	8.02E+00	0.00E+00	0.00E+00	0.00E+00			
Pu239/240	7.70E-02	2.62E-02	8.67E+00	2.27E-01	6.54E-03	5.67E-02			
Pu241	6.20E-02	2.11E-02	1.38E-01	2.91E-03	5.27E-03	7.27E-04			
Am241	8.20E-03	2.79E-03	1.31E+01	3.65E-02	6.97E-04	9.13E-03			
Am243		0.00E+00	1.31E+01	0.00E+00	0.00E+00	0.00E+00			
Cm242 (see note 3)		0.00E+00	6.94E+00	0.00E+00	0.00E+00	0.00E+00			
Cm244		0.00E+00	6.94E+00	0.00E+00	0.00E+00	0.00E+00			
			TOTAL =	1.2E+00 mrem/yr		2.9E-01 mrem/yr			
NOTES:									
1. CAP-88 was not available for Sr79, used GENII for Sr79.									
2. CAP-88 was not available for Np237, used CAP-88 for Np238.									
3. CAP-88 was not available for Cm242, used CAP-88 for Cm244.									
4. CAP-88 was not available for 200E Area, used CAP-88 for 300 Area.									
* WHC-SD-W314B-DA-002-0									
** WHC-EP-0498									

WORST CASE TANK FROM 241-BX TANK FARM									
	ESTIMATED TANK VAPOR CONCENTRATION *	UNABATED EMISSIONS (at 200 cfm)	CAP-88 **	UNABATED DOSE (at 200 cfm)	UNABATED EMISSIONS (at 50 cfm)	UNABATED DOSE (at 50 cfm)	UNABATED OFFSITE DOSE (at 50 cfm)		
	(uCi/L)	(curies)	(mrem/Ci)	(mrem/yr)	(curies)	(mrem/yr)	(mrem/yr)		
RADIONUCLIDE									
C14	1.60E-01	5.44E-02	2.62E-03	1.42E-04	1.36E-02	1.36E-02	3.56E-05		
Co60		0.00E+00	2.90E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Se79 (see note 1)		0.00E+00	6.60E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Sr89/90	3.50E+00	1.19E+00	4.38E-02	5.21E-02	2.97E-01	2.97E-01	1.30E-02		
Y90		0.00E+00	3.77E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Tc99	1.80E-01	6.12E-02	1.09E-03	6.67E-05	1.53E-02	1.53E-02	1.67E-05		
Ru106		0.00E+00	2.09E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
I129	3.70E-04	1.26E-04	2.91E-01	3.66E-05	3.14E-05	3.14E-05	9.15E-06		
Cs134		0.00E+00	3.13E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Cs137	8.60E+00	2.92E+00	2.39E-02	6.98E-02	7.31E-01	7.31E-01	1.75E-02		
Eu154 (see note 4)		0.00E+00	3.64E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Eu155 (see note 4)		0.00E+00	3.68E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Np237 (see note 2)		0.00E+00	1.19E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
U238		0.00E+00	2.84E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Pu238		0.00E+00	8.02E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Pu239/240	7.80E-02	2.65E-02	8.67E+00	2.30E-01	6.63E-03	6.63E-03	5.74E-02		
Pu241	3.50E-02	1.19E-02	1.38E-01	1.84E-03	2.97E-03	2.97E-03	4.10E-04		
Am241	2.20E-02	7.48E-03	1.31E+01	9.79E-02	1.87E-03	1.87E-03	2.45E-02		
Am243		0.00E+00	1.31E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Cm242 (see note 3)		0.00E+00	6.94E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Cm244		0.00E+00	6.94E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
			TOTAL =	4.5E-01 mrem/yr			1.1E-01 mrem/yr		
NOTES:									
	1. CAP-88 was not available for Se79, used GENII for Se79.								
	2. CAP-88 was not available for Np237, used CAP-88 for Np238.								
	3. CAP-88 was not available for Cm242, used CAP-88 for Cm244.								
	4. CAP-88 was not available for 200E Area, used CAP-88 for 300 Area.								
	* WHC-SD-W314B-DA-002-0								
	** WHC-EP-0498								

WORST CASE TANK FROM 241-BY TANK FARM						
	ESTIMATED TANK VAPOR CONCENTRATION * (uCi/L)	UNABATED EMISSIONS (at 200 cfm) (curies)	CAP-88 ** (mrem/Ci) (mrem/yr)	UNABATED DOSE (at 200 cfm) (mrem/yr)	UNABATED EMISSIONS (at 50 cfm) (curies)	UNABATED OFFSITE DOSE (at 50 cfm) (mrem/yr)
RADIONUCLIDE						
C14	4.00E-03	1.36E-03	2.62E-03	3.56E-06	3.40E-04	8.90E-07
Co60		0.00E+00	2.90E-02	0.00E+00	0.00E+00	0.00E+00
Se79 (see note 1)		0.00E+00	6.60E-02	0.00E+00	0.00E+00	0.00E+00
Sr89/90	7.00E+00	2.38E+00	4.38E-02	1.04E-01	5.95E-01	2.60E-02
Y90		0.00E+00	3.77E-04	0.00E+00	0.00E+00	0.00E+00
Tc99	1.20E-02	4.08E-03	1.09E-03	4.44E-06	1.02E-03	1.11E-06
Ru106		0.00E+00	2.09E-02	0.00E+00	0.00E+00	0.00E+00
I129		0.00E+00	2.91E-01	0.00E+00	0.00E+00	0.00E+00
Cs134		0.00E+00	3.13E-02	0.00E+00	0.00E+00	0.00E+00
Cs137	1.40E+01	4.76E+00	2.39E-02	1.14E-01	1.19E+00	2.84E-02
Eu154		0.00E+00	3.64E-01	0.00E+00	0.00E+00	0.00E+00
Eu155		0.00E+00	3.68E-02	0.00E+00	0.00E+00	0.00E+00
Np237 (see note 2)		0.00E+00	1.19E+01	0.00E+00	0.00E+00	0.00E+00
U238		0.00E+00	2.84E+00	0.00E+00	0.00E+00	0.00E+00
Pu238		0.00E+00	8.02E+00	0.00E+00	0.00E+00	0.00E+00
Pu239/240	3.00E-03	1.02E-03	8.67E+00	8.84E-03	2.55E-04	2.21E-03
Pu241	2.60E-03	8.83E-04	1.38E-01	1.22E-04	2.21E-04	3.05E-05
Am241	4.30E-03	1.46E-03	1.31E+01	1.91E-02	3.65E-04	4.79E-03
Am243		0.00E+00	1.31E+01	0.00E+00	0.00E+00	0.00E+00
Cm242 (see note 3)		0.00E+00	6.94E+00	0.00E+00	0.00E+00	0.00E+00
Cm244		0.00E+00	6.94E+00	0.00E+00	0.00E+00	0.00E+00
NOTES:			TOTAL =	2.5E-01 mrem/yr		6.1E-02 mrem/yr

WORST CASE TANK FROM 241-C TANK FARM						
	ESTIMATED TANK VAPOR CONCENTRATION * (uCi/L)	UNABATED EMISSIONS (at 200 cfm) (curies)	CAP-88 ** (mrem/Ci)	UNABATED OFFSITE DOSE (at 200 cfm) (mrem/yr)	UNABATED EMISSIONS (at 50 cfm) (curies)	UNABATED OFFSITE DOSE (at 50 cfm) (mrem/yr)
RADIONUCLIDE						
C14	2.10E-02	7.14E-03	2.62E-03	1.87E-05	1.78E-03	4.67E-06
Co60	1.80E-03	6.12E-04	2.90E-02	1.77E-05	1.53E-04	4.43E-06
Se79 (see note 1)		0.00E+00	6.60E-02	0.00E+00	0.00E+00	0.00E+00
Sr90/90	7.70E+00	2.62E+00	4.38E-02	1.15E-01	6.54E-01	2.87E-02
Y90		0.00E+00	3.77E-04	0.00E+00	0.00E+00	0.00E+00
Tc99	4.20E-03	1.43E-03	1.09E-03	1.56E-06	3.57E-04	3.89E-07
Ru106		0.00E+00	2.09E-02	0.00E+00	0.00E+00	0.00E+00
I129		0.00E+00	2.91E-01	0.00E+00	0.00E+00	0.00E+00
Cs134		0.00E+00	3.13E-02	0.00E+00	0.00E+00	0.00E+00
Cs137	1.10E+01	3.74E+00	2.39E-02	8.93E-02	9.34E-01	2.23E-02
Eu154 (see note 4)		0.00E+00	3.64E-01	0.00E+00	0.00E+00	0.00E+00
Eu155 (see note 4)		0.00E+00	3.68E-02	0.00E+00	0.00E+00	0.00E+00
Np237 (see note 2)		0.00E+00	1.19E+01	0.00E+00	0.00E+00	0.00E+00
U238		0.00E+00	2.84E+00	0.00E+00	0.00E+00	0.00E+00
Pl238		0.00E+00	8.02E+00	0.00E+00	0.00E+00	0.00E+00
Pl239/240	4.60E-02	1.56E-02	8.67E+00	1.36E-01	3.91E-03	3.39E-02
Pl241	6.40E-02	2.17E-02	1.38E-01	3.00E-03	5.44E-03	7.50E-04
Am241	1.10E-02	3.74E-03	1.31E+01	4.90E-02	9.34E-04	1.22E-02
Am243		0.00E+00	1.31E+01	0.00E+00	0.00E+00	0.00E+00
Cm242 (see note 3)		0.00E+00	6.94E+00	0.00E+00	0.00E+00	0.00E+00
Cm244		0.00E+00	6.94E+00	0.00E+00	0.00E+00	0.00E+00
NOTES:			TOTAL =	3.9E-01 mrem/yr	9.8E-02 mrem/yr	
1. CAP-88 was not available for Se79, used GENII for Se79.						
2. CAP-88 was not available for Np237, used CAP-88 for Np238.						
3. CAP-88 was not available for Cm242, used CAP-88 for Cm244.						
4. CAP-88 was not available for 200E Area, used CAP-88 for 300 Area.						
* WHC-SD-W314B-DA-002-0						
** WHC-EP-0498						

WORST CASE TANK FROM 241-S TANK FARM						
	ESTIMATED TANK VAPOR CONCENTRATION * (uCi/L)	UNABATED EMISSIONS (at 200 cfm) (curies)	CAP-88 ** (mrem/Ci)	UNABATED DOSE (at 200 cfm) (mrem/yr)	UNABATED EMISSIONS (at 50 cfm) (curies)	UNABATED DOSE (at 50 cfm) (mrem/yr)
RADIONUCLIDE						
C14	1.40E-02	4.76E-03	1.65E-03	7.85E-06	1.19E-03	1.96E-06
C60		0.00E+00	1.72E-02	0.00E+00	0.00E+00	0.00E+00
Se79 (see note 1)		0.00E+00	3.80E-02	0.00E+00	0.00E+00	0.00E+00
Sr89/90	1.60E+01	5.44E+00	2.60E-02	1.41E-01	1.36E+00	3.53E-02
Y90		0.00E+00	2.22E-04	0.00E+00	0.00E+00	0.00E+00
Tc99	2.70E-02	9.17E-03	6.45E-04	5.92E-06	2.29E-03	1.48E-06
Ru106		0.00E+00	1.24E-02	0.00E+00	0.00E+00	0.00E+00
I129	1.90E-03	6.46E-04	1.14E-01	7.36E-05	1.61E-04	1.84E-05
Cs134		0.00E+00	1.86E-02	0.00E+00	0.00E+00	0.00E+00
Cs137	1.20E+01	4.08E+00	1.42E-02	5.79E-02	1.02E+00	1.45E-02
Eu154 (see note 4)	6.20E-03	2.11E-03	3.64E-01	7.67E-04	5.27E-04	1.92E-04
Eu155 (see note 4)	4.80E-03	1.63E-03	3.68E-02	6.00E-05	4.08E-04	1.50E-05
Np237 (see note 2)		0.00E+00	7.05E+00	0.00E+00	0.00E+00	0.00E+00
U238		0.00E+00	1.69E+00	0.00E+00	0.00E+00	0.00E+00
Pu238		0.00E+00	4.76E+00	0.00E+00	0.00E+00	0.00E+00
Pu239/240	2.00E-01	6.80E-02	5.15E+00	3.50E-01	1.70E-02	8.75E-02
Pu241	5.40E-02	1.83E-02	8.17E-02	1.50E-03	4.59E-03	3.75E-04
Am241	1.40E-02	4.76E-03	7.79E+00	3.71E-02	1.19E-03	9.26E-03
Am243		0.00E+00	7.79E+00	0.00E+00	0.00E+00	0.00E+00
Cm242 (see note 3)		0.00E+00	4.12E+00	0.00E+00	0.00E+00	0.00E+00
Cm244		0.00E+00	4.12E+00	0.00E+00	0.00E+00	0.00E+00
			TOTAL =	5.9E-01 mrem/yr		1.5E-01 mrem/yr
NOTES:						
1. CAP-88 was not available for Se79, used GENII for Se79.						
2. CAP-88 was not available for Np237, used CAP-88 for Np238.						
3. CAP-88 was not available for Cm242, used CAP-88 for Cm244.						
4. CAP-88 was not available for 200W Area, used CAP-88 for 300 AREA.						
* WHC-SD-W314B-DA-002-0						
WHC-EP-0498						

WORST CASE TANK FROM 241-SX TANK FARM									
	ESTIMATED TANK VAPOR CONCENTRATION * (uCi/L)	UNABATED EMISSIONS (at 200 cfm) (curies)	UNABATED OFFSITE DOSE (at 200 cfm) (mrem/yr)		UNABATED EMISSIONS (curies)	UNABATED OFFSITE DOSE (at 50 cfm) (mrem/yr)			
			CAP-88 ** (mrem/Ci)						
RADIONUCLIDE									
C14	1.00E-02	3.40E-03	1.65E-03	5.61E-06	8.50E-04	1.40E-06			
Co60	1.20E+00	4.08E-01	1.72E-02	7.01E-03	1.02E-01	1.75E-03			
Se79 (see note 1)		0.00E+00	3.80E-02	0.00E+00	0.00E+00	0.00E+00			
Sr89/90	1.40E+03	4.76E+02	2.60E-02	1.24E+01	1.19E+02	3.09E+00			
Y90		0.00E+00	2.22E-04	0.00E+00	0.00E+00	0.00E+00			
Tc99	7.50E+02	2.55E+02	6.45E-04	1.64E-01	6.37E+01	4.11E-02			
Ru106		0.00E+00	1.24E-02	0.00E+00	0.00E+00	0.00E+00			
I129		0.00E+00	1.14E-01	0.00E+00	0.00E+00	0.00E+00			
Cs134		0.00E+00	1.86E-02	0.00E+00	0.00E+00	0.00E+00			
Cs137	1.30E-03	4.42E-04	1.42E-02	6.27E-06	1.10E-04	1.57E-06			
Eu154 (see note 4)	8.40E-01	2.85E-01	3.64E-01	1.04E-01	7.14E-02	2.60E-02			
Eu155 (see note 4)		0.00E+00	3.68E-02	0.00E+00	0.00E+00	0.00E+00			
Np237 (see note 2)		0.00E+00	7.05E+00	0.00E+00	0.00E+00	0.00E+00			
U238		0.00E+00	1.69E+00	0.00E+00	0.00E+00	0.00E+00			
Pu238		0.00E+00	4.76E+00	0.00E+00	0.00E+00	0.00E+00			
Pu239/240	1.60E+00	5.44E-01	5.15E+00	2.80E+00	1.36E-01	7.00E-01			
Pu241	2.00E-02	6.80E-03	8.17E-02	5.55E-04	1.70E-03	1.39E-04			
Am241	4.10E+00	1.39E+00	7.79E+00	1.09E+01	3.48E-01	2.71E+00			
Am243		0.00E+00	7.79E+00	0.00E+00	0.00E+00	0.00E+00			
Cm242 (see note 3)		0.00E+00	4.12E+00	0.00E+00	0.00E+00	0.00E+00			
Cm244		0.00E+00	4.12E+00	0.00E+00	0.00E+00	0.00E+00			
			TOTAL =		2.6E+01 mrem/yr		6.6E+00 mrem/yr		
NOTES:									
1. CAP-88 was not available for Se79, used GENII for Se79.									
2. CAP-88 was not available for Np237, used CAP-88 for Np238.									
3. CAP-88 was not available for Cm242, used CAP-88 for Cm244.									
4. CAP-88 was not available for 200W Area, used CAP-88 for 300 Area.									
* WHC-SD-W314B-DA-002-0									
** WHC-EP-0498									

WORST CASE TANK FROM 241-T TANK FARM						
		UNABATED EMISSIONS (at 200 cfm)	CAP-88 ** (mrem/Ci)	UNABATED DOSE (at 200 cfm) (mrem/yr)	UNABATED EMISSIONS (at 50 cfm)	UNABATED DOSE (at 50 cfm) (mrem/yr)
ESTIMATED TANK VAPOR CONCENTRATION *						
	(uCi/L)	(curies)				
RADIONUCLIDE						
C14	3.00E-03	1.02E-03	1.65E-03	1.68E-06	2.55E-04	4.21E-07
Co60		0.00E+00	1.72E-02	0.00E+00	0.00E+00	0.00E+00
Se79 (see note 1)		0.00E+00	3.80E-02	0.00E+00	0.00E+00	0.00E+00
Sr89/90	6.20E+00	2.11E+00	2.60E-02	5.48E-02	5.27E-01	1.37E-02
Y90		0.00E+00	2.22E-04	0.00E+00	0.00E+00	0.00E+00
Tc99	2.30E-03	7.82E-04	6.45E-04	5.04E-07	1.95E-04	1.26E-07
Ru106		0.00E+00	1.24E-02	0.00E+00	0.00E+00	0.00E+00
I129		0.00E+00	1.14E-01	0.00E+00	0.00E+00	0.00E+00
Cs134		0.00E+00	1.86E-02	0.00E+00	0.00E+00	0.00E+00
Cs137	5.10E+00	1.73E+00	1.42E-02	2.46E-02	4.33E-01	6.15E-03
Eu154 (see note 4)	2.40E-03	8.16E-04	3.64E-01	2.97E-04	2.04E-04	7.42E-05
Eu155 (see ntote 4)		0.00E+00	3.68E-02	0.00E+00	0.00E+00	0.00E+00
Np237 (see note 2)		0.00E+00	7.05E+00	0.00E+00	0.00E+00	0.00E+00
U238		0.00E+00	1.69E+00	0.00E+00	0.00E+00	0.00E+00
Pu238		0.00E+00	4.76E+00	0.00E+00	0.00E+00	0.00E+00
Pu239/240	1.10E-02	3.74E-03	5.15E+00	1.92E-02	9.34E-04	4.81E-03
Pu241	7.60E-03	2.58E-03	8.17E-02	2.11E-04	6.46E-04	5.27E-05
Am241	3.30E-03	1.12E-03	7.79E+00	8.74E-03	2.80E-04	2.18E-03
Am243		0.00E+00	7.79E+00	0.00E+00	0.00E+00	0.00E+00
Cm242 (see note 3)		0.00E+00	4.12E+00	0.00E+00	0.00E+00	0.00E+00
Cm244		0.00E+00	4.12E+00	0.00E+00	0.00E+00	0.00E+00
NOTES:			TOTAL =	1.1E-01 mrem/yr		2.7E-02 mrem/yr
1. CAP-88 was not available for Se79, used GENII for Se79.						
2. CAP-88 was not available for Np237, used CAP-88 for Np238.						
3. CAP-88 was not available for Cm242, used CAP-88 for Cm244.						
4. CAP-88 was not available for 200W Area, used CAP-88 for 300 Area.						
* WHC-SD-W314B-DA-002-0						
** WHC-EP-0498						

RADPROBE.XLS

WORST CASE TANK FROM 241-TY TANK FARM									
	ESTIMATED TANK VAPOR CONCENTRATION *	UNABATED EMISSIONS (at 200 cfm)	CAP-88 ** (mrem/GI)	UNABATED DOSE (at 200 cfm)	UNABATED EMISSIONS (at 50 cfm)	UNABATED DOSE (at 50 cfm)	UNABATED OFFSITE DOSE (at 50 cfm)		
RADIONUCLIDE	(uCi/L)	(curies)	(mrem/GI)	(mrem/yr)	(curies)	(mrem/yr)	(mrem/yr)		
C14	8.10E-03	2.75E-03	1.65E-03	4.54E-06	6.88E-04	1.14E-06			
C60		0.00E+00	1.72E-02	0.00E+00	0.00E+00	0.00E+00			
Se79 (see note 1)		0.00E+00	3.80E-02	0.00E+00	0.00E+00	0.00E+00			
Si89/90	3.70E+01	1.26E+01	2.60E-02	3.27E-01	3.14E+00	8.17E-02			
Y90		0.00E+00	2.22E-04	0.00E+00	0.00E+00	0.00E+00			
Tc99	2.60E-02	8.83E-03	6.45E-04	5.70E-06	2.21E-03	1.42E-06			
Ru106		0.00E+00	1.24E-02	0.00E+00	0.00E+00	0.00E+00			
I129	3.40E-03	1.16E-03	1.14E-01	1.32E-04	2.89E-04	3.29E-05			
Cs134		0.00E+00	1.86E-02	0.00E+00	0.00E+00	0.00E+00			
Cs137	6.10E-01	2.07E-01	1.42E-02	2.94E-03	5.18E-02	7.36E-04			
Eu154 (see note 4)		0.00E+00	3.64E-02	0.00E+00	0.00E+00	0.00E+00			
Eu155 (see note 4)		0.00E+00	3.68E-02	0.00E+00	0.00E+00	0.00E+00			
Np237 (see note 2)		0.00E+00	7.05E+00	0.00E+00	0.00E+00	0.00E+00			
U238		0.00E+00	1.69E+00	0.00E+00	0.00E+00	0.00E+00			
Pu238		0.00E+00	4.76E+00	0.00E+00	0.00E+00	0.00E+00			
Pu239/240		0.00E+00	5.15E+00	0.00E+00	0.00E+00	0.00E+00			
Pu241	9.20E-03	3.13E-03	8.17E-02	2.55E-04	7.82E-04	6.39E-05			
Am241	1.80E-03	6.12E-04	7.79E+00	4.76E-03	1.53E-04	1.19E-03			
Am243		0.00E+00	7.79E+00	0.00E+00	0.00E+00	0.00E+00			
Cm242 (see note 3)		0.00E+00	4.12E+00	0.00E+00	0.00E+00	0.00E+00			
Cm244		0.00E+00	4.12E+00	0.00E+00	0.00E+00	0.00E+00			
			TOTAL =	3.3E-01 mrem/yr		8.4E-02 mrem/yr			
NOTES:									
1. CAP-88 was not available for Se79, used GENII for Se79									
2. CAP-88 was not available for Np237, used CAP-88 for Np238.									
3. CAP-88 was not available for Cm242, used CAP-88 for Cm244.									
4. CAP-88 was not available for 200W Area, used CAP-88 for 300 Area.									
* WHC-SD-W314B-DA-002-0									
** WHC-EP-0498									

WORST CASE TANK FROM 241-U TANK FARM						
	ESTIMATED TANK VAPOR CONCENTRATION *	UNABATED EMISSIONS (at 200 cfm) (curies)	CAP-88 ** (mrem/Ci)	UNABATED OFFSITE DOSE (at 200 cfm) (mrem/yr)	UNABATED EMISSIONS (at 50 cfm) (curies)	UNABATED OFFSITE DOSE (at 50 cfm) (mrem/yr)
RADIONUCLIDE	(uCi/L)					
C14	4.10E-02	1.39E-02	1.65E-03	2.30E-05	3.48E-03	5.75E-06
Co60		0.00E+00	1.72E-02	0.00E+00	0.00E+00	0.00E+00
Se79 (see note 1)		0.00E+00	3.80E-02	0.00E+00	0.00E+00	0.00E+00
Sr89/90	5.30E+00	1.80E+00	2.60E-02	4.68E-02	4.50E-01	1.17E-02
Y90		0.00E+00	2.22E-04	0.00E+00	0.00E+00	0.00E+00
Tc99	8.20E-02	2.79E-02	6.45E-04	1.80E-05	6.97E-03	4.49E-06
Ru106		0.00E+00	1.24E-02	0.00E+00	0.00E+00	0.00E+00
I129	1.40E-04	4.76E-05	1.14E-01	5.42E-06	1.19E-05	1.36E-06
Cs134		0.00E+00	1.86E-02	0.00E+00	0.00E+00	0.00E+00
Cs137	7.50E+00	2.55E+00	1.42E-02	3.62E-02	6.37E-01	9.05E-03
Eu154 (see note 4)	1.20E-02	4.08E-03	3.64E-02	1.48E-04	1.02E-03	3.71E-05
Eu155 (see note 4)	4.00E-03	1.36E-03	3.68E-02	5.00E-05	3.40E-04	1.25E-05
Np237 (see note 2)		0.00E+00	7.05E+00	0.00E+00	0.00E+00	0.00E+00
U238		0.00E+00	1.69E+00	0.00E+00	0.00E+00	0.00E+00
Pu238		0.00E+00	4.76E+00	0.00E+00	0.00E+00	0.00E+00
Pu239/240	8.40E-02	2.85E-02	5.15E+00	1.47E-01	7.14E-03	3.67E-02
Pu241	4.80E-03	1.63E-03	8.17E-02	1.33E-04	4.08E-04	3.33E-05
Am241	3.20E-03	1.09E-03	7.79E+00	8.47E-03	2.72E-04	2.12E-03
Am243		0.00E+00	7.79E+00	0.00E+00	0.00E+00	0.00E+00
Cm242 (see note 3)		0.00E+00	4.12E+00	0.00E+00	0.00E+00	0.00E+00
Cm244		0.00E+00	4.12E+00	0.00E+00	0.00E+00	0.00E+00
			TOTAL =	2.4E-01 mrem/yr		6.0E-02 mrem/yr
NOTES:						
1. CAP-88 was not available for Se79, used GENII for Se79.						
2. CAP-88 was not available for Np237, used CAP-88 for Np238.						
3. CAP-88 was not available for Cm242, used CAP-88 for Cm244.						
4. CAP-88 was not available for 200W Area, used CAP-88 for 300 Area.						
* WHC-SD-W314B-DA-002-0						
** WHC-EP-0498						

2.2.10

November 29, 1995

Nick Boechler H5-09
Rosa Seda H5-09
George Vargo H5-09

The Environmental Requirements Checklists prepared for the Cone Penetrometer and the Surface Moisture Measurement System contain an item dealing with preoperational monitoring. Your checklists note that a determination regarding the need for preop monitoring per DOE Order 5400.1 would be forthcoming; the attached letter indicates that you have no monitoring requirements stemming from DOE Order 5400.1. However, the letter also requests a follow-up call be made to the Near-Field Monitoring group to determine if there are any other air monitoring requirements that your projects might trigger.

To make your jobs a little easier, I'll make that call for you. I'll be checking with Near-Field Monitoring to see what other requirements the letter might be referring to. I'll let you know what I find out.

Julie Robertson

**Westinghouse
Hanford Company**

**Internal
Memo**

From: Near-Field Monitoring
Phone: 372-3056 H6-20
Date: November 27, 1995
Subject: ENVIRONMENTAL MONITORING REQUIREMENTS FOR CONE PENETROMETER AND
SURFACE MOISTURE MEASUREMENT SYSTEM AT HANFORD TANK FARMS

8H131-95-073

To: J. R. Robertson H6-21

cc: L. P. Diediker S3-95
J. J. Dorian S3-24
B. G. Erlandson H6-20
R. A. Meznarich H6-30
J. W. Schmidt H6-20
ARJ File/LB

We have reviewed the scope of work for both the Cone Penetrometer Project and for the Moisture Measurement System Project at the Hanford Tank Farms. These projects will not require Preoperational Environmental Monitoring as specified in DOE Order 5400.1. However, because of potential for environmental releases during operation of these systems, air monitoring may need to be conducted.

Please contact Mr. J. W. Schmidt of the Near-Field Monitoring Team on 372-3086 prior to startup of these systems.

A. R. Johnson, Principal Engineer
Near-Field Monitoring

dyl

DON'T SAY IT --- Write It!

DATE: December 18, 1995

TO: Nick Boechler H5-09
Glenn Ritter H0-38
Rosa Seda H5-09

FROM: Julie Robertson H6-21
Telephone: 376-8162

cc: Nancy Homan H6-25
(w/you out)

SUBJECT: APPROVAL OF USE OF SURFACE MOISTURE MEASUREMENT SYSTEM
AND CONE PENETROMETER AT TANK FARMS

Enclosed is a copy of the signed list of routine, exempt, and approved tank farms activities that may be conducted without further consultation with the Washington State Department of Health (DOH). Use of the Surface Moisture Measurement System and of the Cone Penetrometer were proposed for addition to this list in the September 1995 routine monthly technical assistance meeting with DOH. Use of this equipment in the tank farms must be in accordance with controls mandated in Section G.1.b. of the list.

Any questions about this approval may be directed to me at the number listed above or to Nancy Homan on 372-1644.

ROUTINE, EXEMPT AND APPROVED TANK FARMS ACTIVITIES

- A. ROUTINE ACTIVITIES THAT OCCUR AT REGISTERED SOURCES, OR THAT DO NOT CREATE A POTENTIAL NEW PATHWAY FOR AIR EMISSIONS FROM UNREGISTERED SOURCES [4/93]
1. Activities that do not create a potential new air pathway, at actively ventilated, registered, SSTs and DSTs. [4/93]
- a. EXAMPLES
- 1) Opening a riser, where the ventilation system can be depended upon to maintain adequate in-flow to the tank. [4/93]
 - 2) Disturbing the tank waste, where the potential for significant aerosol generation is not present. [4/93]
 - 3) Equipment installation, repair, replacement, or removal. [4/93]
 - 4) Photography. [4/93]
 - 5) Obtaining vapor space samples where the sample is returned to the tank after collection, or there is not release of the vapor sample. [4/93]
 - 6) Receipt of waste into DSTs from SSTs, other DSTs, the evaporator, the 204-AR Waste Unloading Facility, or other waste generators (e.g., laboratories). [4/93]
 - 7) Receipt of SST waste in double contained receiver tanks. [4/93]
- b. CONTROLS
- 1) HPT coverage as required by procedure (with retrievable records*). [4/93]
 - 2) ALARA. [4/93]
2. Activities that involve routine replacement, repair, or replacement-in-kind of ventilation system components. [4/93]
- a. EXAMPLES
- 1) Replacing sample probes. [4/93]
 - 2) Replacing HEPA filters. [4/93]
 - 3) Repair of exhaust damper valves. [4/93]
 - 4) Sampling or replacing ion-exchange filter media. [4/93]
- b. CONTROLS
- 1) HPT coverage as required by procedure (with retrievable records*). [4/93]
 - 2) Greenhouses/glovebags, as practical. [4/93]
 - 3) ALARA. [4/93]

* Retrievable records are defined here as records available for DOE inspection while the activity is ongoing, and all positive indications of airborne releases reported through the off-normal reporting system, or included in the annual dose estimation for Hanford activities.

ROUTINE, EXEMPT AND APPROVED TANK FARMS ACTIVITIES

3. Activities that involve routine replacement, repair, or replacement-in-kind of equipment, at actively ventilated, registered SSTs, or registered double shell tank farm tanks or equipment. [4/93]
 - a. EXAMPLES
 - 1) Repair/replacement of pressure switches. [4/93]
 - b. CONTROLS
 - 1) HPT coverage as required by procedure (with retrievable records*). [4/93]
 - 2) Greenhouses/glovebags, as practical. [4/93]
 - 3) ALARA. [4/93]
4. Activities that do not involve a potential new pathway of air emissions, nor an increase in emissions to a breather filter (including within passively ventilated, unregistered single-shell tank farms). [4/93]
 - a. EXAMPLES
 - 1) Operating core sampling equipment, using push-mode, in soft tank waste. [4/93] Also includes auger sampling. [9/95]
 - 2) Pumping liquid from tanks. [4/93]
 - 3) Transportation of packaged waste and used equipment. [4/93]
 - b. CONTROLS
 - 1) HPT coverage as required by procedure (with retrievable records*). [4/93]
 - 2) Greenhouses/glovebags, as practical. [4/93]
 - 3) ALARA. [4/93]
- B. ACTIVITIES PROVIDING A NEW PATHWAY FOR POTENTIAL EMISSIONS TO THE AIR [4/93]
 1. Activities that disturb only the vapor space and involve a potential new pathway to the air (i.e., open riser) in passively ventilated, unregistered SSTs. [4/93]
 - a. EXAMPLES
 - 1) Equipment installation, repair, replacement, or removal. [4/93]
 - 2) Obtaining samples of vapor space materials. [4/93]
 - 3) In-tank photography. [4/93]
 - 4) Replacement/testing of breather filters. [4/93]
 - 5) Obtaining psychrometric data. [4/93]

* Retrievable records are defined here as records available for DOE inspection while the activity is ongoing, and all positive indications of airborne releases reported through the off-normal reporting system, or included in the annual dose estimation for Hanford activities.

ROUTINE, EXEMPT AND APPROVED TANK FARMS ACTIVITIES

- 6) Installation of core sampling equipment. (4/93)
- b. CONTROLS
 - 1) HPT coverage for entire time potential new pathway is open (with retrievable records*). (4/93)
 - 2) Greenhouses/glovebags, as practical. (4/93)
 - 3) ALARA. (4/93)
2. Activities that temporarily disturb the vapor space and a small amount of the tank waste, in passively ventilated, unregistered SSTs, as defined by the following all-inclusive list of activities specifically covered. (4/93)
 - a. ACTIVITIES SPECIFICALLY COVERED
 - 1) Installation of thermocouples or thermocouple trees. (4/93)
 - 2) Removal of core sampling equipment and samples. (4/93)
 - 3) Pump installation, where the pump will be used solely for the transfer of liquid waste (i.e., no mixer pumps, no sluicing pumps). (4/93) Also includes pump removal. (8/95)
 - 4) Installation of saltwell screens. (4/93)
 - 5) Obtaining liquid waste samples. (4/93)
 - b. CONTROLS
 - 1) HPT coverage for entire time potential new pathway is open (with retrievable records*). (4/93)
 - 2) Greenhouses/glovebags, as practical. (4/93)
 - 3) ALARA. (4/93)
 - 4) Flex-sleeving for retrieval, contained water wash. (8/95)
3. Activities that involve only a small quantity of radioactive material (i.e., surface contamination) and a potential new pathway to the air, that affect passively ventilated, unregistered tank farm ancillary equipment (e.g., valve pits, diversion boxes). (4/93)
 - a. EXAMPLES
 - 1) Non-routine equipment installation, repair, replacement or removal. (4/93)
 - 2) Asbestos removal. (4/93)
 - 3) Leak or pressure testing of transfer lines that have previously been flushed. (4/93)
 - 4) Isolation of abandoned exhaust systems. (4/93)
 - 5) Removal of contaminated soils within or immediately adjacent to

* Retrievable records are defined here as records available for DOE inspection while the activity is ongoing, and all positive indications of airborne releases reported through the off-normal reporting system, or included in the annual dose estimation for Hanford activities.

ROUTINE, EXEMPT AND APPROVED TANK FARMS ACTIVITIES

- the tank farms. [4/93]
- 6) Waste packaging associated with routine operations, including operations described in this list. [4/93]
- b. CONTROLS
- 1) HPT coverage for entire time of potential radionuclide emissions, or to verify that there is not potential for air emissions (with retrievable records*). [4/93]
 - 2) Greenhouses/glovebags, as practical. [4/93]
 - 3) ALARA. [4/93]
4. Activities that disturb the vapor space and a potential new pathway for emissions is temporarily open, in actively ventilated, registered SSTs and DSTs. [4/93]
- a. EXAMPLES
- 1) Obtaining vapor samples, where the sample is not routed back to the actively ventilated vapor space after collection. [4/93]
 - 2) Opening large risers, where the ventilation system cannot be depended upon to maintain a negative pressure, relative to atmosphere, in the tank. [4/93]
- b. CONTROLS
- 1) HPT coverage for entire time potential new pathway is open (with retrievable records*). [4/93]
 - 2) Greenhouses/glovebags, as practical. [4/93]
 - 3) ALARA. [4/93]
- C. USE OF CONTAINMENT TENTS IN THE TANK FARMS [7/93]
1. Actively ventilate, using portable exhausters, up to 10 containment tents in the Tank Farms, for use in conjunction with approved routine activities. [7/93]
- a. SYSTEM PARAMETERS & CONFIGURATION
- 1) Each portable exhauster will exhaust less than 1,000 cfm [7/93]
AND,
 - 2) Each portable exhauster will operate less than 4,176 hr/yr. [7/93]
 - 3) A portion of the exhaust air can be recirculated back into the containment tent for cooling purposes. [7/93] OR
 - 4) All air can be exhausted, drawing fresh outside air into the

* Retrievable records are defined here as records available for DOE inspection while the activity is ongoing, and all positive indications of airborne releases reported through the off-normal reporting system, or included in the annual dose estimation for Hanford activities.

ROUTINE, EXEMPT AND APPROVED TANK FARMS ACTIVITIES

- containment tent. [7/93]
- 5) Each portable exhaustor will be equipped with a HEPA filter. [7/93]
- b. CONTROLS
- 1) An air sample shall be taken each day the containment tent is occupied and the exhaustor is operating. The sample shall be taken while work is ongoing. [9/94] The sample will be of sufficient volume to detect $3.6 \text{ E-09 } \mu\text{Ci/ml}$ total β and $9.3 \text{ E-12 } \mu\text{Ci/ml}$ total α . [7/93]
 - 2) A survey of the inlet to the HEPA filter [9/94] will be taken and documented each day [9/94] the containment is occupied. [7/93]
 - 3) Records supporting these conditions will be available in the field offices. [7/93]
- D. PIT DECONTAMINATION WITHIN TANK FARMS & ANCILLARY FACILITIES [9/95]
1. Application of various methods to reduce dose and contamination levels, in actively ventilated or passively ventilated tank farms. [9/95]
- a. EXAMPLES
- 1) Use of sprays/washes (up to 3,000 psi) and fixatives. Initial wash down is with low pressure sprays. Pit may be open at this time. Higher pressure sprays are done with the pit covered (i.e., cover blocks or work space barriers). Ventilation of the pit during decontamination is not required but air in-flow to the pit is preferred during these activities. Currently this can only be done in tank farms which have active, registered emission sources. [9/95]
 - 2) Use of HEPA vacuums within the contained areas. [9/95]
 - 3) Removal and packaging of failed or reusable equipment. [9/95]
- b. CONTROLS
- 1) HPT coverage during work evolution, with retrievable records*. [9/95]
 - 2) Use of containment methods: closed, open-topped greenhouses. [9/95]
 - 3) Use of sleeving and/or glovebags as appropriate for close decontamination and waste packaging. [9/95]
 - 4) Use of work space barriers such as temporary, clear pit covers during washes as appropriate or possible. [9/95]
 - 5) Use of active ventilation of workspace as appropriate, per the containment tent agreement in Section C. [9/95]
 - 6) ALARA. [9/95]

* Retrievable records are defined here as records available for DOE inspection while the activity is ongoing, and all positive indications of airborne releases reported through the off-normal reporting system, or included in the annual dose estimation for Manford activities.

ROUTINE, EXEMPT AND APPROVED TANK FARMS ACTIVITIES

E. SIZE REDUCTION OF WASTE EQUIPMENT FOR DISPOSAL [9/95]

1. Size-reducing, cutting or disassembling, contaminated equipment as appropriate for more economical waste packaging. The process is employed in full containment only using very rigorous bag-in/bag-out methods. The process may include sawing, snipping, sheering, etc. Containment is never lost during normal operations. The process involves only surface contamination. [9/95]

a. EXAMPLES

- 1) Waste jumpers from pits. [9/95]
- 2) Waste tank-level instrumentation. [9/95]
- 3) Waste sampling equipment such as drill strings or augers. [9/95]
- 4) Waste thermocouple trees, specific gravity probes, observation ports, or other equipment extracted from a tank. [9/95]

b. CONTROLS

- 1) HPT coverage during all work evolution, with retrievable records*. [9/95]
- 2) Use of containment methods: closed, open-topped greenhouses. [9/95]
- 3) Use of sleeving and/or glovebags (hard or soft) as appropriate. [9/95]
- 4) Use of work space barriers as appropriate or possible. [9/95]
- 5) Use of active ventilation of workspace as appropriate, per the containment tent agreement in Section C. [9/95]
- 6) ALARA. [9/95]

F. REMOVAL OF CONTAMINATED EQUIPMENT FROM TANK FARM TANKS AND ANCILLARY FACILITIES [9/95]

1. Removing contaminated equipment from SSTs, DSTs or associated ancillary facilities. Equipment dimensions vary from 12 to 55 ft long and from 4 to 42 inches in diameter. Including but not limited to transfer pumps, instrument trees, steam coils, thermocouple trees, saltwell pumps and screens, and sampling or monitoring equipment. (Reference Sections A.1.a.3, B.1.a.1, B.2.a.3 and B.3.a.1.) [9/95]

a. EXAMPLES (METHODS)

- 1) Use of the manually operated flexible receiver. [9/95]

Equipment to be retrieved is equipped with a flexible sleeve of sufficient length as to provide complete, sealed containment during lifting from the tank. The equipment is rinsed, as appropriate, as it is retrieved, to minimize the contamination

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ROUTINE, EXEMPT AND APPROVED TANK FARMS ACTIVITIES

adhering to the surface. Radiation measurements are performed as the equipment is raised. If elevated levels of contamination are detected the equipment is re-rinsed. Once the equipment is fully retrieved, the process is stopped to allow time to drain any free liquids remaining from the flush. Once the sleeving bag is fully deployed, it is cinched tight, maintaining the containment seal, and separated from the tank riser. The riser is closed and the equipment is then ready for waste packaging or repair.

2) Use of the remotely operated, mobile flexible receiver. (9/95)

The operation involves connecting to/disconnecting from a tank riser; lifting the equipment; washing down the equipment; and bagging the equipment. The flex receiver is an improvement over existing methods of removal & packaging but does not preclude deployment of the manual method previously discussed.

The washing process uses preheated water pressurized up to 3,000 psi and is done concurrent with the lifting process. Washing takes place outside the vapor space of the tank with waste and run-off being returned to the tank through the riser.

Once washed and dripped dry the equipment is pulled through a radiation monitor spool assembly to monitor the amount of radioactivity remaining on the equipment. At this point the flexible receiver bag, which expands as the equipment is being hoisted, is attached to the top of the lifting bail. Once the equipment is pulled fully into the flexible receiver bag, a remotely operated mechanical sealing device crimps the bottom of the bag in two places. A scissoring device severs the bag between the two crimps, leaving a sealed top section (containing the equipment) and sealed bottom section which seals the riser opening. The bag is then hoisted into position for secondary bagging of the first seal.

The bottom section is removed from the riser and disposed of under routine maintenance procedures and the riser is resealed.

b. CONTROLS

- 1) HPT coverage as required by procedure, with retrievable records*. Applicable to removals at actively ventilated tanks. (9/95)
- 2) HPT coverage during the entire removal, with retrievable records*. Applicable to removals at passively ventilated tanks. (9/95)

* Retrievable records are defined here as records available for DOE inspection while the activity is ongoing, and all positive indications of airborne releases reported through the off-normal reporting system, or included in the annual dose estimation for Hanford activities.

ROUTINE, EXEMPT AND APPROVED TANK FARMS ACTIVITIES

- 3) Use of work area barriers as appropriate (i.e., wind control).
[9/95]
- 5) ALARA. [9/95]

G. CHARACTERIZATION ACTIVITIES [9/95]

1. Activities done to determine physical, chemical, radiological or psychrometric properties of a tank vapor space or waste. These activities may involve SSTs, DSTs and ancillary facilities/equipment and can only temporarily disturb the vapor space, a small amount of waste or a small amount of radioactive material (i.e., surface contamination). Including deployment of remotely or manually operated equipment for data or sample gathering. (Reference Sections: A.4.a.1., B.1.a.2., B.2.a.2.)

a. EXAMPLES

- 1) Push mode core sampling in soft tank waste. [4/93]
- 2) Auger sampling in soft tank waste. [9/95]
- 3) Use of the surface moisture measurement system. [9/95]
- 4) Use of the cone penetrometer. [9/95]
- 5) Use of the void fraction meter. [9/95]
- 6) Use of the waste viscometer. [9/95]
- 7) Vapor sampling (grab or continuous) of the vapor space or ventilation effluent stream. [9/95]
- 8) Taking psychrometric measurements of the vapor space or ventilation effluent stream. [9/95]

b. CONTROLS

- 1) HPT coverage for the entire activity, with retrievable records*. Applicable to activities at passively ventilated tanks. [9/95]
- 2) HPT coverage as required by procedure, with retrievable records*. Applicable to activities at actively ventilated tanks. [9/95]
- 3) Greenhouses/glovebags as appropriate. [9/95]
- 4) ALARA. [9/95]

* Retrievable records are defined here as records available for DOE inspection while the activity is ongoing, and all positive indications of airborne releases reported through the off-normal reporting system, or included in the annual dose estimation for Hanford activities.

ROUTINE, EXEMPT AND APPROVED TANK FARMS ACTIVITIES

The Routine, Exempt and Approved Tank Farms Activity list was last updated and revised on October 10, 1995. Part of the basis for that revision was to combine all the existing approvals for routine activities into one document and update the document as needed for future activities.

This change (Rev. 1a) is not the addition of a new activity, rather, it reflects a previously approved change made to the original agreement for venting green houses and should have been included in the October 10, 1995 revision. The effected paragraphs are C.1.b.1 and C.1.b.2 on page five. The requirement to take air and survey samples each shift was changed to each day, and the requirement to take a post job contamination survey of the tent conditions was changed to taking a survey of the inlet to the HEPA filter on the exhauster.

Attached is Revision 1a of the Routine, Exempted and Approved Tank Farm Activities.

Concurrence:

A. W. Conklin, DOH Date

H. M. Rodriguez, RL-EAP Date

C. C. Hass, RL-PRI Date

A. B. Sidpara, RL-TOP Date

Appendix D

Safety Basis Related

FACSIMILE

LOS ALAMOS NATIONAL LABORATORY

TSA-11
PO BOX 1663, MS K557
LOS ALAMOS, NM 87545

FAX NUMBER:
(505)667-5531

VERIFICATION:
(505)667-6231

TO: Carl E. Hanson

Westinghouse Hanford Co.

(509) 376-6521

FROM: Harold Sullivan

NUMBER OF PAGES, INCLUDING THIS COVER SHEET: 3

DATE TRANSMITTED: Feb. 2, 1996

VERIFIED:

APPROVAL:

Harold Sullivan

Cy: CIC-10, MS A150

MESSAGE: Carl - attached is our SMMS proposal. We show an official start date of March 1st, but anticipate obtaining the technical bases and preparing for the HazOps review prior to that date. Please contact me if we need to iterate on scope or schedule. Bill Partain will be the Principal Investigator. Can you give him a point of contact with whom he can set up a meeting and begin the collection of background material?

Los Alamos

NATIONAL LABORATORY

Technology & Safety Assessment Division
TSA-11, Probabilistic Risk and Hazard Analysis, MS K557
Los Alamos, New Mexico 87545
(505) 667-6231, FAX (505) 667-5531

Date: January 29, 1996
Refer to: TSA-11-96-024

Mr. Carl E. Hanson
Westinghouse Hanford Company
P. O. Box 1970, MSIN H5-09
Richland, WA 99352

Dear Carl:

FY 1996 Statement of Work for Surface Moisture Monitoring System Safety Assessment

The proposed scope of work and the associated budget for the safety assessment of the Surface Moisture Monitoring System (SMMS) operations are outlined below.

Scope of the Proposed Work

A safety assessment (SA) covering the activities associated with installation of the SMMS into a representative tank, its operation, and its removal will be prepared and delivered to Westinghouse Hanford Company (WHC). The representative tank will be defined by WHC and may include a combination of hazards. Associated subsystems to be covered in this SA include deployment of a video camera, a riser inspection device, and a laser profiling system. In addition, Los Alamos will work closely with WHC to revise existing Operational Safety Requirements (OSRs) to incorporate the administrative controls identified in the SA. It is assumed that removal of equipment currently in the risers will be covered by existing safety documentation. A second phase of this study (to be defined later) will use the process being developed under the Saltwell Pumping SA to extend the SMMS SA to all of the high-level waste tanks at Hanford.

Proposed Methodology

We will use the "Interim Guidance—Development of Safety Assessments for Underground High-Level Radioactive Waste Storage Tanks" as the format and content guide for the SA. The hazard identification and analysis will be performed using the guidance of DOE-STD-3009, "Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports," and this will be documented in an Appendix.

The SA will consist of six sections.

- Section 1: Scope of the SA
- Section 2: Description of the Action
- Section 3: Hazard Identification
- Section 4: Hazard Analysis
- Section 5: Accident Consequences
- Section 6: Administrative Controls

Resources

The technical staff committed to this work has extensive experience in preparing hazard and safety analyses. We also will use the experience of the TSA-10 staff who have been involved with the SAs for Saltwell Pumping and Rotary Mode Core Sampling. The project oversight will include verifying the consistency of the approaches and methods in the various SAs being produced.

January 29, 1996

The proposed schedule is very aggressive and assumes active cooperation by WHC in making available the technical bases necessary to perform the SA. We also will require the participation by at least two WHC staff actively involved in the operations of the tank farm on the hazard analysis team.

Budget

The estimated budget for conducting the SMMS SA is \$460k. This is based on an effort expenditure of approximately 80 man-weeks plus travel and other costs.

Schedule of Deliverables

Table 1 provides a proposed schedule for major milestones. The schedule assumes that the work will start on March 1, 1996. This is a realistic date for the transfer of funds from DOE-RL to DOE-AL.

TABLE 1
SCHEDULE OF MAJOR MILESTONES

Deliverable	Target Date
Complete On-Site Hazard Identification	March 15, 1996
Brief TRG on Hazards Identification	April 9, 1996
Submit 100% Draft to WHC for Review	May 31, 1996
TRG/SEAC Review	June 10, 1996
Submit Final Draft to WHC	July 1, 1996
Assist in the Preparation of OSRs	Open

Applicable QA Procedures

The work will be performed using the QA procedures document developed by TSA-10 for the other SAs prepared by Los Alamos.

If you have any questions regarding the above statement of work, schedules, or deliverables, please contact either me (505-667-6231; e-mail: hsullivan@lanl.gov) or Bill Partain (505-665-6314; e-mail: wpartain@lanl.gov).

Sincerely,

L. Harold Sullivan

LHS/wlp/jl

Cy: T. J. Hirons, EM/DOE FP, MS J578
J. R. White, Hanford Liaison, WHC MSIN H5-09
J. H. Scott, TSA-10, MS K575
A. S. Neuls, TSA-10, MS K575
K. O. Pasamehmetoglu, TSA-10, MS K575
E. A. Rodriguez, TSA-10, MS K575
D. W. Stack, TSA-11, MS K575
W. L. Partain, TSA-11, MS K575
CIC-10, MS A150
TSA-11 File

Author: George F Jr Vargo at WHC53
Date: 2/8/96 2:12 PM
Priority: Normal
Subject: SMMS HAZOPS TEAM MEETING

----- Message Contents -----

Attention: Judy Siemer, LATA

A meeting is planned for 2-9-96 at the Federal Building to discuss the HAZOPS for the SMMS and the EMI Probe. Start time is 0730. All listed persons are required to attend. This is a top priority meeting.

I do not know the meeting room number at this time. However, B. Board does know the location but I have been unable to reach him. This will be sent to you as soon as he is reached.

If you are unable to attend this meeting please notify me ASAP.

Thanks,

G. F. Vargo, Jr.
Pager: 85-8615
376-5387
Home: 375-0098

~~Fax~~ 943-0856

Attendees

DP Niebuh	J. Bussell
L.S. Krogsrud	R.D. Crowe
B. D. Board	W.T. Watson
T.I. Stokes	

Judy Siemer (LATA)

cc G. Vargo
G.T. DeKelbow
Bill Cowley
M.L. McElroy

HAZOP Deviation Guide

Parameter\ Deviation	No, Not, None	Low, Less, Short	More, High, Long	Part of	As Well As, Also	Other Than	Reverse
Flow	No Flow	Low Rate, Low Total	High Rate, High Total	Missing Ingre- dient	Misdi- rection, Impuri- ties	Wrong Material	Backflow
Pressure	Open to Atmosph ere	Low Pressure	High Pressure				Vacuum
Temperaure	Freezing	Low Temper- ature	High Temper- ature				Auto- refriger- ation
Level	Empty	Low Level	High Level	Low Inter- face	High Interface		
Agitation	No Mixing	Poor Mixing	Excess- ive Mixing	Mixing Inter- ruption	Foaming		Phase Separation
Reaction	No Reaction	Slow Reaction	Runaway Reaction	Partial React- ion	Side Reaction	Wrong Reaction	Decompos ition
Time, Procedure	Skipped or Missing Step	Too short, Too little	Too long, Too much	Action(s) skipped	Extra action, Shortcuts	Wrong Action	Out of order, Opposite
Speed	Stopped	Too slow	Too fast	Out of Synch		Web or Belt Break	Backward
Special	Utility Failure	External Leak	External Rupture	Tube Leak	Tube Rupture	Startup, Shutdow n, Maintena nce	

Other Variables: Concentration, Viscosity, pH, Static, Voltage, Current, etc.

*Thin metallic riser liner?
plastic riser liner?*

Subj: RESULTS OF HAZOP MTG

Date: 96-02-15 20:22:16 EST

From: Troy_I_Stokes@WHC8@ccmail.pnl.gov

To: HilineEngr@aol.com

WHC-SD-WM-SDO-070, REV 0
Page D-7

File: 1VENTHAZ.SMS (18020 bytes)

Time (14400 bps): < 1 minute

Attache dare the results of Friday's HAZOP meeting for the SMMS.

If you have comments, please call Judy at 946-2948 or send them cc:Mail to ^Los Alamos Tech Assoc (TWRS) with subject JUDY SIEMER.

Thanks guys...

P.S. The Monday results are coming.

----- Headers -----
From: Troy_I_Stokes@WHC8@ccmail.pnl.gov Thu Feb 15 20:21:42 1996
Return-Path: Troy_I_Stokes@WHC8@ccmail.pnl.gov
Received: from pnl.gov (gate.pnl.gov [130.20.84.36]) by emin15.mail.aol.com (8.6.12/8.6.12) with ESMTP id UAA12703 for <HilineEngr@aol.com>; Thu, 15 Feb 1996 20:21:40 -0500
From: Troy_I_Stokes@WHC8@ccmail.pnl.gov
Received: from ccmail.pnl.gov by pnl.gov (PMDF V4.3-13 #6012)
1 <01I190M6MBEO8WVYOA@pnl.gov>; Thu, 15 Feb 1996 17:21:30 -0800 (PST)
Date: Thu, 15 Feb 1996 17:17 -0800 (PST)
Subject: RESULTS OF HAZOP MTG
To: HilineEngr@aol.com
Message-id: <01I190M90SGM8WVYOA@pnl.gov>
MIME-version: 1.0
Content-type: MESSAGE/RFC822
Content-transfer-encoding: 7BIT

Subj: SMMS HAZOP
Date: 96-02-15 20:26:32 EST
From: Troy_I_Stokes@WHC8@ccmail.pnl.gov
To: HilineEngr@aol.com

WHC-SO-WM-SDD-070, REV 0
Page D-8

Date: Thu, 15 Feb 1996 15:50 -0800 (PST)
From: Brett D Board@BCS78
Subject: SMMS HAZOP
To: Troy_I_Stokes@WHC8, James_H_Busselle@WHC338, Ralph_D_Crowe@WHC150,
Laroy_S_#1#Steve#r# Krogsrud@WHC289, Daniel_P_#1#Dan#r# Niebuhr@WHC73,
George_F_Jr_Vargo@WHC53, William_T_#1#Todd#r#_Watson@WHC71
MIME-version: 1.0
MIME-version: 1.0
Content-type: TEXT/PLAIN

Please review the HAZOP tables from LATA and return comments directly to LATA with me on cc. If you have no comments then forward that message to me so that I know you've received the tables and had a chance to review them.

Brett

----- Headers -----

From: Troy_I_Stokes@WHC8@ccmail.pnl.gov Thu Feb 15 20:26:12 1996
Return-Path: Troy_I_Stokes@WHC8@ccmail.pnl.gov
Received: from pnl.gov (gate.pnl.gov [130.20.84.36]) by emin15.mail.aol.com (8.6.12/8.6.12) with ESMTP id UAA14384 for <HilineEngr@aol.com>; Thu, 15 Feb 1996 20:26:06 -0500
From: Troy_I_Stokes@WHC8@ccmail.pnl.gov
Received: from ccmail.pnl.gov by pnl.gov (PMDF V4.3-13 #6012) id <01I190RJVFDS8WVYOA@pnl.gov>; Thu, 15 Feb 1996 17:25:56 -0800 (PST)
Date: Thu, 15 Feb 1996 17:22 -0800 (PST)
Subject: SMMS HAZOP
To: HilineEngr@aol.com
Message-id: <01I190RRTIEY8WVYOA@pnl.gov>
MIME-version: 1.0
Content-type: MESSAGE/RFC822
Content-transfer-encoding: 7BIT

SURFACE MOISTURE MEASUREMENT SYSTEM SMMS HAZOP
 PARTICIPANTS: J. M. SIEMER, J. BUSSELL, G. F. VARGO Jr., M. L. McELROY, R. CROWE, L. S. KROGSRUD,
 D. NIEBUHR, T. I. STOKES.
 DATE: 2/9/96

NODE	DESCRIPTION	PROCESS VARIABLE	DEVIATION	POSSIBLE CAUSES	DETECTION/ MITIGATION	POTENTIAL CONSEQUENCE	RANK	REMARKS
1	Van	Placement	Other than (wrong riser)	Human Error	Job Walkdown Riser Preparations (JCS System) Person in Charge/ Designated Cog. Engineer Checklist	Exceed Dome Load limitations Poor measurement Grounding Van to wrong tank (using controls for nonflammable tank?) Parked by an open riser during episodic release--- deflagration	S3 S0 S2 S2	Check the following: 1). Ford Van Model. Can ignition switch ignite fire? 2). Ex-tinguisher should be present in Van
1	Van	Temperature	High	Weather Sun Position Fire	Human/Air Conditioning Worker Observation	Human discomfort Overheating of instrumentation, causing inaccurate measurement	S1 S0	

SURFACE MOISTURE MEASUREMENT SYSTEM SMMS HAZOP
 PARTICIPANTS: J. M. SIEMER, J. BUSSELL, G. F. VARGO Jr., M. L. Mc ELROY, R. CROWE, L. S. KROGSRUD,
 D. NIEBUHR, T.I. STOKES.
 DATE: 2/9/96

NODE	DESCRIPTION	PROCESS VARIABLE	DEVIATION	POSSIBLE CAUSES	DETECTION/ MITIGATION	POTENTIAL CONSEQUENCE	RANK	REMARKS
						Offgassing from batteries	S1	
						Hydrogen explosion Hazard (riser involved)	S2	
						Van parked outside exclusion zone/ Respiratory Hazard/ Worker Hazard	S1	
						Ignition of flammable gas (if propagated)	S2	
1	Van	Temperature	Low	Weather	Human agent	Condensation in Instruments	S0	
					CO Monitor (in Van)	CO in closed Van	S1	
						VCR	S0	

SURFACE MOISTURE MEASUREMENT SYSTEM SMMS HAZOP
 PARTICIPANTS: J. M. SIEMER, J. BUSSELL, G. F. VARGO Jr., M. L. Mc ELROY, R. CROWE, L. S. KROGSrud,
 D. NIEBUHR, T. I. STOKES.
 DATE: 2/9/96

NODE	DESCRIPTION	PROCESS VARIABLE	DEVIATION	POSSIBLE CAUSES	DETECTION/ MITIGATION	POTENTIAL CONSEQUENCE	RANK	REMARKS
						inoperable in closed environments Worker discomfort Problems with operability of controls	S1 S0	
1	Van	Temperature	Low (Van or generator or front bumper)	Long term operation of airconditioner	Gas gauge/ engine stops	Operational delay to refuel Fuel Spill causing Field refueling fire	S0 S1* S2**	Not decided if Van will be refueled in the field *If fire does not propagate to tank. **If fire propagates to tank
1	Van	Grounding	Less	Human error Broken Cables Improper	Measurement Independent verification	Inaccurate instrument readings Sparking (static)	S0 S0	

SURFACE MOISTURE MEASUREMENT SYSTEM SMMS HAZOP
PARTICIPANTS: J. M. SIEMER, J BUSSELL, G. F. VARGO Jr., M. L. Mc ELROY, R. CROWE, L. S. KROGSRUD,
D. NIEBUHR, T.I. STOKES.
DATE: 2/9/96

NODE	DESCRIPTION	PROCESS VARIABLE	DEVIATION	POSSIBLE CAUSES	DETECTION/ MITIGATION	POTENTIAL CONSEQUENCE	RANK	REMARKS
1	Van			Location (bad ground grid)		Possible failure of tank safety barriers*/ Ignition of Flammable atmosphere	S2	*Unlikely by prevented grounding to same point
						Electro-cution	S1	Combined with electrical fault in van
						Delay	S0	We have no backup plan for parking
				Worker with contaminated clothing enters van	Survey prior to entry Health physics routines Regulating entry	Worker contamination	S1	a contaminated van Should be parked other than in contamin-ated area
2	Deployment arm installa-	Bonding Grounding	No/Less	Human error Grounding/	Inspection Measurement	Ignition of tank flammable	S2	

SURFACE MOISTURE MEASUREMENT SYSTEM SMMS HAZOP
PARTICIPANTS: J. M. SIEMER, J. BUSSELL, G. F. VARGO Jr., M. L. McELROY, R. CROWE, L. S. KROGSrud,
D. NIEBUHR, T. I. STOKES.
DATE: 2/9/96

NODE	DESCRIPTION	PROCESS VARIABLE	DEVIATION	POSSIBLE CAUSES	DETECTION/ MITIGATION	POTENTIAL CONSEQUENCE	RANK	REMARKS
	tion	Static Protection		Bonding equipment failure Improper ground location Equipment bonded or grounded to itself	Verification	atmosphere		
2	Deployment arm installation	Lifting devices (Cranes and rigging)	less than (not sufficient capacity)	Human error (Procedure violation) Equipment failure, Crane unattended/overextended Improper installation of rigging	Inspections Load testing Verification of capacity Procedures for deployment Qualified/ designated rigging specialist Manufacturer's charts/ Computer	Worker Injury Tank Structural damage(loss of confinement) Potential for damaging other safety class equipment	S1 S1 S0	

SURFACE MOISTURE MEASUREMENT SYSTEM SMMS HAZOP
 PARTICIPANTS: J. M. SIEMER, J BUSSELL, G. F. VARGO Jr., M. L. McELROY, R. CROWE, L. S. KROGSRUD,
 D. NIEBUHR, T.I. STOKES.
 DATE: 2/9/96

NODE	DESCRIPTION	PROCESS VARIABLE	DEVIATION	POSSIBLE CAUSES	DETECTION/ MITIGATION	POTENTIAL CONSEQUENCE	RANK	REMARKS
			properly performed		equipment	during later operations) Out of round riser resulting equipment being stuck in riser Undetected toxic gas resulting in worker exposure	S0 S1	
2	Deployment arm install-ation	Arm insertion positioning	Other Than/ wrong angle Other Than /ball valve not closed Other Than/ Insertion speed too fast	Human error/ Equipment failure crane drift Human error/ drop Human error equipment failure	Low load/ High load Verification Low load Impact Protection	Difficulty retrieving arm Riser damage/ loss of confinement damage to ball valve damage source/drop dropping source/	S1 S1 S1 S1 S2	

SURFACE MOISTURE MEASUREMENT SYSTEM SMMS HAZOP
 PARTICIPANTS: J. M. SIEMER, J BUSSELL, G. F. VARGO Jr., M. L. Mc ELROY, R. CROWE, L. S. KROGSRUD,
 D. NIEBUHR, T.I. STOKES.
 DATE: 2/9/96

NODE	DESCRIPTION	PROCESS VARIABLE	DEVIATION	POSSIBLE CAUSES	DETECTION/ MITIGATION	POTENTIAL CONSEQUENCE	RANK	REMARKS
						sparks damage to riser/drop equipment stuck/potential to damage tank	S1 S1*	*Environmental consequences/ should be evaluated
2	Deployment arm installation	Contamination control	No/Less	No Sleeve Not enough sleeving Bag Damage	Contamination Surveys Visual Inspection Procedures/T raining	Local Spread of Contamination	S1	

SURFACE MOISTURE MEASUREMENT SYSTEM SMMS HAZOP
PARTICIPANTS: J. M. SIEMER, G. F. VARGO JR., M. L. McELROY, B.D. BOARD, L. S. KROGSrud,
D.NEIBUHR T.I. STOKES
DATE: 2/12/96

NODE	DESCRIPTION	PROCESS VARIABLE	DEVIATION	POSSIBLE CAUSES	DETECTION/ MITIGATION	POTENTIAL CONSEQUENCE	RANK	REMARKS
3	Decon System	Flow	No	Pump Failure Out of gas Plugged line Valve lineup wrong	In tank camera	Worker injury due to pump disassembly worker exposure Time delay Could put excessive H2O in tank	S1 S0 S0*	Note: Positive displacement pump has PRV (pressure relief replacement valve) *it is doubtful that structural damage could be done to the tanks by overflow- ing because of the flow rate **from electrical problems
3	Decon System	Flow	More	Loss of nozzle Broken hose Human error	Pressure would go down Visual	Potential Source of interference with deployment of mast during withdrawal	S1*	*Due to ALARA problems during withdrawal

SURFACE MOISTURE MEASUREMENT SYSTEM SMMS HAZOP
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D. NEIBUHR T.I. STOKES
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NODE	DESCRIPTION	PROCESS VARIABLE	DEVIATION	POSSIBLE CAUSES	DETECTION/ MITIGATION	POTENTIAL CONSEQUENCE	RANK	REMARKS
						Too much water in tank (see above)		
3	Decon System	Flow	Less Other than "Air"	See "no" Human error	Pressure gauge	Pressurization of tank Pump damage	S2 S1	Note that: Water fittings and air fittings are interchangeable in some areas.
3	Decon System	Flow	Other than (fuel)	Hooking supply line to fuel tank*	Visual	Addition of organics to tanks- leading to deflagration	S3	The fittings are probably not compatible
			Reverse	Leaving hose connected to decon system when not in use	Visual/ requirement to disconnect hose because of lightning protection requirements	Flow of flammable gas from tank atmosphere (if present) to pump casing.	S2	*This scenario is highly unlikely

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NODE	DESCRIPTION	PROCESS VARIABLE	DEVIATION	POSSIBLE CAUSES	DETECTION/ MITIGATION	POTENTIAL CONSEQUENCE	RANK	REMARKS
						Potential to cause deflagration if pump started prior to opening inlet valve*		
3	Decon System	Pressure	High	Plugged nozzle	Pressure gauge/mitigation relief valve	Worker injury Equipment damage Time delay	S1 S1* S0	*If water damages other equipment and causes electrical shock hazard.
3	Decon System	Pressure	Low	Open line Pump failure	Pressure gauge	Time delay inadequate decontamination	S1	
3	Deployment arm installa-	Orientation a) radial	Wrong(a)	Broken cable	In tank camera, inclinometer,	Bad sample Broken cable	S0	Possibly require that

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NODE	DESCRIPTION	PROCESS VARIABLE	DEVIATION	POSSIBLE CAUSES	DETECTION/ MITIGATION	POTENTIAL CONSEQUENCE	RANK	REMARKS
	tion	b) vertical C) rotation- al		Jammed cable Stuck Probe Inclinometer failure / Arm not deployed low enough during installation	torque limiters on cranks	inability to retrieve probe/ potential criticality issue (if dropped in wrong place...)	S2*	devices within the swing radius of the probe be rotated out of the way. *Critic- ality probably not credible. **OSR problem/ ***Based on equip- ment recovery ****ALARA problem on a small diameter riser
2	Deployment arm	Vertical orientation	Too high (doesn't clear	Human error	Camera	See above for con- sequences of	S0 S0** *** S1 **** S1	

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NODE	DESCRIPTION	PROCESS VARIABLE	DEVIATION	POSSIBLE CAUSES	DETECTION/ MITIGATION	POTENTIAL CONSEQUENCE	RANK	REMARKS
			riser) Probe too far above waste	Human error	Camera	broken cable or riser blocking. Inadequate data	S0	
2	Deployment arm	Vertical orientation	Too Low	Human error	Camera	Probe immersed in waste Probe entangled or stuck on waste in bottom of tank	S1*	*See criticality issue above (ALARA problem)
2	Deployment arm operation	Orientation	Wrong	Human error	Camera	Break neutron detector Bend arm to make it difficult to retrieve Loss of signal/ Breaking	S1 S1* S0	*ALARA problem

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NODE	DESCRIPTION	PROCESS VARIABLE	DEVIATION	POSSIBLE CAUSES	DETECTION/ MITIGATION	POTENTIAL CONSEQUENCE	RANK	REMARKS
4	Neutron source	Position	Outside of probe	Human error Equipment failure	Neutron detector Administrative controls	Cables above ground by excessive twisting Worker exposure Equipment not retrievable	S1 S1	
				Dropped during installation Probe not controlled	Second party inspection	Account-ability issue	S0	
5	EMI probe	Electrical field	More	Human error Equipment failure	Data potentially outside of expected values (skewed)	No data or wrong data Error or equipment failure causing loss of intrinsic barriers could result	S0 S3*	*If flammable atmosphere de-flagration

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 D. NEIBUHR T.I. STOKES DATE: 2/12/96

NODE	DESCRIPTION	PROCESS VARIABLE	DEVIATION	POSSIBLE CAUSES	DETECTION/ MITIGATION	POTENTIAL CONSEQUENCE	RANK	REMARKS
						in a spark		

**Westinghouse
Hanford Company****Internal
Memo**

From: TWRS SAR Engineering
Phone: 376-9192 S7-71
Date: November 13, 1995
Subject: TRANSMITTAL OF USQ SAFETY REVIEW TF-95-0089
SURFACE MOISTURE MONITORING OF HANFORD TANK WASTE
BY NEUTRON ACTIVATION

8M100-WGF-95084

To: L. J. Coates R1-62

cc: C. A. Booth S7-71
P. R. Deichelbohrer S7-12
R. L. Guthrie S7-71
M. E. Huda S7-07
M. N. Islam R3-08
T. I. Stokes L6-37
G. F. Vargo H5-09
W. T. Watson H0-38
J. Weber S1-57
WGF File/LB

Following the guidelines in WHC-CM-4-40, an Unreviewed Safety Question (USQ) Safety Review was performed to show that the installation, operating, and removal of the in-tank surface moisture monitoring system (SMMS) in Hanford waste tanks is within the authorization basis, and is a safe activity.

WHC-IP-0842, Section 5.4, Rev. 6, requires the attached safety review to be attached to the ECN, PCA, Work Package, or procedure for continuation of the normal review process. The Safety Review form shall be filed with the applicable ECN, PCA, Work Package, or procedure after the review process is completed.

If you have any questions, feel free to call me at 376-9192.

W. G. Farley
Senior Engineer

wgf

Attachment

**8M100-WGF-95084
ATTACHMENT**

**Unreviewed Safety Question Safety Review Form
Surface Moisture Monitoring of Hanford Tank Waste
By Neutron Activation
TF-95-0089**

Consisting of 27 pages

UNREVIEWED SAFETY

(Per

WHC-SD-WM-SDO-070, REV 0
Page D-26

✓ FORM

Page 1 of 27

USQ TRACKING NUMBER TF-95-0089

REFERENCE DOCUMENT(S):

ECN No.

PCA No.

Work Pkg No.

Other (Specify) See Section 8.0

TITLE:

SURFACE MOISTURE MONITORING OF HANFORD TANK WASTE
BY NEUTRON ACTIVATION

The probe (Figure 2) contains three Boron-10 (B10) tube neutron detectors, a 16 microgram Californium-252 neutron source, two thermistors, voltage converters, and electronic amplifiers. The probe is sealed to prevent moisture from contacting the electronics, and is designed to meet National Fire Protection Association (NFPA) code requirements (explosion proof) for Class-1, Division-2, Group-B, environments (H_2 occasionally > LFL). The probe will weigh 11-14 kg (25-30 lbs).

Converters in the probe convert low voltage (24 vdc) input from the logging cable to high voltage (800 to 1500 vdc) needed to operate the neutron detectors. The probe amplifiers operate on 12 volts dc.

One of two video camera types will be used. For flammable gas tanks, the video system used will meet OSD-T-151-00030 requirements in section 30.2.C.4. For non-flammable gas tanks, a non-classified video system may be used.

2.2 Impact Limiter

The deployment device has the potential to cause serious riser damage in the event of a drop accident. Therefore, an impact limiting system will be utilized. The riser must withstand a 30,000 lb relatively steady load while the limiting system foam is crushing, or an I-beam system will be incorporated to transfer the load into the soil, rather than into the riser itself. Tank specific structural analyses will be performed for each riser to be used, and this will guide field installation details and procedural controls.

2.3 Video camera

This section summarizes the design requirements in WHC-SD-WM-DRD-002 [Smet 1995], and documents the operational and administrative safety controls required for deployment in and around flammable gas tanks.

The video system is a custom WHC design incorporating the following:

1. Self-contained lighting and control.
2. Remote pan, tilt and zoom (PTZ).
3. A radiation tolerant microchip B&W camera.
4. Video signal monitoring and recording.
5. Cable management winch.
6. Gas purge loop and control.
7. Electrical shutdown safety controls.
8. SMMS interfacing electrical and mechanical controls.

The video system will meet functional criteria for Class-1, Division-2, Group-B, as indicated below:

- a. For flammable gas tanks, the light system temperature may exceed 416 °C (80% of hydrogen auto-ignition temperature of 520 °C), if the heat source is encased, and the outside case temperature is less than 416° C; or if the case is internally gas purged or rated to operate in a hydrogen gas environment.

- b. For flammable gas tanks in-tank activities where no waste-intrusive work or near waste work is being performed, gas-sensing and automatic power shutoff has been deemed acceptable by the site waste tank safety and electrical oversight groups if specific functional criteria are met. This approach will incorporate timed startup of the system after purge gas introduction, as well as diverse or redundant sensing and shutdown control upon loss of purge gas.
- c. The in-tank components of the system shall be qualified for continuous operation in a flammable gas environment by meeting the purge system criteria.
- d. The in-tank cabling will be 'hard use' rated. Semi-conductive jacketing material will be employed for cabling from the deployment drum to the pan-and-tilt connector. No cabling is required to be purged.
- e. The in-tank connectors will be compression (glanded) type. Molded underwater rated connectors are deemed to be acceptable. Connectors are not required to be purged.
- f. The cable management system, mounted on top of the access riser within the SMMS system deployment center, will be configured such that all potential ignition sources other than cabling and connectors are safely controlled or are contained within the gas purge envelope. All cabling and connectors within the open riser containment will conform to the criteria for cabling and connectors as described above.
- g. Purging will be accomplished with either inert gas (nitrogen preferable), or instrument quality (dried) air.
- h. Purge gas pressure will be diversely or redundantly measured. At least one of the sensors will be located at or downstream of the last ignition source enclosure. Purge gas pressure will be maintained ≥ 0.1 " of water. Diversely or redundantly designed electrical shutdown will be activated upon indication below setpoint.
- i. A controlled safety/purge gas system bypass will be incorporated for non-Watchlist applications of the SMMS system.

2.4 Riser Inspection Characterization

The objective of riser characterization is to obtain reliable data for SMMS deployment, and quantify and document specific risers for other equipment deployment activities. All of the riser tools described will be capable of surveying 10.16 to 30.48 cm (4 to 12") I.D. risers.

Up to five data sets may be gathered. Riser length measurements will be normally required, as will distance to the waste surface. These activities will be accomplished by conventional mechanical length tools and zip cords. Newly developed instrumentation will be employed for other riser characterizations.

Waste inspection will also normally be required. This activity will be accomplished with a proven 7.62 cm (3") diameter remotely operated camera. For flammable gas tanks, a 7.62 cm (3") flammable gas qualified system is currently under construction and will be available for deployment by the current scheduled date for the first SMMS deployment into a flammable gas tank.

For riser inspection, a Riser Inspection Device (RID) [Schofield 1995] will be used to gather qualitative visual data. RID is a standard video inspection system, manufactured by Crestone Products Inc., that mounts on top of a riser flange to inspect the tank riser and waste directly below the riser. The system includes a high resolution (S-video) color TV camera equipped with a 8:1 zoom lens, and a high intensity pre-focused quartz halogen light source. The camera housing is fabricated of 300 series stainless steel.

The RID camera and light is isolated from the tank vapor space by a clear glass or plastic window mounted on the riser to qualify the system for all tanks (e.g., flammable gas, organic, ferrocyanide, non-watchlist).

If the visual data is adequate to show no significant obstacle to insertion of the SMMS arm, no further investigation will be attempted.

Should the RID system data be either inconclusive, or show information that suggests obstruction, then a decision will be made to either move to another riser location, or to deploy the newly developed riser laser profiling system (LPS).

The LPS is deployed through the full length of the riser and gathers quantitative data on riser ovality, protrusions, and plumb. A plug gage may be a suitable alternative to the LPS, if appropriate.

3.0 OPERATIONS

A suitable riser is selected for the SMMS survey either immediately before the survey or several days or weeks before the survey. In flammable gas and/or organic tanks, the riser cover will be removed in a manner (OSD-30, Section 30.2) which prevents static and/or mechanical sparks, and flammability checked in the riser.

If the riser is checked for flammable gas more than 15 minutes prior to SMMS installation, flammability will again be checked on flammable gas and/or organic tanks immediately before deployment device insertion.

Exposure to toxic gases will be prevented by following requirement in the tank farm Health and Safety Plan (HASP) [Mickle 1995].

Next, the risers on all tanks will be checked for obstructions using a non-sparking riser gauge plug [Farley 1994c, or a RID video system [Schofield 1995].

If the riser is suitable for the SMMS, the risers will then be gauged using a zip cord to check waste elevation, and a pole with a foot to gauge actual flange to stub riser length.

Next, a plastic sleeve may be positioned in the riser to lessen radioactive contamination of the SMMS, the decontamination unit mounted on the riser, and the impact limiter positioned over the riser. The impact limiter will prevent damage to the riser or tank bottom, if the SMMS is accidentally dropped. Critical lift procedures [DOE 1994] are used to lessen the likelihood of an accidental drop.

On flammable gas tanks, flammability will be checked continuously during installation and removal per SARR-002 [Van Vleet 1994a] for DSTs, and per SARR-004 [Van Vleet 1994b] for SSTs. Additional explanation of this requirement is provided in Internal Memo 8M400-RJVV-95-00? [Van Vleet 1995].

Where 30 cm (12") diameter risers are used, an adpoter plate will be added for two 10.16 cm (4") openings, one for the video camera and one for the SMMS. The video must be installed first as the SMMS winch container box will extent over both openings. The video will be installed per standard tank farm procedures.

The SMMS in-tank device will be lifted off a flat bed truck with a crane by a two point pick, top bail and a mid-device temporary clamp. After the device is oriented vertically, the mid-device clamp is removed, and the device positioned vertically over the open riser. The device is then lowered into the tank at a maximum rate of 30.48 cm/sec (1 ft/sec) until the device is firmly seated on the decontamination system.

After the device is securely bolted down and electrically connected, the arm will be cranked to a horizontal or some other non-vertical position, as specified for radial spacing requirements. The camera and probe are now free to be lowered as required to place the probe bottom on the waste surface. It is extremely undesirable to lower the camera into the waste, as the calibration would be incorrect, and the probe would become contaminated.

The power will then be turned on in the probe. Reflected neutrons passing through the neutron detectors will induce electrical pulses in the detectors, which will be transmitted to the van and be counted. The probe will be repositioned in several radial directions and distances to obtain approximately 40 samples for statistical analysis of surface moisture.

After completion of sampling, the probe will be mostly retracted, the arm lowered to a vertical positions, and the probe retracted the remaining distance into a receiving socket. The SMMS in-tank device will then be removed. During removal, the device will be decontaminated using high pressure water. Finally the video camera will be removed.

4.0 AUTHORIZATION BASIS

4.1 Interim Safety Basis (ISB)

The authorization basis for Tank Farm activities is Chapter 6.0 of the interim safety basis (ISB) document WHC-SD-WM-ISB-001 [Leach and Stahl 1995], and documents specifically referenced therein.

The ISB identifies the IOSRs [Aguirre 1994, Dougherty 1994, Heubach 1994] as the authorization basis for the nuclear criticality issue in AWTs, SSTs, and DSTs. The IOSRs permit surveillance activities in the dome space outside of the waste. SMMS activities fall within the above authorization.

Other ISB referenced documents covering other issues include the following:

- WHC-SD-WM-OSR-004 [Aguirre 1994] - aging waste tanks
- WHC-SD-WM-OSR-005 [Dougherty 1994] - SSTs
- WHC-SD-WM-OSR-016 [Heubach 1994] - DSTs
- WHC-SD-WM-SARR-001 [Postma, 1994b] - organic watch list tank C-103
- OSD-T-151-00030 [WHC 1995a] - all watch list tanks.

4.2 Interim Operational Safety Requirements (OSRs)

The OSRs identified in Section 4.1 specify that operating specification document WHC-SD-WM-OSD-00030 is currently in place to control activities involving watch list flammable gas, ferrocyanide, organic, and high heat tanks. The OSRs also require flammable gas administrative controls, which are provided in SARR-002 [Van Vleet 1994a] and SARR-004 [Van Vleet 1994b].

OSR-005, Section B 5.0, lists physical parameters that are monitored and controlled (e.g., nuclear criticality, corrosion, heat load, hydrostatic load, dome load, tank and transfer line leakage, concrete temperature, and flammable gases) to keep the tanks conditionally safe.

Parameters that are or could be affected under accident conditions by SMMS activities are dome load, tank leakage, and flammable gases. Safety analyses referenced in the OSRs applicable to these parameters are as follows:

Tank Type	Safety Analysis	Activity and/or Concern
Single-Shell:	SD-RE-TI-012 [RHO 1989] SD-WM-SAR-006 [WHC 1989]	Dome loading Tank leakage
Double-Shell:	SD-WM-SAR-016 [RHO 1986] JCO 9456832 [Lee 1994]	Tank leakage Dome loading
Flammable Gas:	WHC-SD-WM-SAR-034 [WHC 1989] WHC-EP-0562 [Osborn 1994]	Hydrogen burn with oxygen Tank vapor issue (flammable/toxic gases)
Ferrocyanide:	no references	
Organic:	no references	

4.3 Operation Specification Documents (OSDs)

Appendix A in WHC-SD-WM-OSD-00030 identifies individual watch list tanks; and Appendix B tanks that are being considered for the watch list, and until proven otherwise, should be treated like watch list tanks.

Section 30.2.A.4, In-tank Inspection in flammable gas tanks is applicable to SMMS activities, and specifies that equipment design must follow the safety related criteria outlined below for TV camera and light assemblies.

- Lighting to be UL listed for use in Class 1, Division 1, Group B; a flammable hydrogen atmosphere.

Note: This requirement is expected to be changed to Class 1, Division 2, Group B in the next revision of OSD-T-151-00030.

- All other electrical components located inside the tank that are not Class 1, Division 1, Group B will be purged and pressurized with instrument air or inert gas in accordance with the National Fire Protection Association, Inc. (NFPA), Article 496, Type X purging, to conform with the requirements of the National Electric Code (NEC), Article 501 for use in the flammable hydrogen atmosphere.
- Purge gas system to have redundant safety instruments to alarm and automatically shut off electrical power to the electrical components served by the purge gas system due to loss of gas pressure, if required by the safety classification of the equipment or the NFPA classification for the location where the equipment is installed, whichever is more stringent.
- In tank 101-SY radiation shielding of the replacement plug to be equal to original 42-in. shield plug.
- In-Tank inspection using a still photo camera requires approval by WTO and WTPE.

The technical bases for controls, based on safety analysis which are applicable to SMMS installations and operations, are referenced as follows:

Tank Type	Technical Bases	Activity and/or Concern
Flammable Gas:	WHC-SD-WM-HSP-002 [Mickle 1995] WHC-EP-0562, Rev. 1 [Osborn 1994] LAUR-92-3196, Rev. 14 [LANL 1995]	Vapor sampling/toxic gas Tank Vapor Issue (flammable/toxic gases) In-tank video
Ferrocyanide:	WHC-EP-0691 Postma 1994 ^a 1994]	Waste > 220 °C
Organic:	WHC-SD-WM-SAD-009 [Farley/Grigsby] WHC-SD-WM-HSP-002 [Mickle 1995] WHC-EP-0681 [Babad/Turner 1993]	Sparks/heat generation Vapor sampling/toxic gas Waste > 171 °C and moisture < 17 wt%

4.4 Accelerated Safety Analysis

General and activity specific safety controls for activities in flammable gas DSTs is found in WHC-SD-WM-SARR-002 [Van Vleet 1994a], and for flammable gas SSTs in WHC-SD-WM-SARR-004 [Van Vleet 1994b]. Although not yet part of the authorization basis, the safety controls in these reports were developed to ensure compliance with safety criteria specified in the IOSRs [Aguirre 1994, Dougherty 1994, Heubach 1994]; OSD-30 [WHC 1995a], and *Criteria for Flammable Gas Watch List Tanks* [Hopkins 1994]. Therefore, SARR-002 and -004 have been adopted as appropriate controls for this safety evaluation.

Integrated safety information for organic tanks, not yet part of the authorization basis, is found in *Preliminary Safety Criteria for Organic Watch List Tanks for Hanford Site*, WHC-SD-WM-SARR-033 [Webb 1995]. Present safety criteria are conservative compared to listed safety criteria in SARR-33.

Integrated safety information for all tanks, which will shortly become part of the authorization basis, is found in *Interim Chapter 3.0 Hazard and Accident Analysis* WHC-SD-WM-SAR-065 (SAR-65) [WHC 1995b]. Present safety criteria are conservative compared to safety criteria in SAR-65.

5.0 POTENTIAL HAZARDS

The following discussion deals with the installation and operation of the SMMS instrument device in Hanford waste tanks. In some cases, existing equipment (e.g, manual tapes, HEPA filters, LOWs) may have to be temporarily removed before the instrument device can be installed, and/or risers inspected for obstructions. These activities and their associated hazards have been covered in other safety documents, but would be controlled by the same applicable safety controls in Section 7.0 of this report. Examples of such documents include the following USQ Safety Evaluations:

- Riser Inspection Device, USQE TF-95-0082
- Manual Tapes in Flammable Gas Tanks, USQE TF-95-0075
- HEPA Filter Relocation, USQE 7-92-110-BY
- HEPA Filter Relocation, USQE 18-93-BYBX
- LOW Removal, USQE TF-95-0081
- Riser Examination, USQE 9-93-LAMP

After a tank is checked for flammable and toxic gases by Industrial Health & Fire Protection (IHFP) using safety criteria in the WHC-SD-WM-HSP-002 [Mickle 1995], the riser will be inspected for obstructions using one of the methods described in section 2.4 of this report. If direct viewing is selected, a Health Physics Technician (HPT) will determine if it is safe to peer directly into the open riser, or if leaded glass or mirrors will be required.

If deemed necessary by the Industrial Health, Safety, and Fire Protection (IHSFP) organization, the riser inspection may be performed inside a passively ventilated containment structure (tent, greenhouse, etc.) that has a HEPA filter, in order to minimize radionuclide release to the environment.

5.1 Mechanical Sparks in Flammable Gas Tanks

Sparks have a high potential for igniting flammable gases. Many of the tanks are organic tanks, flammable gas tanks, or combination organic and flammable gas tanks. The hazard exist that a spark could ignite the gas and cause an explosion, and/or ignite the organics. A vapor space gas burn might lead to dome collapse and release of radionuclides to the atmosphere. An organic waste burn would breach the HEPA filter and release radionuclides.

Sparks could be created by metals striking other metals during instrument device installation (e.g., dropping device during crane lift). This is extremely unlikely ($1\text{E-}4$ to $1\text{E-}6$) as all in-tank exterior device components are spark resistant, and an impact limiter will be installed around the riser. It is deemed to be incredible ($<1\text{E-}6$) that the device would be dropped and create a spark, and a flammable gas release would occur at the same time.

5.2 Electrical Sparks in Flammable Gas Tanks

Electrical sparks could be created by shorts in the neutron probe, video camera, or inclinometer, or by a severed cable. The likelihood of this happening is judged to be unlikely ($1\text{E-}2$ to $1\text{E-}4$). If a spark did occur in the neutron probe, and hydrogen gas had leaked into the probe, an explosion could occur in the probe but would not ignite gas outside the probe as the probe is designed to be explosion proof.

Explosion proof is defined by the NFPA [1986] as a container that will not rupture and will release combustion products at a controlled rate below the ignition temperature of the gas. Hydrogen in air ignites at 520°C (968°F).

The video camera and inclinometer are designed for a Class-1, Division-2, Group-B environment to qualify for flammable gas tanks. For non-flammable gas tanks, no safety classification is required.

5.3 Radionuclide Contamination of Probe

The probe bottom will rest on hard saltcake or soft sludge for moisture measurements. The potential exist for the probe to become significantly radioactively contaminated ($5\text{E-}1$), the decontamination unit fail ($1\text{E-}3$), the HPT fail to check for radioactivity as the device is being removed ($1\text{E-}2$), and workers to physically handle contaminated equipment and be exposed to the radioactivity in spite of it not being checked by the HPT ($1\text{E-}2$). The likelihood of this sequence ($5\text{E-}8$) is incredible.

5.4 Dropping Instrument Device Through Bottom of Tank

A SMMS instrument device could be dropped by the lifting crane during installation. The likelihood of dropping a load is extremely unlikely ($1\text{E-}4$ to $1\text{E-}6$) when using critical lift procedures. If dropped, it is unlikely ($1\text{E-}2$ to $1\text{E-}4$) that the impact limiter would fail. The likelihood of both a drop and impact limiter failure is incredible ($<1\text{E-}6$).

5.5 Dome Loading Types

- Construction loads (e.g., lifting loads, trucks, cranes, girders)
- Normal loads (e.g., gravity, soil, hydrostatic, thermal)
- Concentrated operational loads (trucks, cranes)
- Natural-hazard loads (flood, wind, seismic)
- Postulated accident loads (waste/vapor burn and/or explosion)

Maximum concentrated load limits from the IOSRs [Aguirre 1994, Dougherty 1994, Heubach 1994] are as follows:

200 series SSTs: 45.36 tonnes (50 tons) over a 3 m (10 ft) radius.
100 series SSTs: 90.72 tonnes (100 tons) over a 3 m (10 ft) radius.
All DSTs: 45.36 tonnes (50 tons) over a 3 m (10 ft) radius

OSD-T-151-00013, Section 13.2.1, parts C.2 and D give dynamic dome loading and deflection limits for concentrated loads over a 3 m (10 ft) radius. Dome deflections of greater than 0.6 cm (0.02 ft) may indicate excessive dome loading or possible structural failure.

The only potential significant dome loading from SMMS activities is from the lifting crane for lifting the instrument device, and driving the monitoring van over the dome. It is not planned for the crane to be positioned over the dome. The van, which will operate over the dome, weighs < 3.6 tonnes (4 tons), thus is well within safety limits. If the 27 tonne (30 ton) crane accidentally drove over the dome, and the van was on the dome at the same time, safety limits would still not be exceeded.

5.6 Criticality from Dropping Neutron Source Into Waste

Criticality Safety Analyses have shown that the waste tanks are over-moderated [Doto 1989]. Analytical results from 30 core samples consistently show fissile material concentrations at least an order of magnitude lower than the 1 g/L limit allowed by the Criticality Prevention Specification. It is deemed to be incredible that accidentally dropping the two curie AmBe neutron source into the waste would trigger a criticality in the waste.

5.7 Natural Phenomena Related Accidents

Natural phenomena related accidents would be those caused by such events as lightning, tornadoes, and earthquakes.

5.7.1 Lightning

Lightning could strike the top of the SMMS instrument device during installation or removal and discharge off the bottom, igniting flammable gas in the vapor space, or striking and igniting a dry waste surface.

The Hanford Site has an average of 10 days per year during which thunderstorms occur. The probability of a direct lightning strike on a tank is about once each 2,000 years (5E-4) [Cowley 1994].

During tank farm activities, adverse weather conditions are observed, and work on waste tanks is not conducted unless the Pacific Northwest Laboratory weather group states that lightning is not present within 81 km (50 miles) of the Hanford Site [Farley 1994]. The likelihood of not tracking the weather and heeding a weather warning (human error) is $1E-2$.

It is assumed that SMMS instrument device installation, operation, and removal would take about 40 hours each, and ten tanks would be surveyed each year. Since there are 8760 hours in a year, the annual likelihood of a lightning strike on a device during installation or removal would be as follows:

$$5E-4 * 1E-2 * 40/8760 * 10 = 2.3E-7/\text{yr (incredible)}.$$

5.7.2 Tornadoes

The likelihood of a tornado on the Hanford site is $1E-5/\text{yr/facility}$ [DOE 1994]. There could be rupturing of the ventilation ducts and HEPA filter housings from such an event, release of radioactivity, and radiation exposure to workers, or injury from flying debris. The likelihood of workers failing to observe a tornado approaching and take cover is $1E-2$. It is estimated that workers would be doing SMMS surveys for about 40 hours in each tank and ten tanks per year would be surveyed. Since there are 8760 hours in the year, the annual likelihood of a tornado caused accident would be as follows:

$$1E-5 * 1E-2 * 40/8760 * 10 = 4.6E-9/\text{yr (incredible)}.$$

5.7.3 Earthquakes

The likelihood of a 0.25 g seismic event, one that could do significant damage in the tank farms, is $1E-4$ per year [Tallman 1989]. There could be rupturing of the ventilation ducts and HEPA filter housings from such an event, release of radioactivity, and radiation exposure to duct inspection workers. It will be assumed that workers have pre-tremor warning of the earthquake. The likelihood that workers would continue to work on a tank with pre-tremor warning is $1E-2$. It is estimated that workers would be doing SMMS surveys for about 40 hours in each tank and ten tanks per year would be surveyed. Since there are 8760 hours in the year, the annual likelihood of an earthquake caused accident would be as follows:

$$1E-4 * 1E-2 * 40/8760 * 10 = 4.6E-8/\text{yr (incredible)}.$$

5.8 Industrial Accidents

Industrial accidents (e.g., exposure to toxic gases, worker injury) are controlled by adhering to the requirements in the tank farm Health and Safety Plan [Mickle 1995].

6.0 CONSEQUENCES

No consequences were calculated, as all potential accidents that could cause significant damage to the tanks or harm to personnel were judged to be incredible.

7.0 CONTROLS

Controls are split between general controls that cover all tanks and specific controls that cover the different categories of watch list tanks.

General Controls

Radiation:

During SMMS instrument device installation and removal, or whenever a riser is open, a Health Physics Technician (HPT) shall be present to enforce ALARA principles, as specified in Hanford Site Radiation Control Manual (HSRCM-1).

Toxic Gases and Hazardous Materials:

During SMMS instrument device installation and removal, and whenever a riser is open, a technician from Industrial Health, Safety, and Fire Protection (IHSFP) shall be present to implement safety controls concerning toxic gases and hazardous materials, as specified in the Tank Farm Health and Safety Plan (WHC-SD-WM-HSP-002) [Mickle 1995].

Flammable Gas in non-flammable gas tanks:

Immediately after opening a riser, the vapor space of the riser shall be checked for flammable gases with a combustible gas meter (CGM). If the CGM reads > 25% of the LFL, a grab sample of the riser gases shall be obtained, the riser closed, and tank farm management notified. If the CGM reading is ≤ 25% of the LFL, SMMS activities may continue.

Dome Loading:

Before SMMS activities, it shall be ensured that the applicable OSRs for dome loading (both distributed and point loads) are satisfied for the tank on which the activity is occurring. This analysis will need to take into account all loads placed on the tank since the tank was certified to be in compliance with the OSRs. This includes new equipment, new concrete pads, new soil cover, etc., along with equipment needed to perform the activity such as cranes and trucks.

Crane Lifts:

- The crane and rigging that are used in SMMS instrument device installation and removal shall be load tested with loads that equal or exceed the weight of the heaviest assembly. The actual lift shall be treated as a critical lift.

Routine Maintenance and Surveillance

- All tools and equipment used around the open riser that are small enough to fall through the riser shall be equipped with lanyards.

Specific Controls

Ventilation Controls for Flammable Gas tanks

- The flammable gas SSTs intended to be on active ventilation are those in the SX tank farm. However, there is no requirement that the active ventilation system on flammable gas SSTs be functional. Therefore, this section will treat all flammable gas SSTs as being passively ventilated.
- The tank ventilation system shall be operating before and during SMMS instrument device installations and during device removal (i.e, the breather filter must be functional). Exceptions to these requirements may occur occasionally for short periods while maintenance activities to the HEPA filters are being conducted. An example of the term "occasionally for short periods of time" is 8 hours, once a month (31 days).
- On breaking tank containment in a particular riser for the first time, a 5-minute pause shall be observed. This allows any accumulated gases to be swept out of the riser.

Grounding/Bonding Prior to SMMS Activities Flammable Gas and Organic Tanks

- The riser flange cover shall be removed in such a way as to prevent possible ignition of flammable gas inside the riser because of static charges or mechanical sparks. To prevent electrostatic sparks, the riser cover shall be electrically bonded to the tank in accordance with the appropriate NFPA Code requirements for the classified regions of the tank vapor space and ventilation system [NFPA 1990].
- To prevent mechanical sparks, only spark-resistant tools shall be used, except for the initial loosening (one full turn) and the final tightening (final torquing) of the bolts.
- All equipment inserted into the tank vapor space shall be electrically grounded and bonded in accordance with the appropriate NFPA requirements for the classified regions of the tank vapor space.

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Hydrogen Concentration Control in Flammable gas tanks

Note: Because no specific time of intrusion control (similar to the "window" for 101-SY) is imposed, it is important to provide real-time measurements of the hydrogen concentration while activities are being performed. Until the standard hydrogen monitoring system is installed on each tank, this control can be satisfied by monitoring the tank using a hand-held CGM. The CGM would be positioned so that the sample is drawn from approximately the same location as the standard hydrogen monitoring system would draw its sample, i.e., near the waste surface.

- If the standard hydrogen monitoring system (SHMS) and gas probe assembly are not installed or are not functioning, the flammable gas concentrations shall be taken with a CGM at three locations before starting the in-tank activity.

(1) At the HEPA filter before any riser cover is removed.

(2) After the riser bolts sealing the riser flange are loosened enough to take a gas reading from the riser, a reading shall be taken at the riser opening.

(3) After complete riser cover removal, a reading shall be taken from the tank vapor space and every 15 minutes thereafter during the intrusive activity.

At each of these locations, the following instructions shall be followed. If the CGM reading is $\leq 25\%$ of the LFL, the SMMS installation may proceed. If the CGM reading exceeds 25% of the LFL, a flow-through bulb sample shall be taken for specific gas species analysis in the laboratory, the activity shall cease, and the tank shall be placed in safe shutdown mode. The activity shall not resume until results of the flow-through bulb sample are known, and the appropriate Safety and Tank Farm Project Management approvals are received.

- If the SHMS is operating, continuous monitoring system shall be accomplished by viewing the strip chart recorder. Activities in the tank shall cease when flammable gas concentration exceed 25% of the LFL.

Time of Intrusion

- SMMS installation work shall be done after a review group has looked at recent tank behavior and decided that the tank is behaving in a manner consistent with its historical norm.

This review group will have members from Waste Tank Safety Assurance, Operations (200 East or 200 West Area, as

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appropriate), Waste Tank Process Engineering (200 East or 200 West Area, as appropriate), Waste Tank Process Control, Tank Waste Remediation System Safety Analysis and Engineering, Waste Tank Plant Engineering (200 East or 200 West Area, as appropriate), and Flammable Gas Tank Safety Program Office.

If conditions exist outside of the normal behavior of the tank, a formal presentation will be made to the Plant Review Committee.

- During SMMS activities, tank conditions shall be monitored for the entire time that the activity is being performed. This monitoring will include the tank waste level and the hydrogen concentration in the tank. The operator shall look for indications that a gas release might occur, e.g., a sudden decrease in waste surface level and/or an increase in the hydrogen concentration. If any measurements indicate that a gas release is imminent, the tank shall be placed in safe shutdown mode and the tank farm shall be evacuated.

Specific Controls for Organic Tank 103-C

Ignition Sources:

- Fire, flaming objects, or hot materials > 120 °C (248 °F) shall not be permitted in the vicinity of an open riser. The objective of this control is to preclude the introduction of ignition sources at the pool-air interface.
- Porous materials which could serve as wicks at the organic -air interface shall be prevented from entering the tank, since as described in WHC-SD-WM-SARR-001 [Postma, et al 1994^b, a wick-stabilized flame is easier to ignite than a fire on an open pool.
- Vehicles operating at grade level over tank C-103 must employ fuels (e.g., propane) or fuel tank protection (e.g., skid plate, tank location) that greatly reduces the chance for an accident in which ignitable liquid fuel could enter tank C-103.

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9.0 USQ SAFETY REVIEW QUESTIONS:

- A. Does the PROPOSED CHANGE represent a change to the facility as described in the AUTHORIZATION BASIS documentation?

☐ N/A ☒ No ☐ Yes/Maybe

Basis: The authorization basis is identified in Section 4.0 of this report. This temporary installation does not constitute a change, according to guidelines in DOE 5480.21 [DOE 1991], since:

- a. It does not add, delete, or convert an automatic or manual feature of the system, structure, or components important to safety.
- b. It does not introduce new system interactions.
- c. It does not change the seismic qualifications of the tank, environmental qualifications, or quality classifications of the system, structure, or components important to safety.

- B. Does the PROPOSED CHANGE represent a change to procedures as described in the AUTHORIZATION BASIS?

☐ N/A ☒ No ☐ Yes/Maybe

Basis: There are presently no procedures for in-situ monitoring of moisture in the surface solids in the single-shell waste tanks.

- C. Does the test or experiment represent a test or experiment not described in the AUTHORIZATION BASIS documentation?

☐ N/A ☐ No ☒ Yes/Maybe

Basis: This is a new configuration for neutron activation moisture monitoring of tank waste to determine if the waste meet conditionally-safe safety criteria. DOE 5480.21 [DOE 1991] states that one-of-a-kind tests used to measure the effectiveness of new techniques or a new system configuration that might affect systems important to safety will require a safety evaluation before they can be conducted.

- D. Does the change, test or experiment impact:

- Implemented OSRs or IOSRs? ☐ N/A ☒ No ☐ Yes/Maybe
- Approved IOSR Compliance Implementation Plans? ☐ N/A ☒ No ☐ Yes/Maybe

Basis: There are presently no IOSRs that identify safe moisture levels in the SST waste, or requirements for keeping waste moisture at specified levels, as these are still being developed.

Since there are no IOSRs for waste moisture level requirements, there are no implementation plans for keeping waste moisture at specified levels.

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(Continued)

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Based on the above, a Safety Evaluation
need to be performed for this change

☒ DOES ☐ DOES NOT

USQE No. 1 W. G. Farley

USQE No. 2 R. L. Guthrie

Print Name

Print Name

Wayne G. Farley
Signature

11/9/95
Date

R. L. Guthrie
Signature

11/9/95
Date

Figure 1 - SMMS Schematic Diagram

Figure 2 - Deployment Arm and Neutron Probe

Figure 3 - Electronic Block Diagram

FIG 3- SHMS ELECTRONIC BLOCK DIAGRAM SHOWING DATA ACQUISITION SYSTEM

UNREVIEWED SAFETY QUESTIO

(Per WHC-IP-08)

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USQ Tracking Number: TF-95-0089

AREA: ☐ East ☒ WestFacility: ☐ 242-A ☐ DST ☒ SST ☐ LERF
☐ Aging Waste ☐ Other

EQUIPMENT DESCRIPTION: See section 2.0

REFERENCE DOCUMENT(S):

ECN No.

PCA No.

Work Pkg No.

Other (Specify) See section 8.0

TITLE: SURFACE MOISTURE MONITORING OF HANFORD TANK WASTE BY NEUTRON ACTIVATION

1. Does the PROPOSED CHANGE, test, experiment or DISCOVERY increase the probability of occurrence of an accident previously evaluated in the AUTHORIZATION BASIS documentation?

☒ No ☐ Yes

Basis: The authorization basis is outlined in Section 4.0 of this report. Accidents are not discussed in the first tier of the authorization basis (ISB-001) [Leach and Stahl 1995]; the second tiers of the authorization bases, OSR-004 for AWTs [Aguirre 1994], OSR-005 for SSTs [Dougherty 1994], OSR-016 for DSTs [Heubach 1994] OSD-013 [WHC 1994], and OSR-030 [WHC 1995a]. Accident probabilities are discussed in third tier authorization basis documents SAR-006 [WHC 1989a, SAR-034 [WHC 1989b], and SAD-009 [Farley/Grigsby 1994]. Those related to SMMS installation and operation are as follows:

SAR-006 lists the only credible accidents as loss of seal loop fluid and breach of HEPA filter or ventilation ductwork due to natural phenomenon.

SAR-034 lists the likelihood of dome failure from heavy equipment and earthquakes, crane load drops, hydrogen accumulation and ignition, leaks of liquid waste to soil, and occupational personal exposure, and industrial accidents.

SAD-009 lists the likelihood of workers being exposed to contaminated equipment during equipment removal, and exposure to toxic gases.

The SMMS test will not increase the probability of accidents analyzed in the above safety documents.

2. Does the PROPOSED CHANGE, test, experiment or DISCOVERY increase the consequences of an accident previously evaluated in the AUTHORIZATION BASIS documentation?

☒ No ☐ Yes

Basis: Consequences could be increased by structural changes to waste containment or vapor confinement, changes to the waste source term, increase worker exposure time to radiation or toxic gases, or adverse changes in industrial work procedures. All significant accidents involved with SMMS installation and operation were deemed to be incredible in Section 5.0 of this report, therefore, consequences were not calculated. However, since SMMS installation and operation will not significantly affect any of the above safety parameters, there is no increase in consequences previously evaluated.

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(Continued)

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3. Does the PROPOSED CHANGE, test, experiment or DISCOVERY increase the probability of occurrence of a malfunction of EQUIPMENT previously evaluated in the AUTHORIZATION BASIS documentation?

☒ No ☐ Yes

Basis: Equipment important to safety are tank structure, the ventilation system, flammable gas monitoring system, waste level monitoring system, and temperature monitoring systems, and pressure monitoring systems. Since SMMS activities will not affect any of the above, they will not increase the probability of malfunction of this equipment.

4. Does the PROPOSED CHANGE, test, experiment or DISCOVERY increase the consequences of a malfunction of ITS EQUIPMENT previously evaluated in the AUTHORIZATION BASIS documentation?

☒ No ☐ Yes

Basis: Since the equipment important to safety (ITS) will not be effected, consequences will not be effected.

5. Does the PROPOSED CHANGE, test, experiment or DISCOVERY create the possibility of an accident of a different type than any previously evaluated in the AUTHORIZATION BASIS documentation?

☒ No ☐ Yes

Basis: Type accidents previously analyzed were loss of tank containment or confinement from dropped equipment, flammable gas ignition, breach of dome or ventilation system, criticality, radiation and toxic gas exposure, and industrial accidents. No new type of accident is anticipated from SMMS activities.

6. Does the PROPOSED CHANGE, test, experiment or DISCOVERY create the possibility of a malfunction of EQUIPMENT of a different type than any previously evaluated in the AUTHORIZATION BASIS documentation?

☒ No ☐ Yes

Basis: Since the SMMS will not affect equipment important to safety, it can not increase the possibility of malfunction of the equipment.

7. Does the PROPOSED CHANGE, test, experiment or DISCOVERY reduce the margin of safety as defined in the basis for any Technical Specification/Operational Safety Requirement?

☒ No ☐ Yes

Basis: Margins of safety are stipulated in the IOSRs [Aguirre 1994, Dougherty 1994, Heubach 1994] OSR-005 for maximum waste level, maximum waste temperature, vapor space pressure, vapor space flammability, and moisture content of ferrocyanide and organic waste. Since SMMS activities will not affect any of the above, it can not affect the margins of safety.

UNREVIEWED SAFETY QUESTION
(Continued)

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3. Does the PROPOSED CHANGE, test, experiment, or DISCOVERY require a new or revised OSR, IOSR or a compensatory measure required by a Compliance Implementation Plan?

[X] No [] Yes

Basis: OSR-005 adequately covers all safety issues, thus no changes are required. IOSR compliance plan WHC-IP-0954, Rev. 4 [Gelman 1995], was reviewed to determine if compensatory (remediation) measures were required to cover SMMS activities, and it was judged that none were needed.

USQE No. 1 W. G. Farley

Print Name

USQE No. 2 R. L. Guthrie

Print Name

Wayne G. Farley
Signature

11/9/95
Date

R. L. Guthrie
Signature

11/9/95
Date

PRC REVIEW (If Required)

Meeting No.: _____ Date _____

PRC Chairman Concurrence: _____
Signature _____ Date _____

**Westinghouse
Hanford Company**

**Internal
Memo**

From: TWRS SAR Engineering
Phone: 376-9192 A3-37
Date: April 29, 1996
Subject: TRANSMITTAL OF USQ SAFETY REVIEW TF-95-0089, REV. 1
SURFACE MOISTURE MONITORING OF HANFORD TANK WASTE
BY NEUTRON ACTIVATION

8M100-WGF-96033

To: L. J. Coates R1-62

cc: B. D. Board A3-37
R. D. Crow H0-38
G. T. Dukelow S7-14
C. E. Hanson H5-09
G. N. Hanson S5-05
M. E. Huda S7-07
M. N. Islam R3-08
D. C. Langlois S7-03
S. H. Rifaey S1-57
J. F. Schofield S7-12
T. I. Stokes L6-37
G. F. Vargo H5-09
J. Weber S1-57
WGF File/LB

Following the guidelines in WHC-CM-4-40, an Unreviewed Safety Question (USQ) Safety Review was performed to show that the installation, operating, and removal of the in-tank surface moisture monitoring system (SMMS) in Hanford waste tanks is within the authorization basis, and is a safe activity.

This revision adds responses to potential hazards identified in a Hazards and Operability Study (HAZOP) by Los Alamos Technical Associates (LATA), and updates the authorization and safety basis references.

WHC-IP-0842, Section 5.4, Rev. 6, requires the attached safety review to be attached to the ECN, PCA, Work Package, or procedure for continuation of the normal review process. The Safety Review form shall be filed with the applicable ECN, PCA, Work Package, or procedure after the review process is completed.

If you have any questions, feel free to call me at 376-9192.

W. G. Farley
Senior Engineer

wgf

Attachment

UNREVIEWED SAFETY QUESTION

(Per WHC-IP-0842, 1

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USQ TRACKING NUMBER TF-95-0089, Rev. 1

REFERENCE DOCUMENT(S):

ECN No.

PCA No.

Work Pkg No.

Other (Specify) See Section 8.0

TITLE:

**SURFACE MOISTURE MONITORING OF HANFORD
TANK WASTE BY NEUTRON ACTIVATION**

1.0 INTRODUCTION:

This report covers potential hazards associated with installing and operating the surface moisture measurement system (SMMS) in all single-shell tanks (SSTs) and double-shell tanks (DSTs), and appropriate safety controls to keep risk within guidelines in WHC-CM-4-46. Many of the watch list tanks are combinations of organic, ferrocyanide and flammable gas tanks, thus this report is developed to cover all SST and DST safety criteria.

The new probe uses the same principle as the neutron probes used in SST liquid observation wells (LOWs) for the past 12 years to determine liquid levels and determine relative moisture content in the waste immediately around the LOWs. An unreviewed safety question evaluation (USQE) for neutron activation logging in ferrocyanide and organic tank LOWs was previously performed in USQE TF-95-0007 [Farley 1995].

2.0 EQUIPMENT DESCRIPTION

2.1 SMMS

The SMMS (Figure 1) consists of a monitoring van, deployment device, and a neutron probe installed on the deployment device. The van contains electronic systems, operator console, a self contained battery supply power system, and storage for the neutron source (when not installed in the probe housing). Also attached to the front of the van is a LOW logging system, which will not be used at the same time as the SMMS.

The deployment device consists of an upper stainless steel (SS) containment box for control winches, and an 8.9 cm (3.5") O.D. SS column to support in-tank instrumentation. The in-tank instrumentation consists of a SS rotatable arm, neutron probe, and video camera/light. The first surveys will be conducted with a video camera/light in a separate riser. Later, a retractable video camera/light may be installed within the lower portion of the SS column. The maximum weight of SMMS related equipment which will be located on a tank at any time will be approximately 20,000 lbs. Allowing for a 56,000 lb crane for installation of some items, the total weight to be considered for dome loading is 86,000 lbs.

The length of the column and/or arm can be adjusted for various waste levels by adding additional sections. The maximum length will be about 15 m (50 ft), and maximum weight about 363 kg (800 lbs). A winch containment box sits on top of the column. Lifting provisions are incorporated under the containment box.

The containment box contains manually operated winches to control arm angularity from vertical, camera elevation (if integral system used), and probe elevation. Angularity will be determined by an electronic inclinometer. The winches will incorporate a combination of slip rings and/or reverse wound drums to connect the van system to the neutron probe, and video camera if integral system is used.

The deployment device is used to guide deployment of the neutron probe to about 40 points (for each test) on the waste surface within 0.9 m (3 ft) of the column axis projected to the waste surface. Visual observations on the video camera will be used to determine when the probe contacts the waste surface.

The probe (Figure 2) contains three Boron-10 (B10) tube neutron detectors, a 16 microgram Californium-252 neutron source, two thermistors, voltage converters, and electronic amplifiers. The probe is sealed to prevent moisture from contacting the electronics, and is designed to meet National Fire Protection Association (NFPA) code requirements (explosion proof) for Class-1, Division-2, Group-B, environments (H_2 occasionally > LFL). The probe will weigh 11-14 kg (25-30 lbs).

Converters in the probe convert low voltage (24 vdc) input from the logging cable to high voltage (800 to 1500 vdc) needed to operate the neutron detectors. The probe amplifiers operate on 12 volts dc.

One of two video camera types will be used. For flammable gas tanks, the video system used will meet OSD-T-151-00030 requirements in section 30.2.C.4. For non-flammable gas tanks, a non-classified video system may be used.

2.2 Impact Limiter

The deployment device has the potential to cause serious riser damage in the event of a drop accident. Therefore, an impact limiting system will be utilized. The riser must withstand a 30,000 lb relatively steady load while the limiting system foam is crushing, or an I-beam system will be incorporated to transfer the load into the soil, rather than into the riser itself. Tank specific structural analyses will be performed for each riser to be used, and this will guide field installation details and procedural controls.

2.3 Video camera

This section summarizes the design requirements in WHC-SD-WM-DRD-002 [Stokes 1995], and documents the operational and administrative safety controls required for deployment in and around flammable gas tanks.

The video system will meet functional criteria for Class-1, Division-1, Group-B atmospheres. In addition, the video system will have redundant controls which will cause the system to shut down upon loss of purge gas flow.

2.4 Riser Inspection Characterization

The objective of riser characterization is to obtain reliable data for SMMS deployment, and quantify and document specific risers for other equipment deployment activities. All of the riser tools described will be capable of surveying 10.16 to 30.48 cm (4 to 12") I.D. risers.

Up to five data sets may be gathered. Riser length measurements will be normally required, as will distance to the waste surface. These activities

will be accomplished by conventional mechanical length tools and zip co...
lately developed tools will be employed for other riser characterizations.

Waste inspection will normally be required with a remotely operated camera. For flammable gas tanks, a 7.62 cm (3") flammable gas qualified system is currently under construction and will be available for deployment by the current scheduled date for the first SMMS deployment.

For riser inspection, a Riser Inspection Device (RID) [Schofield 1995] will be used to gather qualitative visual data. RID is a standard video inspection system, manufactured by Crestone Products Inc., that mounts on top of a riser flange to inspect the tank riser and waste directly below the riser. The system includes a high resolution (S-video) color TV camera equipped with a 8:1 zoom lens, and a high intensity pre-focused quartz halogen light source. The camera housing is fabricated of 300 series stainless steel.

The RID camera and light is isolated from the tank vapor space by a clear glass or plastic window mounted on the riser to qualify the system for all tanks (e.g., flammable gas, organic, ferrocyanide, non-watchlist).

If the visual data is adequate to show no significant obstacle to insertion of the SMMS arm, no further investigation will be attempted.

Should the RID system data be either inconclusive, or show information that suggests obstruction, then a decision will be made to either move to another riser location, or to deploy the newly developed riser laser profiling system (LPS).

The LPS is deployed through the full length of the riser and gathers quantitative data on riser ovality, protrusions, and plumb. A plug gage may be a suitable alternative to the LPS, if appropriate.

3.0 OPERATIONS

A suitable riser is selected for the SMMS survey either immediately before the survey or several days or weeks before the survey. The riser cover will be removed in a manner which minimizes the potential static and/or mechanical sparks. Next, flammability will be checked first in the riser, and then in the tank vapor space below the bottom of the riser. For all activities equipment will be electrically bonded and/or grounded as required in OSD-T-151-00007, -00013, and -00030.

If the checking for flammable gas is more than 15 minutes prior to SMMS installation, flammability will again be checked on flammable gas and/or organic tanks immediately before deployment device insertion.

Exposure to toxic gases will be controlled by following requirements in the tank farm Health and Safety Plan (HASP) [Hewitt 1995].

Next, the riser will be checked for obstructions using a non-sparking riser gauge plug [Farley 1994c], or a RID video system [Schofield 1995].

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If the riser is suitable for the SMMS, the risers will then be gauged using a zip cord to check waste elevation, and a pole with a foot to gauge actual flange to stub riser length.

Next, a plastic sleeve may be positioned in the riser to lessen radioactive contamination of the SMMS, the decontamination unit mounted on the riser, and the impact limiter positioned over the riser. The impact limiter will prevent damage to the riser or tank bottom, if the SMMS is accidentally dropped.

On flammable gas tanks, flammability will be checked continuously during installation and removal per SARR-004 [Schlosser 1996]. Additional explanation of this requirement is provided in Internal Memo RJVV-8M400-95-003 [Van Vleet 1995].

Where 30 cm (12") diameter risers are used, an adapter plate will be added for two 10.16 cm (4") openings, one for the video camera and one for the SMMS. The video must be installed first as the SMMS winch container box will extent over both openings. The video will be installed per standard tank farm procedures.

The SMMS in-tank device will be lifted off a flat bed truck with a crane. The device is then lowered into the tank until the device is firmly seated on the decontamination system.

After the device is securely bolted down and electrically connected, the arm will be cranked to a horizontal or some other non-vertical position, as specified for radial spacing requirements. The camera and probe are now free to be lowered as required to place the probe bottom on the waste surface. It is undesirable to lower the probe into the waste, as the calibration would be incorrect, and the probe would become contaminated. This will be prevented by close video surveillance of the probe as it is being lowered.

The power will then be turned on in the probe. Reflected neutrons passing through the neutron detectors will induce electrical pulses in the detectors, which will be transmitted to the van and be counted. The probe will be repositioned in several radial directions and distances to obtain approximately 40 samples for statistical analysis of surface moisture.

After completion of sampling, the probe will be mostly retracted, the arm lowered to a vertical positions, and the probe retracted the remaining distance into a receiving socket. The SMMS in-tank device will then be removed. During removal, the device will be decontaminated using high pressure water, with the water flowing back into the tank. Finally, the video camera will be removed per standard tank farm procedures.

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4.0 AUTHORIZATION BASIS

4.1 Interim Safety Basis (ISB)

The authorization basis for Tank Farm activities is Chapter 6.0 of the interim safety basis (ISB) document WHC-SD-WM-ISB-001 [Leach and Stahl 1995], and documents specifically referenced therein.

In turn, except for criticality in SSTs and dome loading in DSTs, the ISB identifies interim operational safety requirements (IOSRs) WHC-SD-WM-OSR-004 [Aguirre 1996], WHC-SD-WM-OSR-005 [Dougherty 1996], WHC-SD-WM-OSR-016 [Heubach 1996] as the authorization basis for AWTs, SSTs, and DSTs.

For SST criticality issues, the ISB identifies administrative control (AC) 5.12 in WHC-SD-WM-OSR-005 [Dougherty 1996] as the authorization basis. Authorization basis for criticality issues in DSTs is not indicated in Chapter 6.0 of the ISB, but is indicated in the DST IOSRs.

For DST dome loading issues, the ISB identifies JCO WHC correspondence 9456832. The JCO was never released as a supporting document, thus was never given a formal JCO number. SST dome loading is covered by AC 5.22 DOME LOAD and B 5.22 DOME LOAD in WHC-SD-WM-OSR-005 [Dougherty 1996].

4.2 Interim Operational Safety Requirements (OSRs)

WHC-SD-WM-OSR-005, AC 5.15 WATCH LIST TANKS, states that a program shall be established to include criteria for placing a tank on or removing a tank from the WATCH LIST, and for special sampling and monitoring requirements and frequencies.

The SMMS is considered one of the special monitoring techniques for helping to determine when a tank meets criteria for addition to or removal from the WATCH LIST, per AC 5.15 a.

The IOSR AC 5.15 also states that an operating specification document (OSD-T-151-00030) is currently in place to control activities involving WATCH LIST TANKS, as well as numerous safety studies that cover ferrocyanide, organic, vapor flammability issues; and upon approval (assumed to be WHC functional review), the results of these studies shall be incorporated into the established program (assumed to be OSD-T-151-00030).

OSR-005, Section B 5.0, lists physical parameters that are monitored and controlled (e.g., nuclear criticality, corrosion, heat load, hydrostatic load, dome load, tank and transfer line leakage, concrete temperature, and flammable gases) to keep the tanks conditionally safe.

Parameters that are or could be affected under accident conditions by SMMS activities are dome load, tank leakage, and flammable gases. Safety analyses referenced in the OSRs applicable to these parameters are as follows:

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Tank Type	Safety Analysis	Activity and/or Concern
Single-Shell:	SD-RE-TI-012 [RHO 1989] SD-WM-SAR-006 [WHC 1989]	Dome loading Tank leakage
Double-Shell:	SD-WM-SAR-016 [RHO 1986] JCO 9456832 [Lee 1994]	Tank leakage Dome loading
Flammable Gas:	WHC-SD-WM-SAR-034 [WHC 1989] LA-UR-92-3196 [LANL 1995] WHC-EP-0562 [Osborn 1994]	Hydrogen burn with oxygen Flammable gas ignition in 101-SY Tank vapor issue (flammable/toxic gases)
Ferrocyanide:	no references	
Organic:	no references	

4.3 Other Safety Related Controls

WHC-SD-WM-SARR-004 [Schlosser 1996] contain recently updated safety studies that have been performed for developing work safety controls for flammable gas tanks, using the latest characterizations of flammable gas tanks. These reports have been submitted to the DOE [Bacon 1996] for inclusion of certain sections into the authorization basis, but at this time are not considered part of the authorization basis.

The Bacon report breaks down sections of the SARRs that have already been implemented into the OSDs, controls to be implemented, and controls to undergo further evaluation. Controls already implemented in OSD-T-151-00030, or recommended to be implemented, are summarized in Section 7.0 of this report.

5.0 POTENTIAL HAZARDS

5.1 HAZOP

Los Alamos Technical Associates (LATA) has recently performed a Hazards and Operability Study (HAZOP) to classify potential hazards involved with installation, operation, and removal of the SMMS in Hanford waste tanks. A summary of results from that report is incorporated into this revision.

The results of the HAZOP were a number of postulated abnormal events which were ranked with respect to safety consequences. The first cut, qualitative, consensus estimates of the safety severity of the consequences were ranked according to the following alphanumeric system:

- S0 No effect outside the immediate area with no safety concerns for the facility worker, the onsite worker, or members of the general public.
- S1 Potential industrial injury, radiological dose consequences, or chemical exposure to the facility worker

- S2 Potential significant radiological dose consequences or chemical exposure to the onsite worker at the nearest adjacent facility
- S3 Potential significant radiological dose consequences or chemical exposure to the offsite population

Type S1 potential hazards are covered by controls in the Tank Farm Health and Safety Plan (HASP) WHC-SD-WM-HASP-002 [Hewitt 1995] and the Hanford Site Radiological Control Manual [HSRCM-1.1994], thus will not be discussed further in this report.

Type S1 Potential Hazards:

1. Heat exhaustion caused by hot weather and failure of the air conditioning in the data collection van.
2. Ignition of small fire resulting from offgassing from the batteries.
3. Toxic offgas from a riser affecting the individual in the van.
4. Carbon monoxide hazard (possible in cold weather due to proximity of data collection van and camera van).
5. Worker exposure to cold weather if van heater failed.
6. Fire caused by fuel spill during field refueling of data collection van.
7. Worker electrocution hazard due to improper grounding of van combined with electrical fault.
8. Worker radioactive contamination due to previous worker having entered the van with contaminated clothing. (Note that the van will be parked in a surface contamination area.)
9. Worker injury due to failure of lifting device (crane).
10. Worker injury due to electrical shorting caused by crane boom hitting electrical equipment.
11. Worker exposure to toxic gas from open riser.
12. Worker exposure due to recovery actions for improper positioning of deployment arm.
13. Worker exposure to radioactive contamination due to improper contamination control procedures during deployment arm installation.
14. Worker injury from catastrophic failure of decontamination system pump.
15. Worker injury from electrical short caused by spill of process water from the decontamination system.
16. Worker injury caused by high pressure water from the decontamination system.
17. Worker injury caused by difficulties in withdrawing deployment arm mast (specifically interference of lost decontamination system nozzle).
18. Worker contamination caused by inadequate operation of the decontamination system.
19. Worker radiation dose caused by separation of neutron source from probe.

Type S2 and S3 potential hazards are discussed at the end of each HAZOP potential hazard.

Type S2 Potential Hazards:

Type S2 potential hazards from the [LATA 1996] HAZOP are indicated below. Likelihood numbers in the responses were developed for this report.

1. HAZOP: Events which result in a spark in the tank headspace when flammable but not detonatable concentrations of gas are present.

Response: Flammable, but not detonatable gases could result from a slow leak of combustible gases. Should a spark occur in the vicinity of the gas leak prior to the gas being diluted by air to a nonflammable concentration, a small flame could persist as long as the gas was continuously released in small quantities. The likelihood of this type gas release in the area of the activity is judged to be 1E-1/yr with waste penetrating activities, and 1E-4/yr without waste penetrating activities.

- a. HAZOP: Grounding the Van Incorrectly

Response: SMMS activities are non waste penetrating thus the likelihood of continuous small plumes of flammable gas in the area of the activity is 1E-4. The likelihood that waste would not be grounded from pipes and instrument trees in the waste and overlying soil is judged to be 1E-3. The combined likelihood is 1E-7.

- b. HAZOP: Parking the Van With Non-spark-resistant Electrical Equipment Next to an Open Riser During an Episodic Release of Flammable Gases

Response: The likelihood of an episodic release of flammable gas that would expel flammable gases to the atmosphere around an open riser is judged to be 1E-4. The likelihood of the van being present during an atmosphere release (assuming 8 hours to perform the work) is calculated to be 8 hrs/8760 hrs per year = 9.1E-4. The combined likelihood is 9.1E-8.

- c. HAZOP: Ignition of Flammable Gases in the Tank Caused by a Fire in the Van Propagating Down a Riser

Response: This likelihood is the likelihood of b. above times the likelihood of a fire in the van (1E-3) or 9.1E-11.

- d. HAZOP: Propagation of a Fuel Fire During Field Refueling to a Tank Flammable Atmosphere

Response: This likelihood is the same as in c. above (9.1E-11).

- e. HAZOP: Failure of the Tank Electrical Safety Barriers Resulting in Igniting a Flammable Atmosphere

Response: The likelihood of tank electrical barriers failing is judged to be 1E-3. The likelihood of flammable gases is 1E-4. The combined likelihood is 1E-7.

- f. HAZOP: Ignition of an Undiscovered Flammable Atmosphere Due to Not Using Flammable Gas Controls;

Response: Discovered and undiscovered flammable but not detonable gases are equally likely. Therefore this case is the same as item a. above 1E-7).

- g. HAZOP: Ignition of a Flammable Gas Buildup in the Decontamination System Pump Casing (failure to isolate pump after decontamination) Propagating to the Tank;

Response: The likelihood of flammable gas in the tank or decontamination system pump casing is 1E-4. The likelihood of an ignition source in the pump casing is 1E-3. The total is 1E-7

- h. HAZOP: Ignition of a Flammable Atmosphere Due to Dropping Equipment

Response: The likelihood of dropped equipment causing flammable gas is judged to be 1E-1. The likelihood of dropping equipment is judged to be 2.7E-5 [Farley 1994]. The likelihood that the impact limiter would fail if equipment was dropped is judged to be 1E-3. The total is 2.7E-9.

- i. HAZOP: Ignition of a Flammable Atmosphere in the Winch Box Due to Failure of Electrical Barriers Between Non-intrinsically-safe Electrical Equipment and the Winch Box Atmosphere

Response: The likelihood of flammable gas in the tank or winch box is judged to be 1E-4. The winches are manually turned. The likelihood of a mechanical spark is 1E-3. The total is 1E-7.

2. HAZOP: A Criticality in the Tank Caused by Dropping the Neutron Source from the Probe in a Region Which is Only Slightly Subcritical.

Response: See Section 5.6 in this report.

3. HAZOP: Release of Radionuclides Caused by Pressurization of the Tank Resulting from Hooking Up Air Instead of Water to the Decontamination System.

Response: The likelihood of water fittings and air fittings being interchangeable is assumed to be 1E-1, as some are known to exist. The likelihood that a worker would hook up the wrong source under these conditions is 1E-2. The tank has a four inch diameter opening to the atmosphere through the HEPA filter, and several leak paths. Pressurization would force vapor space gases out the HEPA filter, the path of least resistance, and radionuclides would be filtered out. The likelihood that the filter would be blocked is judged to be 1E-3. The likelihood that radionuclides would be released from the above sequence of events is therefore $1E-1 * 1E-2 * 1E-3 = 1E-6$.

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4. HAZOP: Toxic Release of Polychlorinated-biphenyl (PCB) Oil if Crane Boom Hits Transformer.

Response: This potential event would be an industrial accident and is controlled by safety requirements in WHC-SD-WM-HSP-002 [Hewitt 1995].

Type S3 Potential Hazards

The events which were judged in the LATA report [LATA 1996] to have potential for S3 (public) consequences consisted of tank dome collapse by various mechanisms, and are as follows:

1. HAZOP: Exceeding Dome Loading Limits Because of Misplacement of the Data Van (wrong spot on the tank or wrong tank).

Response: See Section 5.5

2. HAZOP: Exceeding Dome Loading Limits Because of Misuse or Misplacement of the Crane.

Response: See Section 5.5

3. HAZOP: Addition of Organic Material to Tank Due to Hooking a Fuel Line Up to the Decontamination Water Supply Piping (judged extremely unlikely, but assumed would result in energetic deflagration and possible dome collapse)

Response: The likelihood that a water supply line and fuel supply line would have the same connection is judged to be 1E-3. If the connections were the same, the likelihood that a worker would hook up the wrong supply line is judged to be 1E-2. The sequence of events is not incredible, therefore refueling of the monitoring van over a tank is not permitted.

4. HAZOP: Spark Source in Detonatable Atmosphere (see S2 for mechanisms) Resulting in Dome Collapse.

Response: See Sections 5.1 and 5.2

5.2 Non-HAZOP

The following discussions on the SMMS were developed before the HAZOP, but are still appropriate. They deal with the installation, operation, and removal of the SMMS instrument device in Hanford waste tanks. In some cases, existing equipment (e.g. manual tapes, HEPA filters, LOWs) may have to be temporarily removed before the instrument device can be installed, and/or risers inspected for obstructions. These activities and their associated hazards have been covered in other safety documents, but would be controlled by the same applicable safety controls in Section 7.0 of this report. Examples of such documents include the following USQ Safety Evaluations:

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- Riser Inspection Device, USQE TF-95-0082
- Manual Tapes in Flammable Gas Tanks, USQE TF-95-0075
- HEPA Filter Relocation, USQE 7-92-110-BY
- HEPA Filter Relocation, USQE 18-93-BYBX
- LOW Removal, USQE TF-95-0081
- Riser Examination, USQE 9-93-LAMP

The technical bases for controls, based on safety analyses which are applicable to SMMS installations and operations, are referenced as follows:

Tank Type	Technical Bases	Activity and/or Concern
All tanks:	WHC-SD-WM-HSP-002 [Hewitt 1995]	Vapor sampling/toxic gas, Industrial accidents
	HSRCM-1 [HSRCM 1994]	Radioactivity dose and contamination
Flammable Gas:	WHC-EP-0562, Rev. 1 [Osborn 1994]	Tank Vapor Issue (flammable/toxic gases)
	LAUR-92-3196, Rev. 14 [LANL 1995]	Vapor Space combustible gas > 25% of LFL
	WHC-SD-WM-SARR-004 [Schlosser 1996]	Plume gas release from waste intrusive activities with plume > 25% of LFL
Ferrocyanide:	WHC-EP-0691 Postma 1994 ^a	Waste > 220 °C
Organic:	WHC-SD-WM-SAD-009 [Farley/Grigsby]	Sparks/heat generation
	WHC-EP-0681 [Babad/Turner 1993]	Waste > 171 °C and moisture < 17 wt%
	WHC-SD-WM-SARR-033 [Webb 1995]	TOC > 4.5 wt%, moisture < 20 wt%, and temp. > 200 °C (392 °F)

After a tank is checked for flammable and toxic gases by Industrial Health & Fire Protection (IHFP) using safety criteria in WHC-SD-WM-HSP-002 [Hewitt 1995], the riser will be inspected for obstructions using one of the methods described in section 2.4 of this report. If direct viewing is selected, a Health Physics Technician (HPT) will determine if it is safe to peer directly into the open riser, or if leaded glass or mirrors will be required.

If deemed necessary by the Industrial Health, Safety, and Fire Protection (IHSFP) organization, the riser inspection may be performed inside a passively ventilated containment structure (tent, greenhouse, etc.) that has a HEPA filter, in order to minimize radionuclide release to the environment.

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5.1 Mechanical Sparks in Flammable Gas Tanks

Sparks have a high potential for igniting flammable gases. Many of the tanks are organic tanks, flammable gas tanks, or combination organic and flammable gas tanks. The hazard exist that a spark could ignite the gas and cause an explosion, and/or ignite the organics. A vapor space gas burn might lead to dome collapse and release of radionuclides to the atmosphere. An organic waste burn would breach the HEPA filter and release radionuclides.

Sparks could be created by metals striking other metals during instrument device installation (e.g., dropping device during crane lift). This is extremely unlikely ($1\text{E}-4$ to $1\text{E}-6$) as all in-tank exterior device components are spark resistant, and an impact limiter will installed around the riser. It is deemed to be incredible ($<1\text{E}-6$) that the device would be dropped and create a spark, and a flammable gas release would occur at the same time.

5.2 Electrical Sparks in Flammable Gas Tanks

Electrical sparks could be created by shorts in the neutron probe, video camera, or inclinometer, or by a severed cable. The likelihood of this happening is judged to be unlikely ($1\text{E}-2$ to $1\text{E}-4$). If a spark did occur in the neutron probe, and hydrogen gas had leaked into the probe, an explosion could occur in the probe but would not ignite gas outside the probe as the probe is designed to be explosion proof.

Explosion proof is defined by the NFPA [1993] as a container that will not rupture and will release combustion products at a controlled rate below the ignition temperature of the gas. Hydrogen in air ignites at 520°C (968°F).

The separate video camera used to position the SMMS probe is a purged system designed for Class-1 Division-1, Group-B environments [Farley 1996]. The SMMS inclinometer is designed for a Class-1, Division-1, Group-B environment. For non-flammable gas tanks, no safety classification is required.

5.3 Radionuclide Contamination of Probe

The probe bottom will rest on hard saltcake or soft sludge for moisture measurements. The potential exist for the probe to become significantly radioactively contaminated ($5\text{E}-1$), the decontamination unit fail ($1\text{E}-3$), the HPT fail to check for radioactivity as the device is being removed ($1\text{E}-2$), and workers to physically handle contaminated equipment and be exposed to the radioactivity in spite of it not being checked by the HPT ($1\text{E}-2$). The likelihood of this sequence ($5\text{E}-8$) is incredible.

5.4 Dropping Instrument Device Through Bottom of Tank

A SMMS instrument device could be dropped by the lifting crane during installation. The likelihood of dropping a load is extremely unlikely ($1\text{E}-4$ to $1\text{E}-6$) when using critical lift procedures. If dropped, it is unlikely ($1\text{E}-2$ to $1\text{E}-4$) that the impact limiter would fail. The likelihood of both a drop and impact limiter failure is incredible ($<1\text{E}-6$).

5.5 Dome Loading Types

- Construction loads (e.g., lifting loads, trucks, cranes, girders)
- Normal loads (e.g., gravity, soil, hydrostatic, thermal)
- Concentrated operational loads (trucks, cranes)
- Natural-hazard loads (flood, wind, seismic)
- Postulated accident loads (waste/vapor burn and/or explosion)

Maximum concentrated load limits from the IOSRs [Aguirre 1996, Dougherty 1996, Heubach 1996] are as follows:

200 series SSTs: 45.36 tonnes (50 tons) over a 3 m (10 ft) radius.
100 series SSTs: 90.72 tonnes (100 tons) over a 3 m (10 ft) radius.
All DSTs: 45.36 tonnes (50 tons) over a 3 m (10 ft) radius

OSD-T-151-00013, Section 13.2.1, parts C.2 and D give dynamic dome loading and deflection limits for concentrated loads over a 3 m (10 ft) radius. Dome deflections of greater than 0.6 cm (0.02 ft) may indicate excessive dome loading or possible structural failure.

The only potential significant dome loading from SMMS activities is from the lifting crane for lifting the instrument device, and driving the monitoring van over the dome. It is not planned for the crane to be positioned over the dome. The van, which will operate over the dome, weighs < 3.6 tonnes (4 tons), thus is well within safety limits. If the 27 tonne (30 ton) crane accidentally drove over the dome, and the van was on the dome at the same time, safety limits would still not be exceeded.

5.6 Criticality from Dropping Neutron Source Into Waste

The neutron source used in the SMMS is a 0.16 microgram Cf^{252} sealed source. The neutron flux through the wall of the source is approximately 3.5×10^7 n/sec, with an average energy of 2.2 MEV/n. These neutrons are subsequently moderated by the water in the waste.

Criticality Safety Analyses have shown that the waste tanks are over-moderated [Doto 1989]. The plutonium in the waste is so well diluted that the addition of the source will have negligible impact on the margin of safety of the system. The minimum critical plutonium concentration in an infinite solid waste matrix is 2.6 g/L. Analytical results from characterization data show fissile material concentrations are significantly less than 1 g/L. Per WHC-CM-4-29, section 2, item 5.2.1.3, less than 2 grams of a material with an atomic number greater than 95 ($\text{Cf} = 98$) is an exempt quantity and not subject to criticality controls. The source of 1.6×10^{-7} grams of californium is much less than an exempt quantity, thus its addition to the waste is not a criticality concern for tank farms.

5.7 Natural Phenomena Related Accidents

Natural phenomena related accidents would be those caused by such events as lightning, tornadoes, and earthquakes.

5.7.1 Lightning

Lightning could strike the top of the SMMS instrument device during installation or removal and discharge off the bottom, igniting flammable gas in the vapor space, or striking and igniting a dry waste surface.

The Hanford Site has an average of 10 days per year during which thunderstorms occur. The probability of a direct lightning strike on a tank is about once each 2,000 years (5E-4) [Cowley 1994].

During tank farm activities, adverse weather conditions are observed, and work on waste tanks is not conducted unless the Pacific Northwest Laboratory weather group states that lightning is not present within 81 km (50 miles) of the Hanford Site [Farley 1994]. The likelihood of not tracking the weather and heeding a weather warning (human error) is 1E-2. It is assumed that SMMS instrument device installation, operation, and removal would take about 40 hours each, and ten tanks would be surveyed each year. Since there are 8760 hours in a year, the annual likelihood of a lightning strike on a device during installation or removal would be $5E-4 * 1E-2 * 40/8760 * 10 = 2.3E-7/\text{yr}$ (incredible).

5.7.2 Tornadoes

The likelihood of a tornado on the Hanford site is 1E-5/yr/facility [DOE 1994]. There could be rupturing of the ventilation ducts and HEPA filter housings from such an event, release of radioactivity, and radiation exposure to workers, or injury from flying debris. The likelihood of workers failing to observe a tornado approaching and take cover is 1E-2. It is estimated that workers would be doing SMMS surveys for about 40 hours in each tank and ten tanks per year would be surveyed. Since there are 8760 hours in the year, the annual likelihood of a tornado caused accident would be $1E-5 * 1E-2 * 40/8760 * 10 = 4.6E-9/\text{yr}$ (incredible).

5.7.3 Earthquakes

The likelihood of a 0.25 g seismic event, one that could do significant damage in the tank farms, is 1E-4 per year [Tallman 1989]. There could be rupturing of the ventilation ducts and HEPA filter housings from such an event, release of radioactivity, and radiation exposure to duct inspection workers. It will be assumed that workers have pre-tremor warning of the earthquake. The likelihood that workers would continue to work on a tank with pre-tremor warning is 1E-2. It is estimated that workers would be doing SMMS surveys for about 40 hours in each tank and ten tanks per year would be surveyed. Since there are 8760 hours in the year, the annual likelihood of an earthquake caused accident would be $1E-4 * 1E-2 * 40/8760 * 10 = 4.6E-8/\text{yr}$ (incredible).

5.8 Industrial Accidents

Industrial accidents are controlled by adhering to the requirements in the tank farm Health and Safety Plan (HASP) [Hewitt 1995].

6.0 CONSEQUENCES

No consequences were calculated, as all potential accidents that could cause significant damage to tanks or harm to personnel were judged to be incredible.

7.0 CONTROLS

Controls are split between general controls that cover all tanks and specific controls that cover the different categories of watch list tanks.

7.1 General Controls

Radiation:

During SMMS installation and removal, or whenever a riser is open, a Health Physics Technician (HPT) shall be present to enforce ALARA principles, as specified in Hanford Site Radiation Control Manual [HSRCM-1 1994].

Toxic Gases and Hazardous Materials:

During SMMS installation and removal, and whenever a riser is open, a technician from Industrial Health, Safety, and Fire Protection (IHSFP) shall be present to implement safety controls concerning toxic gases and hazardous materials, as specified in the Tank Farm Health and Safety Plan (HASP), (WHC-SD-WM-HSP-002) [Hewitt 1995].

Dome Loading:

Before the SMMS support vehicle is positioned over the tank dome, it shall be ensured that the applicable OSRs for dome loading (both distributed and point loads) are satisfied for the tank on which the activity is occurring. This analysis will need to take into account all loads placed on the tank since the tank was certified to be in compliance with the OSRs. This includes new equipment, new concrete pads, new soil cover, etc., along with equipment needed to perform the activity such as cranes and trucks.

Crane Lifts:

- The crane and rigging that are used in SMMS instrument device installation and removal shall be load tested with loads that equal or exceed the weight of the heaviest assembly. The actual lift shall be treated as a critical lift.

Routine Maintenance and Surveillance

All tools and equipment used around the open riser that are small enough to fall through the riser shall be equipped with lanyards.

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Identification of Watch List Tanks:

Appendix A in OSD-T-151-00030 identifies individual watch list tanks; and Appendix B tanks that are being considered for the watch list, and until proven otherwise, should be treated like watch list tanks.

7.2 Specific Controls for Flammable Gas Tanks

7.2.1 OSD-T-151-00030

OSD-30 [WHC 1996], Section 30.2.A.4, In-tank Inspection in Flammable Gas Tanks, is applicable to SMMS activities; and specifies that equipment design must follow the safety related criteria for TV cameras and light assemblies.

- Lighting to be UL listed for use in Class 1, Division 1, Group B; a flammable hydrogen atmosphere.
- All other electrical components located inside the tank that are not Class 1, Division 1, Group B will be purged and pressurized with instrument air or inert gas in accordance with the National Fire Protection Association, Inc. (NFPA), Article 496, Type X purging, to conform with the requirements of the National Electric Code (NEC), Article 501 for use in the flammable hydrogen atmosphere.
- Purge gas system to have redundant safety instruments to alarm and automatically shut off electrical power to the electrical components served by the purge gas system due to loss of gas pressure, if required by the safety classification of the equipment or the NFPA classification for the location where the equipment is installed, whichever is more stringent.
- In tank 101-SY radiation shielding of the replacement plug to be equal to original 42-in. shield plug.
- In-Tank inspection with a still camera requires approval by WTO & WTPE.

7.2.2 WHC-SD-WM-SARR-004 (most controls are also in OSD-T-151-00030)

WHC was directed by DOE-RL [Bader 1996] to include SARR-004 in ISB-001 [Leach and Stahl 1995] as authorization basis. SARR-004 [Schlosser 1996] was therefore updated and submitted to DOE-RL by WHC letter 9650576 [Bacon 1996] for approval. SARR-004 will not be authorization basis until approved by DOE-RL and referenced in the ISB. However, it is presently considered to be a qualified safety basis document.

Ventilation Controls for Flammable Gas tanks

The flammable gas SSTs intended to be on active ventilation are those in the SX tank farm. However, there is no requirement that the active ventilation system on flammable gas SSTs be functional. Therefore, this section will treat all flammable gas SSTs as being passively ventilated.

The tank ventilation system shall be operating before and during SMMS installations and removal (i.e., the breather filter must be functional). Exceptions to these requirements may occur occasionally for short periods while maintenance activities to the HEPA filters are being conducted. An example of the term "occasionally for short periods of time" is 8 hours, once a month (31 days).

On breaking tank containment in a particular riser for the first time, a 5-minute pause shall be observed. This allows any accumulated gases to be swept out of the riser.

Grounding/Bonding Prior to SMMS Activities in Flammable Gas and Organic Tanks

The riser flange cover shall be removed in such a way as to prevent possible ignition of flammable gas inside the riser because of static charges or mechanical sparks.

To prevent electrostatic sparks, the riser cover shall be electrically bonded to the tank in accordance with the appropriate NFPA Code requirements for the classified regions of the tank vapor space and ventilation system [NFPA 1993].

To prevent mechanical sparks, only spark-resistant tools shall be used, except for the initial loosening (one full turn) and the final tightening (final torquing) of the bolts.

All equipment inserted into the tank vapor space shall be electrically grounded and bonded in accordance with the appropriate NFPA requirements for the classified regions of the tank vapor space.

Hydrogen Concentration Control in Flammable gas tanks

Note: Because no specific time of intrusion control (similar to the "window" for 101-SY) is imposed, it is important to provide real-time measurements of the hydrogen concentration while activities are being performed. Until the standard hydrogen monitoring system (SHMS) is installed on each tank, this control can be satisfied by monitoring the tank using a hand-held CGM. The CGM would be positioned so that the sample is drawn from approximately the same location as the SHMS would draw its sample, i.e., near the waste surface.

If the SHMS and gas probe assembly are not installed or are not functioning, the flammable gas concentrations shall be taken with a CGM at three locations before starting the in-tank activity.

1. At the HEPA filter before any riser cover is removed.
2. After the riser bolts sealing the riser flange are loosened enough to take a gas reading from the riser, a reading shall be taken at the riser opening.
3. After complete riser cover removal, a reading shall be taken from the tank vapor space and every 15 minutes thereafter during the intrusive activity.

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(Continued)

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At each of these locations, the following instructions shall be followed. If the CGM reading is $\leq 25\%$ of the LFL, the SMMS installation may proceed. If the CGM reading exceeds 25% of the LFL, a flow-through bulb sample shall be taken for specific gas species analysis in the laboratory, the activity shall cease, and the tank shall be placed in safe shutdown mode. The activity shall not resume until results of the flow-through bulb sample are known, and the appropriate Safety and Tank Farm Project Management approvals are received. Note: This control only applies to installation and removal. If a system is installed, and meets requirements for Class-1, Division-1, Group-B, operations are permitted over 25% LFL.

If the SHMS is operating, continuous monitoring system shall be accomplished by viewing the strip chart recorder. Activities in the tank shall cease when flammable gas concentration exceed 25% of the LFL.

Time of Intrusion

SMMS installation work shall be done after a review group has looked at recent tank behavior and decided that the tank is behaving in a manner consistent with its historical norm.

This review group will have members from Waste Tank Safety Assurance, Operations (200 East or 200 West Area, as appropriate), Waste Tank Process Engineering (200 East or 200 West Area, as appropriate), Waste Tank Process Control, Tank Waste Remediation System Safety Analysis and Engineering, Waste Tank Plant Engineering (200 East or 200 West Area, as appropriate), and Flammable Gas Tank Safety Program Office.

If conditions exist outside of the normal behavior of the tank, a formal presentation will be made to the Plant Review Committee.

During SMMS activities, tank conditions shall be monitored for the entire time that the activity is being performed. This monitoring will include the tank waste level and the hydrogen concentration in the tank. The operator shall look for indications that a gas release might occur, e.g., a sudden decrease in waste surface level and/or an increase in the hydrogen concentration. If any measurements indicate that a gas release is imminent, the tank shall be placed in safe shutdown mode and the tank farm shall be evacuated.

7.3 Organic Tanks

No special controls are required for organic tanks (except C-103), as the SMMS activities will not affect fuel content of the waste, waste moisture, or waste temperature.

Specific Controls for Organic Tank 103-C (from WHC-SD-WM-SARR-001)

Ignition Sources:

Fire, flaming objects, or hot materials $> 120^\circ\text{C}$ (248°F) shall not be permitted in the vicinity of an open riser. The objective of this control is to preclude the introduction of ignition sources at the pool-air interface.

The prohibited materials do not include small filaments included in lighting or electronic equipment because such filaments are both small and enclosed within solid boundaries.

Electronic equipment used in tank C-103 e.g., flood lights and cameras, shall be suspended by electrical supply cords whose length is too small to permit the equipment or its supply cord from approaching within 1.52 m (5 ft) of the pool surface.

Porous materials which could serve as wicks at the organic-air interface shall be prevented from entering the tank, since a wick-stabilized flame is easier to ignite than a fire on an open pool [Postma 1994b].

Vehicles operating at grade level over tank C-103 must employ fuels (e.g., propane) or fuel tank protection (e.g., skid plate, tank location) that greatly reduces the chance for an accident in which ignitable liquid fuel could enter tank C-103.

7.4 Ferrocyanide Tanks

No special controls are required for ferrocyanide tanks, as the SMMS activities will not affect fuel content of the waste, waste moisture, or waste temperature.

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(Continued)

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9.0 USQ SAFETY REVIEW QUESTIONS:

- A. Does the PROPOSED CHANGE represent a change to the facility as described in the AUTHORIZATION BASIS documentation?

☐ N/A ☒ No ☐ Yes/Maybe

Basis: The authorization basis is identified in Section 4.0 of this report. This temporary installation does not constitute a change, according to guidelines in DOE 5480.21 [DOE 1991], since:

- a. It does not add, delete, or convert an automatic or manual feature of the system, structure, or components important to safety.
- b. It does not introduce new system interactions.
- c. It does not change the seismic qualifications of the tank, environmental qualifications, or quality classifications of the system, structure, or components important to safety.

- B. Does the PROPOSED CHANGE represent a change to procedures as described in the AUTHORIZATION BASIS?

☐ N/A ☒ No ☐ Yes/Maybe

Basis: There are presently no procedures for in-situ monitoring of moisture in the surface solids in the single-shell waste tanks.

- C. Does the test or experiment represent a test or experiment not described in the AUTHORIZATION BASIS documentation?

☐ N/A ☐ No ☒ Yes/Maybe

Basis: This is a new configuration for neutron activation moisture monitoring of tank waste to determine if the waste meet conditionally-safe safety criteria. DOE 5480.21 [DOE 1991] states that one-of-a-kind tests used to measure the effectiveness of new techniques or a new system configuration that might affect systems important to safety will require a safety evaluation before they can be conducted.

UNREVIEWED SAFETY QUESTION SAFETY REVIEW FORM

(Continued)

D. Does the change, test or experiment impact:

- Implemented OSRs or IOSRs? ☐ N/A ☒ No ☐ Yes/Maybe
- Approved IOSR Compliance Implementation Plans? ☐ N/A ☒ No
☐ Yes/Maybe

Basis: Except for the general restriction against drying out the waste in Conditionally Safe Ferrocyanide tanks in WHC-EP-0691, there are presently no Authorization Basis requirements that identify safe moisture levels in the SST waste, or requirements for keeping waste moisture at specified levels, as these are still being developed. Operation of the SMMS to monitor moisture levels is within the bounds of the current OSRs and IOSRs, and will thus have no impact on any of them, nor will it impact any CIP.

Based on the above, a Safety Evaluation
need to be performed for this change

☒ DOES ☐ DOES NOT

USQE No. 1

W. G. Farley

Print Name

USQE No. 2

J. S. Schofield

Print Name

Signature

Wayne H. Farley

Date

4/25/96

Signature

John Schofield

Date

4/25/96

UNREVIEWED SAFETY QUESTION SAFETY REVIEW FORM

(Continued)

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Figure 1 - SMMS Schematic Diagram

Figure 2 - Deployment Arm and Neutron Probe

UNREVIEWED SAFETY QUESTION SAFETY REVIEW FORM

(Continued)

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Figure 3 - Electronic Block Diagram

FIG 3- SHLIS ELECTRONIC BLOCK DIAGRAM SHOWING DATA ACQUISITION SYSTEM

UNREVIEWED SAFETY QUESTION EVALUATION FORM

(Per WHC-IP-0842)

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USQ Tracking Number: TF-95-0089

AREA: ☒ East ☒ West

Facility: ☐ 242-A ☒ DST ☒ SST ☐ LERF
☐ Aging Waste ☐ Other

EQUIPMENT DESCRIPTION: See section 2.0

REFERENCE DOCUMENT(S):

ECN No.

PCA No.

Work Pkg No.

Other (Specify) See section 8.0

TITLE: SURFACE MOISTURE MONITORING OF HANFORD TANK WASTE BY NEUTRON ACTIVATION

1. Does the PROPOSED CHANGE, test, experiment or DISCOVERY increase the probability of occurrence of an accident previously evaluated in the AUTHORIZATION BASIS documentation?

☒ No ☐ Yes

Basis: The authorization basis is outlined in Section 4.0 of this report. Accidents are not discussed in the first tier of the authorization basis (ISB-001) [Leach and Stahl 1995] or the second tiers of the authorization bases, OSR-004 for AWTs [Aguirre 1996], OSR-005 for SSTs [Dougherty 1996], OSR-016 for DSTs [Heubach 1996]. Accident probabilities are discussed in third tier authorization basis documents SAR-006 [WHC 1989a, SAR-034 [WHC 1989b], and SAD-009 [Farley/Grigsby 1994]. Those related to SMMS installation and operation are as follows:

SAR-006 lists the only credible accidents as loss of seal loop fluid and breach of HEPA filter or ventilation ductwork due to natural phenomenon.

SAR-034 lists the likelihood of dome failure from heavy equipment and earthquakes, crane load drops, hydrogen accumulation and ignition, leaks of liquid waste to soil, and occupational personal exposure, and industrial accidents.

SAD-009 lists the likelihood of workers being exposed to contaminated equipment during equipment removal, and exposure to toxic gases. This document was signed by DOE but is not currently included as part of the Authorization Basis.

The SMMS test will not increase the probability of accidents analyzed in the above safety documents.

2. Does the PROPOSED CHANGE, test, experiment or DISCOVERY increase the consequences of an accident previously evaluated in the AUTHORIZATION BASIS documentation?

☒ No ☐ Yes

Basis: Consequences could be increased by structural changes to waste containment or vapor confinement, changes to the waste source term, increase worker exposure time to radiation or toxic gases, or adverse changes in industrial work procedures. All significant accidents involved with SMMS installation and operation were deemed to be incredible in Section 5.0 of this report, therefore, consequences were not calculated. However, since SMMS installation and operation will not significantly affect any of the above safety parameters, there is no increase in consequences previously evaluated.

UNREVIEWED SAFETY QUESTION EVALUATION FORM

(Continued)

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Does the PROPOSED CHANGE, test, experiment or DISCOVERY increase the probability of occurrence of a malfunction of EQUIPMENT previously evaluated in the AUTHORIZATION BASIS documentation?

☒ No ☐ Yes

Basis: Equipment important to safety are tank structure, the ventilation system, flammable gas monitoring system, waste level monitoring system, and temperature monitoring systems, and pressure monitoring systems. Since SMMS activities will not affect any of the above, they will not increase the probability of malfunction of this equipment.

4. Does the PROPOSED CHANGE, test, experiment or DISCOVERY increase the consequences of a malfunction of ITS EQUIPMENT previously evaluated in the AUTHORIZATION BASIS documentation?

☒ No ☐ Yes

Basis: Since the equipment important to safety (ITS) will not be effected, consequences of accidents associated with this equipment will not be effected.

5. Does the PROPOSED CHANGE, test, experiment or DISCOVERY create the possibility of an accident of a different type than any previously evaluated in the AUTHORIZATION BASIS documentation?

☒ No ☐ Yes

Basis: Type accidents previously analyzed were loss of tank containment or confinement from dropped equipment, flammable gas ignition, breach of dome or ventilation system, criticality, radiation and toxic gas exposure, and industrial accidents. No new type of accident is anticipated from SMMS activities.

6. Does the PROPOSED CHANGE, test, experiment or DISCOVERY create the possibility of a malfunction of EQUIPMENT of a different type than any previously evaluated in the AUTHORIZATION BASIS documentation?

☒ No ☐ Yes

Basis: Since the SMMS will not affect equipment important to safety, it is not expected to increase the possibility of malfunction of the equipment.

UNREVIEWED SAFETY QUESTION EVALUATION FORM

(Continued)

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Does the PROPOSED CHANGE, test, experiment or DISCOVERY reduce the margin of safety as defined in the basis for any Technical Specification/Operational Safety Requirement?

☒ No ☐ Yes

Basis: Margins of safety are stipulated in the IOSRs [Aguirre 1996, Dougherty 1996, Heubach 1996] OSR-005 for maximum waste level, maximum waste temperature, vapor space pressure, vapor space flammability, and moisture content of ferrocyanide waste. Since SMMS activities will not affect any of the above, it can not affect the margins of safety.

8. Does the PROPOSED CHANGE, test, experiment or DISCOVERY require a new or revised OSR, IOSR or a compensatory measure required by a Compliance Implementation Plan?

☒ No ☐ Yes

Basis: OSR-005 adequately covers all safety issues, thus no changes are required. IOSR compliance plan WHC-IP-0954, Rev. 4 [Twiselton 1995], was reviewed to determine if compensatory (remediation) measures were required to cover SMMS activities, and it was judged that none were needed.

USQE No. 1 W. G. Farley

Print Name

USQE No. 2 J. S. Schofield

Print Name

Signature Wayne H. Farley

Date 4/25/96

Signature J. S. Schofield

Date 4/25/96

PRC REVIEW (If Required)

Meeting No.: _____

Date _____

PRC Chairman

Concurrence:

Signature _____

Date _____

**Westinghouse
Hanford Company**

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211-11
SMMS96-096
**Internal
Memo**

From: TWRS SAR Engineering
Phone: 376-9192
Date: June 17, 1996
Subject: Transmittal of USQ Review TF-96-0364,
SURFACE MOISTURE MONITORING OF WASTE IN TANK 241-BY-110

8M100-WGF-96041

To: L. J. Coates R1-62

cc: G. T. Dukelow S7-14
C. A. Esvelt S7-12
C. E. Hanson H5-09
R. D. House R1-05
M. Huda S7-07
M. N. Islam R3-08
J. L. Schofield S7-12
G. F. Vargo H5-09
J. Weber S1-57
WGF File/LB

Following the guidelines in MRP 5.12 and WHC-IP-0842, a USQ Review was performed for analysis of hazards associated with installation, operation, and removal of the Surface Moisture Monitoring System (SMMS) in Ferrocyanide Watch List Tank 241-BY-110. The review determined that potential hazards are within acceptable risk guidelines in WHC-CM-4-46.

If you have any questions, feel free to call me at 376-9192.

Wayne H. Farley
W. G. Farley
Senior Engineer

wgf

Attachment

8M100-WGF-96041

ATTACHMENT

Unreviewed Safety Question Review Form
Surface Moisture Monitoring
of Waste in Tank 241-BY-110

Consisting of 26 pages

UNREVIEWED SAFETY QUESTION SAFETY REVIEW

(Per WHC-IP-0842, 15.9)

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USQ TRACKING NUMBER TF-96-0364, Rev. 0

REFERENCE DOCUMENT(S):

ECN No.

PCA No.

Work Pkg No.

Other (Specify)

WHC-SD-WM-DRD-002 [Stokes 1995]

USQE TF-95-0089, Rev. 1 [Farley 1996]

WHC-EP-0691 [Postma 1994]

TITLE: SURFACE MOISTURE MONITORING OF WASTE IN TANK 241-BY-110

1.0 INTRODUCTION:

The responses to the Unreviewed Safety Question Review (USQR) forms is against the *Design Requirements Document (DRD) for Surface Moisture Measurement System (SMMS)* [Stokes 1995], the USQ Evaluation *Surface Moisture Monitoring of Hanford Tank Waste By Neutron Activation* [Farley 1996], and qualification document *NEC Hazardous Classification and Compliance Regarding the Surface Moisture Measurement System* [Busse] and Stokes 1996].

This report covers potential hazards associated with installing, operating, and removing the SMMS in single-shell Ferrocyanide Watch List Tank 241-BY-110, and appropriate safety controls to keep risk within WHC-CM-4-46 guidelines.

BY-110 is a 2,872,820 L (758,000 gal) tank holding 208 kgal of saltcake and 190 kgal of sludge, with no supernate or pumpable liquid remaining [Brevick 1995]. Tank characterization data from WHC-SD-WM-DP-153 [Schreiber 1996] indicates that the waste is fairly dry, with over half of the tank rotary mode core segments containing less than 17 wt% water. However, the energetics found are not significant enough to cause a propagating reaction in the waste, and the tank is classified as "safe" [Schreiber 1996].

The SMMS probe uses the same principle as the neutron probes used in SST liquid observation wells (LOWs) over the past 12 years to determine liquid levels and relative moisture content in the waste immediately around the LOWs.

An unreviewed safety question evaluation (USQE) for neutron activation logging in ferrocyanide and organic tank LOWs was previously performed in USQE TF-95-0007 [Farley 1995], and for surface neutron activation monitoring of all tanks in USQE TF-95-0089, Rev. 1, [Farley 1996]. TF-95-0089, Rev. 1, is presently being revised to meet new safety criteria in JCOs covering flammable gas and organic-nitrate tanks, but is still applicable to non-flammable-gas and non-organic tanks (e.g., BY-110).

2.0 EQUIPMENT DESCRIPTION

2.1 SMMS

The SMMS (Figure 1) consists of a monitoring van, deployment device, and a neutron probe installed on the deployment device. The van contains electronic systems, operator console, a self contained battery supply power system, and storage for the neutron source (when not installed in the probe housing). Also attached to the front of the van is a LOW logging system, which will not be used at the same time as the SMMS.

The deployment device (Figure 2) consists of an upper stainless steel (SS) containment box for manual control winches, and an 8.9 cm (3.5") O.D. SS column to support in-tank instrumentation. See ECN 624770. The in-tank instrumentation consists of a SS support shaft, rotatable arm, and neutron probe. This surveillance will be conducted with an independent video camera/light in a separate riser. Later, a retractable video camera/light may be installed within the lower portion of the SS column.

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The maximum weight of SMMS related equipment which will be located on a tank at any time will be approximately 20,000 lbs. Allowing for a 56,000 lb crane for installation of some items, the total weight to be considered for dome loading is 86,000 lbs.

The length of the column and/or arm can be adjusted for various waste levels by adding additional sections. The maximum length will be about 15 m (50 ft), and maximum weight about 363 kg (800 lbs). A winch containment box sits on top of the column. Lifting provisions are incorporated under the box.

The containment box contains manually operated winches to control arm angularity from vertical, and probe elevation. Angularity will be determined by an electronic inclinometer. The signal-power winch will use a reverse wound drums to connect the van system to the neutron probe, thus there will be no spark sources (e.g., slip rings) in the winch containment box.

For each test, the deployment device is used to guide deployment of the neutron probe to about 40 points on the waste surface within 0.9 m (3 ft) of the column axis projected to the waste surface. Visual observations from the video will be used to determine when the probe contacts the waste surface.

The probe (Figure 2) contains three Boron-10 (B10) tube neutron detectors, a 16 microgram Californium-252 neutron source, two thermistors, voltage converters, and electronic amplifiers. The probe is sealed to prevent moisture from contacting the electronics. The probe weighs 14 kg (30 lbs).

Converters in the probe convert low voltage (24 vdc) input from the logging cable to high voltage (800 to 1500 vdc) needed to operate the neutron detectors. The probe amplifiers operate on 12 volts dc.

The SMMS is designed and qualified to meet National Fire Protection Association (NFPA) code requirements (explosion proof and/or purged) for Class-1, Division-1, Group-B environments per WHC-SD-WM-DA-202 [Bussell and Stokes 1996]. Presently only Flammable-gas and Organic Watch List Tanks require the above classification for vapor space equipment. See OSD-T-151-00030, Sections 30.2.A.4 and 30.2.C.4) [WHC 1996b].

Engineering Change Notices (ECNs)

These ECNs represent minor changes to the system, and are included in this report to avoid the complications of completely redoing the original drawings.

ECN 624768, June 7, 1996 This ECN corrects drawing H-14-100460, sheets 1-4, 7-9, and 11 to as-built conditions and adds a redesigned elbow joint with much greater strength. These changes improve safety, but do not significantly affect the hazard assessment and safety evaluation in Section 5.0 of this report.

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ECN 624769, June 3, 1996 This ECN corrects drawing H-14-100461, sheets 1-9, to as-built conditions. Primary modifications were to remove the Camera Winch and all its related items, replace the Arm Winch with a new winch similar to the Probe Winch, add a Clutch/Break Assembly to the Arm Winch, and add instrumentation panel meters. None of these changes significantly affect the hazard assessment and safety evaluation in Section 5.0 of this report.

ECN 624770, May 31, 1996 This ECN corrects drawing H-14-100459, sheets 1-4 and 6 to as-built conditions; and adds an Anti-Rotation Clamp, changes the Arm Lifting Cable, adds holes to the Bearing Housing Flange for interfacing with the Shipping/Storage Container, and adds a spring loaded clamp for the Inclinator Cable. None of these changes significantly affect the hazard assessment and safety evaluation in Section 5.0 of this report.

ECN 624771, June 3, 1996 This ECN incorporates design improvements to components shown on drawing H-14-100458, sheets 1-4, as suggested by Operations, and aids deployment of the SMMS in the field. None of these changes significantly affect the hazard assessment and safety evaluation in Section 5.0 of this report.

ECN 624772, June 7, 1996 This ECN incorporates design improvements to components shown on drawing H-14-100553, sheets 1-3, as suggested by Operations or discovered during acceptance testing, and aids deployment of the SMMS in the field. These changes improve safety, but do not significantly affect the hazard assessment and safety evaluation in Section 5.0 of this report.

ECN 624773, June 7, 1996 This ECN incorporates changes to components shown on drawing H-14-100463, sheets 1 & 3 to correct assembly call outs and incorporate loops and straps to secure the Impact Limiter during field installation. These changes improve safety, but do not significantly affect the hazard assessment and safety evaluation in Section 5.0 of this report.

ECN 624774, June 7, 1996 This ECN incorporates design improvements to components shown on drawings H-14-100557, sheet 1, and H-14-100558, sheet 1, to add holes in the calibration fixtures in order to relieve vacuum in the fixtures when the Neutron Source is removed. These changes do not significantly affect safety, nor the hazard assessment and safety evaluation in Section 5.0 of this report.

ECN 624775, June 7, 1996 This ECN incorporates design improvements to components shown on drawing H-14-100554, sheet 2, to adjust Insert lengths to allow the Adapter Seal Assembly to seat on the Insert when installed. These changes do not significantly affect safety, nor the hazard assessment and safety evaluation in Section 5.0 of this report.

ECN 624776, June 10, 1996 This ECN incorporates a change to a component shown on drawing H-14-100461, sheet 1, to correct material call out in order to reflect as-built conditions. The change does not affect safety, nor the hazard and safety evaluation in section 5.0 of this report.

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ECN 628800, June 14, 1996 This ECN incorporates changes to 21 drawings listed in the ECN to correct the drawings to as-built conditions. Units affected include: 1. Intercom Communication System, 2. Remote Digital Display System, 3. Probe Master Power Switch, 4. Light Duty Utility Arm (LUDA) Surface Moisture Probe End Effector 24 VDC Power Sense Wiring, and 6.0 EMI Probe Support Wiring. These changes do not significantly affect safety, nor the hazard assessment and safety evaluation in Section 5.0 of this report.

ECN 628801, June 14, 1996 This ECN incorporates changes to drawings H-14-100469, sheet 1 & 2, and H-14-100483, sheet 1 through 7 to improve operability of the system. These changes do not significantly affect safety, nor the hazard assessment and safety evaluation in Section 5.0 of this report.

ECN 628805, June 5, 1996 This ECN incorporates changes to drawings H-14-100469, sheet 1, and H-14-100479, sheet 1 & 2, to improve operability of the system. These changes do not significantly affect safety, nor the hazard assessment and safety evaluation in Section 5.0 of this report.

The change on H-14-100469 involves removing the outer armor layer of the support/signal cable to improve signal conditioning. The original well logging cable was selected in the design phase when an integral camera was planned for the mast of the SMMS. This is no longer applicable. This change will not significantly affect the safety of the cable, as the armored cable was originally selected for its abrasion resistance and long flexural life, not for its strength. Removal of the outer layer of armor improves the flexibility of the cable, thus abrasion is not as likely. The National Electric Code (NFPA 70) permits this new type of cable in classified locations, when the cable is part of an intrinsically safe circuit.

ECN 630666, May 22, 1996 This ECN incorporates changes to WHC-SD-WM-ATP-158, Rev. 0, [Gimera 1996] to improve software operability of the SMMS. These changes do not significantly affect safety, nor the hazard assessment and safety evaluation in Section 5.0 of this report.

ECN 630672, June 11, 1996 This ECN involves a complete rewrite of the SMMS operation and maintenance manual WHC-SD-WM-OMM-024 [Vargo 1996] to include additions as recommended by field operations. The OMM addresses deployment, equipment and field hazards, operating instructions, calibration verification, removal, maintenance, and other pertinent information to safely operate and store the SMMS neutron source. This document has been reviewed and the changes will not significantly affect safety, nor the hazard assessment and safety evaluation in Section 5.0 of this report.

ECN 158625, June 12, 1996 This ECN (WHC-SD-WM-DA-202) [Bussell and Stokes 1996] covers NEC hazard classification and compliance for the SMMS. All safety issues are covered in Section 5.0 of this report.

ECN 158645, June 11, 1996 This ECN (WHC-SD-WM-ATR-158) Gimera 1996] covers the software acceptance test report for the SMMS. All safety issues are covered in Section 5.0 of this report.

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2.2 Impact Limiter

The deployment device has the potential to cause serious riser damage in the event of a drop accident. Therefore, an impact limiting system will be utilized. The riser must withstand a 30,000 lb relatively steady load while the limiting system foam is crushing, or an I-beam system will be incorporated to transfer the load into the soil, rather than into the riser itself. Tank specific structural analyses will be performed for each riser to be used, and this will guide field installation details and procedural controls.

2.3 Video camera

Since BY-110 is not a flammable-gas or organic-nitrate Watch List Tank, SMMS operations may use either a classified or non-classified video camera.

2.4 Riser Inspection Characterization

The objective of riser characterization is to obtain reliable data for SMMS deployment, and quantify and document specific risers for other equipment deployment activities. All of the riser tools described will be capable of surveying 10.16 to 30.48 cm (4 to 12") I.D. risers.

Up to five data sets may be gathered. Riser length measurements will be normally required, as will distance to the waste surface. These activities will be accomplished by conventional mechanical length tools and zip cords. Newly developed tools will be employed for other riser characterizations.

Before SMMS deployment, waste inspection may be required with a remotely operated video camera to determine waste surface conditions (e.g., smoothness, roughness, liquid pools).

For riser inspection, a Riser Inspection Device (RID) [Schofield 1995] will be used to gather qualitative visual data. RID is a standard video inspection system, manufactured by Crestone Products Inc., that mounts on top of a riser flange to inspect the tank riser and waste directly below the riser. The system includes a high resolution (S-video) color TV camera equipped with a 8:1 zoom lens, and a high intensity pre-focused quartz halogen light source. The camera housing is fabricated of 300 series stainless steel.

The RID camera and light is isolated from the tank vapor space by a clear glass or plastic window mounted on the riser to qualify the system for all tanks (e.g., flammable gas, organic, ferrocyanide, non-watchlist). If the visual data is adequate to show no significant obstacle to insertion of the SMMS arm, no further investigation will be attempted. Should the RID system data be either inconclusive, or show information that suggests obstruction, then a decision will be made to either move to another riser location, or to deploy the newly developed riser laser profiling system (LPS).

The LPS is deployed through the full length of the riser and gathers quantitative data on riser ovality, protrusions, and plumb. A plug gage may be a suitable alternative to the LPS, if appropriate.

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3.0 OPERATIONS

A suitable riser is selected for the SMMS survey either immediately before the survey or several days or weeks before the survey. The riser cover will be removed in a manner which minimizes the potential static and/or mechanical sparks. Electrically bonding/grounding of the riser and equipment, and checking of the tank vapor space flammability will be performed per requirements in OSD-T-151-00013 [WHC 1996a] and OSD-T-151-00030 [WHC 1996b].

Exposure to toxic gases will be controlled by following requirements in the tank farm Health and Safety Plan (HASP) [Hewitt 1995].

Before SMMS equipment insertion into the tank, the riser will be checked for obstructions using a non-sparking riser gauge plug [Farley 1994], or a RID video system [Schofield 1995].

If the riser is suitable for the SMMS, the riser length will be gauged using a pole with a bottom detecting foot, and the distance to the waste surface measured with a zip cord.

Also before SMMS equipment insertion, a plastic sleeve may be positioned in the riser to lessen radioactive contamination of the SMMS, the decontamination unit mounted on the riser, and the impact limiter positioned over the riser. The impact limiter will prevent damage to the riser or tank bottom, if the SMMS is accidentally dropped.

Where 30 cm (12") diameter risers are used, an adapter plate will be added for two 10.16 cm (4") openings, one for the video camera and one for the SMMS. The video must be installed first as the SMMS winch container box will extent over both openings. The video will be installed per requirements in OSD-T-151-00013 and OSD-T-151-00030.

The SMMS in-tank device will be lifted off a flat bed truck with a crane. The device is then lowered into the tank until the device is firmly seated on the decontamination system. After the device is securely bolted down and electrically connected, the arm will be cranked to a horizontal or some other non-vertical position as specified for radial spacing requirements. The camera and probe are then lowered into the tank to about one meter (3 ft) above the waste surface. The camera is then directed to watch the probe.

The SMMS 1.8 meter (6 ft) arm is then raised from the vertical entry position to horizontal, or some other angle, to position the probe from zero to 1.8 meters (6 ft) from the shaft axis.

The probe is then lowered on its support cable to gently place the probe bottom on the waste surface. It is undesirable to lower the probe into the waste, as the moisture detection calibration would be incorrect. This will be prevented by close video surveillance of the probe as it is being lowered.

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After the probe is positioned, the power will then be turned on in the probe. Reflected neutrons passing through the neutron detectors will induce electrical pulses in the detectors, which will be transmitted to the van and counted. The probe will be repositioned in several radial directions and distances to obtain approximately 40 samples for statistical analysis of surface moisture.

After completion of sampling, the probe will be mostly retracted, the arm lowered to a vertical position, and the probe retracted the remaining distance into a receiving socket. The SMMS in-tank device will then be removed. During removal, the device will be decontaminated using high pressure water, with the water flowing back into the tank. Finally, the video camera will be removed per standard tank farm procedures.

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4.0 AUTHORIZATION BASIS

4.1 Interim Safety Basis (ISB)

The authorization basis for Tank Farm activities is Chapter 6.0 of the interim safety basis (ISB) document WHC-SD-WM-ISB-001 [Leach and Stahl 1995], and documents specifically referenced therein. For intrusive activities in SSTs, the ISB identifies IOSR WHC-SD-WM-OSR-005 [Dougherty 1996]. For SST criticality issues, the ISB identifies administrative control (AC) 5.12 in WHC-SD-WM-OSR-005 [Dougherty 1996]. For Ferrocyanide Watch List Tanks, the ISB identifies WHC-EP-0691 [Postma 1994].

4.2 Interim Operational Safety Requirements (OSRs)

WHC-SD-WM-OSR-005, AC 5.15 WATCH LIST TANKS, states that a program shall be established to include criteria for placing a tank on or removing a tank from the WATCH LIST, and for special sampling and monitoring requirements and frequencies.

The SMMS is considered one of the special monitoring techniques for helping to determine when a tank meets criteria for addition to or removal from the WATCH LIST, per AC 5.15 a.

The IOSR AC 5.15 also states that an operating specification document (OSD-T-15I-00030) is currently in place to control activities involving WATCH LIST TANKS, as well as numerous safety studies that cover ferrocyanide, organic, vapor flammability issues; and upon approval (assumed to be WHC functional review), the results of these studies shall be incorporated into the established program (assumed to be OSD-T-15I-00030).

OSR-005, Section B 5.0, lists physical parameters that are monitored and/or controlled (e.g., nuclear criticality, corrosion, heat load, hydrostatic load, dome load, tank and transfer line leakage, concrete temperature, flammable gases, and vapor space pressure) to keep the tanks conditionally safe.

Parameters that are or potentially could be adversely affected under accident conditions by SMMS activities in BY-110 are dome load, tank leakage, and vapor space pressure from a ferrocyanide waste burn. Safety analyses referenced in the IOSRs applicable to these parameters are as follows:

Tank Type	Safety Analysis	Activity and/or Concern
Single-Shell:	SD-RE-TI-012 [RHO 1989] SD-WM-SAR-006 [WHC 1989]	Dome loading Tank leakage
Ferrocyanide:	no references	

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5.0 POTENTIAL HAZARDS

5.1 HAZOP

Los Alamos Technical Associates (LATA) has recently performed a Hazards and Operability Study (HAZOP) to classify potential hazards involved with installation, operation, and removal of the SMMS in Hanford waste tanks. A summary of results from that report is incorporated into this revision.

The results of the HAZOP were a number of postulated abnormal events which were ranked with respect to safety consequences. The first cut, qualitative, consensus estimates of the safety severity of the consequences were ranked according to the following alphanumeric system:

- S0 No effect outside the immediate area with no safety concerns for the facility worker, the onsite worker, or members of the general public.
- S1 Potential industrial injury, radiological dose consequences, or chemical exposure to the facility worker
- S2 Potential significant radiological dose consequences or chemical exposure to the onsite worker at the nearest adjacent facility
- S3 Potential significant radiological dose consequences or chemical exposure to the offsite population

Type S1 potential hazards are covered by controls in the Tank Farm Health and Safety Plan (HASP) WHC-SD-WM-HASP-002 [Hewitt 1995] and the Hanford Site Radiological Control Manual [HSRCM-1 1994], thus will not be discussed further in this report.

Type S1 Potential Hazards:

- 1. Heat exhaustion caused by hot weather and failure of the air conditioning in the data collection van.
- 2. Ignition of small fire resulting from off-gassing from the batteries.
- 3. Toxic off-gas from a riser affecting the individual in the van.
- 4. Carbon monoxide hazard (possible in cold weather due to proximity of data collection van and camera van).
- 5. Worker exposure to cold weather if van heater failed.
- 6. Fire caused by fuel spill during field refueling of data collection van.
- 7. Worker electrocution hazard due to improper grounding of van combined with electrical fault.
- 8. Worker radioactive contamination due to previous worker having entered the van with contaminated clothing. (Note that the van will be parked in a surface contamination area.)
- 9. Worker injury due to failure of lifting device (crane).
- 10. Worker injury due to electrical shorting caused by crane boom hitting electrical equipment.
- 11. Worker exposure to toxic gas from open riser.
- 12. Worker exposure due to recovery actions for improper positioning of deployment arm.

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13. Worker exposure to radioactive contamination due to improper contamination control procedures during deployment arm installation.
14. Worker injury from catastrophic failure of decontamination system pump.
15. Worker injury from electrical short caused by spill of process water from the decontamination system.
16. Worker injury caused by high pressure water from the decontamination system.
17. Worker injury caused by difficulties in withdrawing deployment arm mast (specifically interference of lost decontamination system nozzle).
18. Worker contamination caused by inadequate operation of the decontamination system.
19. Worker radiation dose caused by separation of neutron source from probe.

Type S2 and S3 potential hazards are discussed at the end of each HAZOP potential hazard. When available, likelihoods values used in the responses are based on DOE accepted values from previous safety analysis (e.g., 1E-2 for human error, 1E-3 for component failure). When standard likelihood values were not available, likelihood numbers are based on best engineering judgements agreed to between the author and peer reviewer.

Type S2 Potential Hazards:

Type S2 potential hazards from the [LATA 1996] HAZOP are indicated below. Likelihood numbers in the responses were developed for this report.

1. HAZOP: Events which result in a spark in the tank headspace when flammable but not detonatable concentrations of gas are present.

Response: Flammable, but not detonatable gases could result from a slow leak of combustible gases from the waste. Should a spark occur in the vicinity of the gas leak prior to the gas being diluted by air to a nonflammable concentration, a small flame could persist as long as the gas was continuously released in small quantities. The likelihood of this type gas release in the area of the activity has not been previously evaluated. For this report, it is judged to be 1E-1 / 8 hr activity with waste penetrating activities, and 1E-3 / 8 hr activity without waste penetrating activities.

a. HAZOP: Grounding the Van Incorrectly

Response: The likelihood of grounding the van incorrectly is the likelihood of human error (1E-2). If the van is not grounded correctly, and the van is struck by lightning, a spark could penetrate the waste. It is assumed that the likelihood of lightning striking the van is the same as lightning striking the top of the tank, 1E-5 [Cowley 1994]. The combined likelihood is 1E-7.

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- b. HAZOP: Parking the Van With Non-spark-resistant Electrical Equipment Next to an Open Riser During an Episodic Release of Flammable Gases

Response: The draft JCO for flammable gases [Grigsby 1996] indicates that surface areas beyond 36 tank opening diameters, or 457 cm (15'), whichever is closer, is the limit for potential flammable gas around openings in the tank (e.g., riser, filter ports, pump pits, etc). Tank BY-110 will not be surveyed for openings to the atmosphere around the van as the tank is not classified as a flammable gas tank. Since the SMMS survey is non waste intrusive, there is no potential of induced gas releases and ignition of flammable gases from spark sources in the van.

- c. HAZOP: Ignition of Flammable Gases in the Tank Caused by a Fire in the Van Propagating Down a Riser

Response: BY-110 is not a flammable-gas Watch List Tank, thus the likelihood of flammable gases in the vapor space is judged to be 1E-3. Nevertheless, a test for flammable gases will be made as required by OSD-T-151-00013, Section 13.4.1.2. The likelihood that after checking, flammable gas would occur during SMMS activities is judged to be 1E-3.

The combined likelihood of a van fire (1E-3), fire propagation down a riser that is only open during SMMS installation and removal (1E-3), and flammable gas in a non-flammable-gas tank that has been checked for flammable gas (1E-3), is 1E-9.

- d. HAZOP: Propagation of a Fuel Fire During Field Refueling to a Tank Flammable Atmosphere

Response: This likelihood is the same as item c. above, incredible.

- e. HAZOP: Failure of the Tank Electrical Safety Barriers Resulting in Igniting a Flammable Atmosphere

Response: The likelihood of the SMMS electrical barriers within the tank failing is judged to be $3.0E-6/\text{hr}$, based on standard generic values published in WSRC-TR-93-262 [WSRC 1993]. The likelihood for each 8 hr activity is therefore $2.4E-5$. The likelihood of flammable gases in the vapor space from c. above is 1E-3. The combined likelihood is $2.4E-5 * 1E-3 = 2.4E-8$.

- f. HAZOP: Ignition of an Undiscovered Flammable Atmosphere Due to Not Using Flammable Gas Controls;

Response: All tanks are checked for flammable gas. The likelihood of not checking is 1E-2 (standard human error). The likelihood of electrical failure from f. above is $2.4E-5 / 8 \text{ hr activity}$. The combined likelihood is $1E-2 * 2.4E-5 = 2.4E-7$ (incredible).

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- g. HAZOP: Ignition of a Flammable Gas Buildup in the Decontamination System Pump Casing (failure to isolate pump after decontamination) Propagating to the Tank;

Response: The decontamination pump uses uncontaminated raw water from the tank farm, thus there is no potential for buildup of radiolytic hydrogen in the casing.

- h. HAZOP: Ignition of a Flammable Atmosphere Due to Dropping Equipment

Response: The only equipment placed in the tanks is the SMMS instrument tree and the monitoring video camera.

The frequency of dropping heavy loads was calculated in NUREG-0612 [NUREG 1980] to be $2.7E-5$ per lift. Based on that data, the likelihood of dropping a heavy load (e.g., instrument tree) when using critical lift procedures was calculated in WHC-SD-WM-SAD-014 [Farley 1994] to be $2.7E-6$ per critical lift. Since this value is not incredible, impact limiters are employed to decrease the likelihood of sparks from a dropped SMMS and prevent tank bottom penetration.

If a load is dropped without an impact limiter, it is judged that the likelihood of releasing flammable gas and simultaneously creating a spark is $1E-1$. The likelihood that the impact limiter would fail (not be deployed) is $1E-2$ (human error). The combined likelihood of a drop, impact limiter failure, flammable gas release and spark, is $2.7E-6 * 1E-2 * 1E-1 = 2.7E-9/\text{lift}$.

The video camera does not use an impact limiter, and is lowered manually, thus the likelihood of a drop is $1E-2$ (human error). If dropped, the likelihood that the support cable would break is judged to be $1E-3$. If the cable broke, the likelihood that the camera would penetrate the waste and release gas judged to be $1E-1$. The likelihood that the stainless steel spark resistant housing would create a spark is judged to be $1E-2$. The combined likelihood is $1E-2 * 1E-3 * 1E-1 * 1E-2 = 1E-8/\text{lift}$ (incredible).

- i. HAZOP: Ignition of a Flammable Atmosphere in the Winch Box Due to Failure of Electrical Barriers Between Non-intrinsically-safe Electrical Equipment and the Winch Box Atmosphere

Response: The winches are manually operated, and the winch box does not use sliding electrical power or control contacts, thus it is considered intrinsically-safe.

2. HAZOP: A Criticality in the Tank Caused by Dropping the Neutron Source from the Probe in a Region Which is Only Slightly Subcritical.

Response: See Section 5.6 in this report.

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3. HAZOP: Release of Radionuclides Caused by Pressurization of the Tank Resulting from Hooking Up Air Instead of Water to the Decontamination System.

Response: The likelihood of water fittings and air fittings being interchangeable is assumed to be 1E-1, as some are known to exist. The likelihood that a worker would hook up the wrong source under these conditions is 1E-2. The tank has a four inch diameter opening to the atmosphere through the HEPA filter, and several leak paths. Pressurization would force vapor space gases out the HEPA filter, the path of least resistance, and radionuclides would be filtered out. The likelihood that the filter would be blocked is judged to be 1E-3. The likelihood that radionuclides would be released from the above sequence of events is therefore $1E-1 * 1E-2 * 1E-3 = 1E-6$ (incredible).

4. HAZOP: Toxic Release of Polychlorinated-biphenyl (PCB) Oil if Crane Boom Hits Transformer.

Response: This potential event would be an industrial accident and is controlled by safety requirements in WHC-SD-WM-HSP-002 [Hewitt 1995].

Type S3 Potential Hazards

The events which were judged in the LATA report [LATA 1996] to have potential for S3 (public) consequences consisted of tank dome collapse by various mechanisms, and are as follows:

1. HAZOP: Exceeding Dome Loading Limits Because of Misplacement of the Data Van (wrong spot on the tank or wrong tank).

Response: See Section 5.5 in this report.

2. HAZOP: Exceeding Dome Loading Limits Because of Misuse or Misplacement of the Crane.

Response: See Section 5.5 in this report.

3. HAZOP: Addition of Organic Material to Tank Due to Hooking a Fuel Line Up to the Decontamination Water Supply Piping (judged extremely unlikely, but assumed would result in energetic deflagration and possible dome collapse)

Response: The likelihood that a water supply line and fuel supply line would have the same connection is judged to be 1E-3. If the connections were the same, the likelihood that a worker would hook up the wrong supply line is 1E-2. The sequence of events is not incredible, therefore refueling the van over the waste tank with a fuel line is not permitted.

4. HAZOP: Spark Source in Detonatable Atmosphere (see S2 for mechanisms) Resulting in Dome Collapse.

Response: See Sections 5.1 and 5.2 in this report.

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5.2 Non-HAZOP

The following discussions on the SMMS were developed before the HAZOP, but are still appropriate. They deal with the installation, operation, and removal of the SMMS instrument device in Hanford waste tanks. In some cases, existing equipment (e.g., manual tapes, HEPA filters, LOWs) may have to be temporarily removed before the instrument device can be installed, and/or risers inspected for obstructions. These activities and their associated hazards have been covered in other safety documents, but would be controlled by the same applicable safety controls in Section 7.0 of this report. Examples of such documents include the following USQ Safety Evaluations:

- Riser Inspection Device, USQE TF-95-0082
- Manual Tapes in Flammable Gas Tanks, USQE TF-95-0075
- HEPA Filter Relocation, USQE 7-92-110-BY
- HEPA Filter Relocation, USQE 18-93-BYBX
- LOW Removal, USQE TF-95-0081
- Riser Examination, USQE 9-93-LAMP

The technical bases for controls, based on safety analyses which are applicable to SMMS installations and operations in SSTs BY-110 are referenced as follows:

Tank Type	Technical Bases	Activity and/or Concern
All tanks:	WHC-SD-WM-HSP-002 [Hewitt 1995]	Vapor sampling/toxic gas, Industrial accidents.
	HSRCM-1 [HSRCM 1994]	Radioactivity dose and contamination.
Ferrocyanide:	WHC-EP-0691 Postma 1994 ^a	Waste > 220 °C.

After a tank is checked for flammable and toxic gases by Industrial Health & Fire Protection (IHFP) using safety criteria in WHC-SD-WM-HSP-002 [Hewitt 1995], the riser will be inspected for obstructions using one of the methods described in section 2.4 of this report. If direct viewing is selected, a Health Physics Technician (HPT) will determine if it is safe to peer directly into the open riser, or if leaded glass or mirrors will be required.

If deemed necessary by the Industrial Health, Safety, and Fire Protection (IHSFP) organization, the riser inspection may be performed inside a passively ventilated containment structure (tent, greenhouse, etc.) that has a HEPA filter, in order to minimize radionuclide release to the environment.

5.1 Mechanical Sparks in Watch List Tanks

BY-110 is a CONDITIONALLY SAFE ferrocyanide Watch List Tank, but not a flammable gas or organic Watch List Tank. Potential hazards could be created in ferrocyanide tanks by drying or heating the waste.

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Sparks could be created by metals striking other metals during instrument device installation (e.g., dropping device during crane lift). This is extremely unlikely (1E-4 to 1E-6) as all in-tank exterior device components are spark resistant, and an impact limiter will be installed around the riser. It is judged to be incredible (<1E-6) that the device would be dropped and create a spark that could significantly dry or heat the ferrocyanide waste.

5.2 Electrical Sparks in Watch List Tanks

Electrical sparks could be created by shorts in the neutron probe, video camera, or inclinometer, or by a severed cable. The likelihood of this happening is judged to be unlikely (1E-2 to 1E-4). If a spark did occur in the neutron probe, and hydrogen gas had leaked into the probe, an explosion could occur in the probe but would not ignite gas outside the probe as the probe is designed to be explosion proof.

Explosion proof is defined by the NFPA [1993] as a container that will not rupture and will release combustion products at a controlled rate below the ignition temperature of the gas. Hydrogen in air ignites at 520 °C (968 °F).

The separate video camera used to position the SMMS probe in ferrocyanide tank BY-110 does not require a classified video system, as the tank is not an organic or flammable gas tank [WHC 1996b]. The SMMS inclinometer is designed for a Class-1, Division-1, Group-B environment, however this is not required for ferrocyanide tanks.

5.3 Radionuclide Contamination of Probe

The probe bottom will rest on hard saltcake or soft sludge for moisture measurements. The potential exist for the probe to become significantly radioactively contaminated (5E-1), the decontamination unit fail (1E-3), the HPT fail to check for radioactivity as the device is being removed (1E-2), and workers to physically handle contaminated equipment and be exposed to the radioactivity in spite of it not being checked by the HPT (1E-2). The likelihood of this sequence (5E-8) is incredible.

5.4 Dropping Instrument Device Through Bottom of Tank

A SMMS instrument device could be dropped by the lifting crane during installation. The frequency of dropping crane loads, from which likelihoods were developed, was calculated in *Control of Heavy Loads at Nuclear Power Plants* [NUREG-0612 1980], based on extensive U. S. Navy statistics. The mean likelihood of a load drop without critical lift procedures was calculated to be 2.7E-5. With critical lift procedures, the likelihood was judged to be reduced an order of magnitude [Farley 1994]. Hanford frequently uses critical lift procedures for heavy loads in the tank farms, thus the likelihood would fall within the extremely unlikely category (1E-4 to 1E-6). If dropped however, it is judged to be unlikely (1E-2 to 1E-4) that the impact limiter used during SMMS installations/removals would fail. The combined likelihood of both a drop (with or without critical lift) and impact limiter failure is judged to be incredible (<1E-6).

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5 Dome Loading Types

- Construction loads (e.g., lifting loads, trucks, cranes, girders)
- Normal loads (e.g., gravity, soil, hydrostatic, thermal)
- Concentrated operational loads (trucks, cranes)
- Natural-hazard loads (flood, wind, seismic)
- Postulated accident loads (waste/vapor burn and/or explosion)

Maximum concentrated load limits for SSTs from IOSR-005 [Dougherty 1996] are as follows:

200 series SSTs: 45.36 tonnes (50 tons) over a 3 m (10 ft) radius.

100 series SSTs: 90.72 tonnes (100 tons) over a 3 m (10 ft) radius.

OSD-T-151-00013, Section 13.2.1, parts C.2 and D give dynamic dome loading and deflection limits for concentrated loads over a 3 m (10 ft) radius. Dome deflections of greater than 0.6 cm (0.02 ft) may indicate excessive dome loading or possible structural failure.

The only potential significant dome loading from SMMS activities is from the lifting crane for lifting the instrument device, and driving the monitoring van over the dome. It is not planned for the crane to be positioned over the dome. The van, which will operate over the dome, weighs < 3.6 tonnes (4 tons), thus is well within safety limits. If the 27 tonne (30 ton) crane accidentally drove over the dome, and the van was on the dome at the same time, safety limits would still not be exceeded.

5.6 Criticality from Dropping Neutron Source Into Waste

The neutron source used in the SMMS is a 0.16 microgram Cf^{252} sealed source. The neutron flux through the wall of the source is approximately 3.5×10^7 n/sec, with an average energy of 2.2 MEV/n. These neutrons are subsequently moderated by the water in the waste.

Criticality Safety Analyses have shown that the waste tanks are over-moderated [Doto 1989]. The plutonium in the waste is so well diluted that the addition of the source will have negligible impact on the margin of safety of the system. The minimum critical plutonium concentration in an infinite solid waste matrix is 2.6 g/L. Analytical results from characterization data show fissile material concentrations are significantly less than 1 g/L. Per WHC-CM-4-29, section 2, item 5.2.1.3, less than 2 grams of a material with an atomic number greater than 95 ($\text{Cf} = 98$) is an exempt quantity and not subject to criticality controls. The source of 1.6×10^{-7} grams of californium is much less than an exempt quantity, thus its addition to the waste is not a criticality concern for tank farms.

5.7 Natural Phenomena Related Accidents

Natural phenomena related accidents would be those caused by such events as lightning, tornadoes, and earthquakes.

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5.7.1 Lightning

Lightning could strike the top of the SMMS instrument device during installation or removal and discharge off the bottom, igniting flammable gas in the vapor space, or striking and igniting a dry waste surface. The Hanford Site has an average of 10 days per year during which thunderstorms occur. The probability of a direct lightning strike on a tank is about once each 2,000 years (5E-4) [Cowley 1994].

During tank farm activities, adverse weather conditions are observed, and work on waste tanks is not conducted if lightning is within 8 km (5 mi) of the Tank Farm, per WHC-SD-WM-HSP-002, Section 2.8.7, [Hewitt 1995]. The likelihood of not heeding a lighting warning (human error) is 1E-2. It is assumed that SMMS activities would take about 40 hours each, and ten tanks would be surveyed each year. Since there are 8760 hours in a year, the annual likelihood of a lightning strike on the SMMS is $5E-4 * 1E-2 * 40/8760 * 10 = 2.3E-7/\text{yr}$.

5.7.2 Tornadoes

The likelihood of a tornado on the Hanford site is 1E-5/yr/facility [DOE 1994]. There could be rupturing of the ventilation ducts and HEPA filter housings from such an event, release of radioactivity, and radiation exposure to workers, or injury from flying debris. The likelihood of workers failing to observe a tornado approaching and take cover is 1E-2. It is estimated that workers would be doing SMMS surveys for about 40 hours in each tank and ten tanks per year would be surveyed. Since there are 8760 hours in the year, the annual likelihood of a tornado caused accident would be $1E-5 * 1E-2 * 40/8760 * 10 = 4.6E-9/\text{yr}$ (incredible).

5.7.3 Earthquakes

The likelihood of a 0.25 g seismic event, one that could do significant damage in the tank farms, is 1E-4 per year [Tallman 1989]. There could be rupturing of the ventilation ducts and HEPA filter housings from such an event, release of radioactivity, and radiation exposure to duct inspection workers. It will be assumed that workers have pre-tremor warning of the earthquake. The likelihood that workers would continue to work on a tank with pre-tremor warning is 1E-2. It is estimated that workers would be doing SMMS surveys for about 40 hours in each tank and ten tanks per year would be surveyed. Since there are 8760 hours in the year, the annual likelihood of an earthquake caused accident would be $1E-4 * 1E-2 * 40/8760 * 10 = 4.6E-8/\text{yr}$ (incredible).

5.8 Industrial Accidents

Industrial accidents are controlled by adhering to the requirements in the tank farm Health and Safety Plan (HASP) [Hewitt 1995].

6.0 CONSEQUENCES

No consequences were calculated, as all potential accidents that could cause unacceptable doses to onsite/offsite personnel were judged to be incredible.

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7.0 CONTROLS

Controls are split between general controls that cover all tanks and specific controls that cover the different categories of watch list tanks.

7.1 General Controls

Crane Lifts:

- Crane lift safety controls shall be as specified in the Hanford Site Hoisting and Rigging Manual [DOE-RL 1993].

Dome Loading:

- Dome loading safety controls shall be as specified in OSD-T-151-00013, Section 13.2.1C [WHC 1996a] for SSTs.

Flammable Gas:

- Flammable gas controls shall be as specified in OSD-T-151-00013, Section 13.4.1.2 for tank intrusive work in all SSTs.

Radiation:

- During SMMS installation and removal, or whenever a riser is open, a Health Physics Technician (HPT) shall be present to enforce ALARA principles, as specified in Hanford Site Radiation Control Manual [HSRCM-1 1994].

Toxic Gases and Hazardous Materials:

- During SMMS installation and removal, and whenever a riser is open, a technician from Industrial Health, Safety, and Fire Protection (IHSFP) shall be present to implement safety controls concerning toxic gases and hazardous materials, as specified in the Tank Farm Health and Safety Plan (HASP), (WHC-SD-WM-HSP-002) [Hewitt 1995].

Watch List Tank Identification:

Appendix A in OSD-T-151-00030 [WHC 1996b] identifies individual watch list tanks and tanks that are being considered for the watch list, and until proven otherwise, should be treated like watch list tanks.

7.2 Ferrocyanide Tank Controls

OSD-T-151000030, Section 30.2.B, controls for CONDITIONALLY SAFE ferrocyanide tanks (e.g., BY-110) require vapor space temperatures to be kept below 90 °C, and operations which could heat or dry the waste be restricted until approved by Waste Tank Plant Engineering and TWRS Nuclear Safety.

The SMMS activities will not dry or heat the waste, thus no special controls are required for operating the system in tank BY-110.

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(Continued)

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9.0 USQ SAFETY REVIEW QUESTIONS:

- A. Does the PROPOSED CHANGE represent a change to the facility as described in the AUTHORIZATION BASIS documentation?

☐ N/A ☒ No ☐ Yes/Maybe

Basis: The authorization basis is identified in Section 4.0 of this report. This temporary installation does not constitute a change, according to guidelines in DOE 5480.21 [DOE 1991], since:

- a. It does not permanently add, delete, or convert an automatic or manual feature of the system, structure, or components important to safety. However, seal loops or brather filters may temporarily be removed for the duration of the survey, per guidelines in OSD-T-151-00013, Section 13.2.1F Vapor Space Pressure [WHC 1996a].
- b. It does not introduce new system interactions.
- c. It does not change the seismic qualifications of the tank, environmental qualifications, or quality classifications of the system, structure, or components important to safety.

- B. Does the PROPOSED CHANGE represent a change to procedures as described in the AUTHORIZATION BASIS?

☐ N/A ☒ No ☐ Yes/Maybe

Basis: There are presently no procedures for in-situ monitoring of moisture in the surface solids in the single-shell waste tanks.

- C. Does the test or experiment represent a test or experiment not described in the AUTHORIZATION BASIS documentation?

☐ N/A ☒ No ☐ Yes/Maybe

Basis: This is a new configuration for neutron activation moisture monitoring of tank waste to determine if the waste meet conditionally-safe safety criteria, but is not a new type of test or experiment. Authorization Basis document WHC-EP-0691, Section 5.3.3, [Postma 1994] for Ferrocyanide Watch List Tanks describes using neutron activation moisture measurements in LOWs.

UNREVIEWED SAFETY QUESTION SAFETY REVIEW FORI

(Continued)

D. Does the change, test or experiment impact:

- Implemented OSRs or IOSRs? ☐ N/A ☒ No ☐ Yes/Maybe
- Approved IOSR Compliance Implementation Plans? ☐ N/A ☒ No ☐ Yes/Maybe

Basis: Except for the general restriction against drying out the waste in Conditionally Safe Ferrocyanide tanks in WHC-EP-0691 [Postma 1994], there are presently no Authorization Basis requirements that identify safe moisture levels in the SST waste, or requirements for keeping waste moisture at specified levels, as these are still being developed. Operation of the SMMS to monitor moisture levels is within the bounds of the current OSRs and IOSRs, and will thus have no impact on any of them, nor will it impact any CIP.

Based on the above, a Safety Evaluation ☐ DOES ☒ DOES NOT
need to be performed for this change

USQE No. 1 W. G. Farley

Print Name

Signature

Date

USQE No. 2 J. S. Schofield

Print Name

Signature

Date

UNREVIEWED SAFETY QUESTION SAFETY REVIEW FORM
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Figure 1 - SMMS Schematic Diagram

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re 2 - Deployment Arm and Neutron Probe

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(Continued)

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Figure 3 - Electronic Block Diagram

FIG. 3 - ELEC. BLOCK DIAGRAM

UNREVIEWED SAFETY QUESTION SAFETY REVIEW FORM

DON'T SAY IT --- Write It!

DATE: June 24,

WHC-SD-WM-SDD-070, REV 0
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TO: L. J. Coates R1-62

FROM: W. G. Farley/C. A. Booth

Telephone: 376-9192

cc: G. T. Dukelew S7-14
C. A. Esvelt S7-12
C. E. Hanson H5-09
R. D. House R1-05
M. Huda S7-07
M. N. Islam R3-08
K. H. Morris A2-34
J. L. Schofield S7-12
G. F. Vargo H5-09
J. Weber S1-57
D. L. Wegener S7-01

SUBJECT: TRANSMITTAL OF USQ REVIEW TF-96-0089, REV. 2 (INTERNAL MEMO 8M100-WGF-96045)

If you haven't already replaced the attached sheet please do so, thanks.

A-3000-723 (01/95) GEF015

The maximum weight of SMMS related equipment which will be located on a tank at any time will be approximately 20,000 lbs. Allowing for a 56,000 lb crane for installation of some items, the total weight to be considered for dome loading is 86,000 lbs.

The length of the column and/or arm can be adjusted for various waste levels by adding additional sections. The maximum length will be about 15 m (50 ft), and maximum weight about 363 kg (800 lbs). A winch containment box sits on top of the column. Lifting provisions are incorporated under the box.

The containment box contains manually operated winches to control arm angularity from vertical, and probe elevation. Angularity will be determined by an electronic inclinometer. Electrical cabling in the winch containment box is intrinsically safe. There are no spark sources in this zone.

For each test, the deployment device is used to guide deployment of the neutron probe to about 40 points on the waste surface within 1.8 m (6 ft) of the column axis projected to the waste surface. Visual observations from the video will be used to determine when the probe contacts the waste surface.

The probe (Figure 2) contains three Boron-10 (B10) tube neutron detectors, a 16 microgram Californium-252 neutron source, two thermistors, voltage converters, and electronic amplifiers. The probe is sealed to prevent moisture from contacting the electronics. The probe weighs 14 kg (30 lbs).

Converters in the probe convert low voltage (24 vdc) input from the logging cable to high voltage (800 to 1500 vdc) needed to operate the neutron detectors. The probe amplifiers operate on 12 volts dc.

The SMMS is designed to meet the intent of the National Fire Protection Association (NFPA) code requirements (explosion proof and/or purged) for Class-1, Division-1, Group-B environments per WHC-SD-WM-DA-202 [Bussell and Stokes 1996]. Presently only Flammable-gas and Organic Watch List Tanks require the above classification for vapor space equipment. See OSD-T-151-00030, Sections 30.2.A.4 and 30.2.C.4) [WHC 1996b].

Engineering Change Notices (ECNs)

These ECNs represent minor changes to the system, and are included in this report to avoid the complications of completely redoing the original drawings.

ECN 624768, June 7, 1996 This ECN corrects drawing H-14-100460, sheets 1-4, 7-9, & 11 to as-built conditions and add a redesigned elbow joint with greater strength. These changes improve safety, but do not significantly affect the hazard assessment and safety evaluation in Section 5.0 of this report.

ECN 624769, June 3, 1996 This ECN corrects drawing H-14-100461, sheets 1-9, to as-built conditions. Primary modifications were to remove the Camera Winch and all its related items, replace the Arm Winch with a new winch similar to the Probe Winch, add a Clutch/Break Assembly to the Arm Winch, and add instrumentation panel meters. None of these changes significantly affect the hazard assessment and safety evaluation in Section 5.0 of this report.

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(Continued)

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ECN 624770, May 31, 1996 This ECN corrects drawing H-14-100459, sheets 1-4 and 6 to as-built conditions; and adds an Anti-Rotation Clamp, changes the Arm Lifting Cable, adds holes to the Bearing Housing Flange for interfacing with the Shipping/Storage Container, and adds a spring loaded clamp for the Inclinator Cable. None of these changes significantly affect the hazard assessment and safety evaluation in Section 5.0 of this report.

ECN 624771, June 3, 1996 This ECN incorporates design improvements to components shown on drawing H-14-100458, sheets 1-4, as suggested by Operations, and aids deployment of the SMMS in the field. None of these changes significantly affect the hazard assessment and safety evaluation in Section 5.0 of this report.

ECN 624772, June 7, 1996 This ECN incorporates design improvements to components shown on drawing H-14-100553, sheets 1-3, as suggested by Operations or discovered during acceptance testing, and aids deployment of the SMMS in the field. These changes improve safety, but do not significantly affect the hazard assessment and safety evaluation in Section 5.0 of this report.

ECN 624773, June 7, 1996 This ECN incorporates changes to components shown on drawing H-14-100463, sheets 1 & 3 to correct assembly call outs and incorporate loops and straps to secure the Impact Limiter during field installation. These changes improve safety, but do not significantly affect the hazard assessment and safety evaluation in Section 5.0 of this report.

ECN 624774, June 7, 1996 This ECN incorporates design improvements to components shown on drawings H-14-100557, sheet 1, and H-14-100558, sheet 1, to add holes in the calibration fixtures in order to relieve vacuum in the fixtures when the Neutron Source is removed. These changes do not significantly affect safety, nor the hazard assessment and safety evaluation in Section 5.0 of this report.

ECN 624775, June 7, 1996 This ECN incorporates design improvements to components shown on drawing H-14-100554, sheet 2, to adjust Insert lengths to allow the Adapter Seal Assembly to seat on the Insert when installed. These changes do not significantly affect safety, nor the hazard assessment and safety evaluation in Section 5.0 of this report.

ECN 624776, June 10, 1996 This ECN incorporates a change to a component shown on drawing H-14-100461, sheet 1, to correct material call out in order to reflect as-built conditions. The change does not affect safety, nor the hazard and safety evaluation in section 5.0 of this report.

ECN 628800, June 14, 1996 This ECN incorporates changes to 21 drawings listed on the ECN to correct the drawings to as-built conditions. Units affected include: 1. Intercom Communication System, 2. Remote Digital Display System, 3. Probe Master Power Switch, 4. Light Duty Utility Arm (LUDA) Surface Moisture Probe End Effector 24 VDC Power Sense Wiring, and 6.0 EMI Probe Support Wiring. These changes do not significantly affect safety, nor the hazard assessment and safety evaluation in Section 5.0 of this report.

Shm596-072
2.2.10

**Westinghouse
Hanford Company**

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**Internal
Memo**

From: TWRS SAR Engineering
Phone: 376-9192 A3-37
Date: April 29, 1996
Subject: TRANSMITTAL OF USQ SAFETY REVIEW TF-95-0089, REV. 1
SURFACE MOISTURE MONITORING OF HANFORD TANK WASTE
BY NEUTRON ACTIVATION

8M100-WGF-96033

To: L. J. Coates R1-62

cc: B. D. Board A3-37
R. D. Crow H0-38
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M. E. Huda S7-07
M. N. Islam R3-08
D. C. Langlois S7-03
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J. F. Schofield S7-12
T. I. Stokes L6-37
G. F. Vargo H5-09
J. Weber S1-57
WGF File/LB

Following the guidelines in WHC-CM-4-40, an Unreviewed Safety Question (USQ) Safety Review was performed to show that the installation, operating, and removal of the in-tank surface moisture monitoring system (SMMS) in Hanford waste tanks is within the authorization basis, and is a safe activity.

This revision adds responses to potential hazards identified in a Hazards and Operability Study (HAZOP) by Los Alamos Technical Associates (LATA), and updates the authorization and safety basis references.

WHC-IP-0842, Section 5.4, Rev. 6, requires the attached safety review to be attached to the ECN, PCA, Work Package, or procedure for continuation of the normal review process. The Safety Review form shall be filed with the applicable ECN, PCA, Work Package, or procedure after the review process is completed.

If you have any questions, feel free to call me at 376-9192.

Wayne H. Farley

W. G. Farley
Senior Engineer

wgf

Attachment

UNREVIEWED SAFETY QUESTION SAFETY REVIEW FOI

(Per WHC-IP-0842, 15.9)

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USQ TRACKING NUMBER TF-95-0089, Rev. 1

REFERENCE DOCUMENT(S):

ECN No.

PCA No.

Work Pkg No.

Other (Specify) See Section 8.0

TITLE:

**SURFACE MOISTURE MONITORING OF HANFORD
TANK WASTE BY NEUTRON ACTIVATION**

1.0 INTRODUCTION:

This report covers potential hazards associated with installing and operating the surface moisture measurement system (SMMS) in all single-shell tanks (SSTs) and double-shell tanks (DSTs), and appropriate safety controls to keep risk within guidelines in WHC-CM-4-46. Many of the watch list tanks are combinations of organic, ferrocyanide and flammable gas tanks, thus this report is developed to cover all SST and DST safety criteria.

The new probe uses the same principle as the neutron probes used in SST liquid observation wells (LOWs) for the past 12 years to determine liquid levels and determine relative moisture content in the waste immediately around the LOWs. An unreviewed safety question evaluation (USQE) for neutron activation logging in ferrocyanide and organic tank LOWs was previously performed in USQE TF-95-0007 [Farley 1995].

2.0 EQUIPMENT DESCRIPTION

2.1 SMMS

The SMMS (Figure 1) consists of a monitoring van, deployment device, and a neutron probe installed on the deployment device. The van contains electronic systems, operator console, a self contained battery supply power system, and storage for the neutron source (when not installed in the probe housing). Also attached to the front of the van is a LOW logging system, which will not be used at the same time as the SMMS.

The deployment device consists of an upper stainless steel (SS) containment box for control winches, and an 8.9 cm (3.5") O.D. SS column to support in-tank instrumentation. The in-tank instrumentation consists of a SS rotatable arm, neutron probe, and video camera/light. The first surveys will be conducted with a video camera/light in a separate riser. Later, a retractable video camera/light may be installed within the lower portion of the SS column. The maximum weight of SMMS related equipment which will be located on a tank at any time will be approximately 20,000 lbs. Allowing for a 56,000 lb crane for installation of some items, the total weight to be considered for dome loading is 86,000 lbs.

The length of the column and/or arm can be adjusted for various waste levels by adding additional sections. The maximum length will be about 15 m (50 ft), and maximum weight about 363 kg (800 lbs). A winch containment box sits on top of the column. Lifting provisions are incorporated under the containment box.

The containment box contains manually operated winches to control arm angularity from vertical, camera elevation (if integral system used), and probe elevation. Angularity will be determined by an electronic inclinometer. The winches will incorporate a combination of slip rings and/or reverse wound drums to connect the van system to the neutron probe, and video camera if integral system is used.

The deployment device is used to guide deployment of the neutron probe to about 40 points (for each test) on the waste surface within 0.9 m (3 ft) of the column axis projected to the waste surface. Visual observations on the video camera will be used to determine when the probe contacts the waste surface.

The probe (Figure 2) contains three Boron-10 (B10) tube neutron detectors, a 16 microgram Californium-252 neutron source, two thermistors, voltage converters, and electronic amplifiers. The probe is sealed to prevent moisture from contacting the electronics, and is designed to meet National Fire Protection Association (NFPA) code requirements (explosion proof) for Class-1, Division-2, Group-B, environments (H_2 occasionally > LFL). The probe will weigh 11-14 kg (25-30 lbs).

Converters in the probe convert low voltage (24 vdc) input from the logging cable to high voltage (800 to 1500 vdc) needed to operate the neutron detectors. The probe amplifiers operate on 12 volts dc.

One of two video camera types will be used. For flammable gas tanks, the video system used will meet OSD-T-151-00030 requirements in section 30.2.C.4. For non-flammable gas tanks, a non-classified video system may be used.

2.2 Impact Limiter

The deployment device has the potential to cause serious riser damage in the event of a drop accident. Therefore, an impact limiting system will be utilized. The riser must withstand a 30,000 lb relatively steady load while the limiting system foam is crushing, or an I-beam system will be incorporated to transfer the load into the soil, rather than into the riser itself. Tank specific structural analyses will be performed for each riser to be used, and this will guide field installation details and procedural controls.

2.3 Video camera

This section summarizes the design requirements in WHC-SD-WM-DRD-002 [Stokes 1995], and documents the operational and administrative safety controls required for deployment in and around flammable gas tanks.

The video system will meet functional criteria for Class-1, Division-1, Group-B atmospheres. In addition, the video system will have redundant controls which will cause the system to shut down upon loss of purge gas flow.

2.4 Riser Inspection Characterization

The objective of riser characterization is to obtain reliable data for SMMS deployment, and quantify and document specific risers for other equipment deployment activities. All of the riser tools described will be capable of surveying 10.16 to 30.48 cm (4 to 12") I.D. risers.

Up to five data sets may be gathered. Riser length measurements will be normally required, as will distance to the waste surface. These activities

will be accomplished by conventional mechanical length tools and zip cords. Newly developed tools will be employed for other riser characterizations.

Waste inspection will normally be required with a remotely operated camera. For flammable gas tanks, a 7.62 cm (3") flammable gas qualified system is currently under construction and will be available for deployment by the current scheduled date for the first SMMS deployment.

For riser inspection, a Riser Inspection Device (RID) [Schofield 1995] will be used to gather qualitative visual data. RID is a standard video inspection system, manufactured by Crestone Products Inc., that mounts on top of a riser flange to inspect the tank riser and waste directly below the riser. The system includes a high resolution (S-video) color TV camera equipped with a 8:1 zoom lens, and a high intensity pre-focused quartz halogen light source. The camera housing is fabricated of 300 series stainless steel.

The RID camera and light is isolated from the tank vapor space by a clear glass or plastic window mounted on the riser to qualify the system for all tanks (e.g., flammable gas, organic, ferrocyanide, non-watchlist).

If the visual data is adequate to show no significant obstacle to insertion of the SMMS arm, no further investigation will be attempted.

Should the RID system data be either inconclusive, or show information that suggests obstruction, then a decision will be made to either move to another riser location, or to deploy the newly developed riser laser profiling system (LPS).

The LPS is deployed through the full length of the riser and gathers quantitative data on riser ovality, protrusions, and plumb. A plug gage may be a suitable alternative to the LPS, if appropriate.

3.0 OPERATIONS

A suitable riser is selected for the SMMS survey either immediately before the survey or several days or weeks before the survey. The riser cover will be removed in a manner which minimizes the potential static and/or mechanical sparks. Next, flammability will be checked first in the riser, and then in the tank vapor space below the bottom of the riser. For all activities equipment will be electrically bonded and/or grounded as required in OSD-T-151-00007, -00013, and -00030.

If the checking for flammable gas is more than 15 minutes prior to SMMS installation, flammability will again be checked on flammable gas and/or organic tanks immediately before deployment device insertion.

Exposure to toxic gases will be controlled by following requirements in the tank farm Health and Safety Plan (HASP) [Hewitt 1995].

Next, the riser will be checked for obstructions using a non-sparking riser gauge plug [Farley 1994c], or a RID video system [Schofield 1995].

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If the riser is suitable for the SMMS, the risers will then be gauged using a zip cord to check waste elevation, and a pole with a foot to gauge actual flange to stub riser length.

Next, a plastic sleeve may be positioned in the riser to lessen radioactive contamination of the SMMS, the decontamination unit mounted on the riser, and the impact limiter positioned over the riser. The impact limiter will prevent damage to the riser or tank bottom, if the SMMS is accidentally dropped.

On flammable gas tanks, flammability will be checked continuously during installation and removal per SARR-004 [Schlosser 1996]. Additional explanation of this requirement is provided in Internal Memo RJVV-8M400-95-003 [Van Vleet 1995].

Where 30 cm (12") diameter risers are used, an adapter plate will be added for two 10.16 cm (4") openings, one for the video camera and one for the SMMS. The video must be installed first as the SMMS winch container box will extend over both openings. The video will be installed per standard tank farm procedures.

The SMMS in-tank device will be lifted off a flat bed truck with a crane. The device is then lowered into the tank until the device is firmly seated on the decontamination system.

After the device is securely bolted down and electrically connected, the arm will be cranked to a horizontal or some other non-vertical position, as specified for radial spacing requirements. The camera and probe are now free to be lowered as required to place the probe bottom on the waste surface. It is undesirable to lower the probe into the waste, as the calibration would be incorrect, and the probe would become contaminated. This will be prevented by close video surveillance of the probe as it is being lowered.

The power will then be turned on in the probe. Reflected neutrons passing through the neutron detectors will induce electrical pulses in the detectors, which will be transmitted to the van and be counted. The probe will be repositioned in several radial directions and distances to obtain approximately 40 samples for statistical analysis of surface moisture.

After completion of sampling, the probe will be mostly retracted, the arm lowered to a vertical position, and the probe retracted the remaining distance into a receiving socket. The SMMS in-tank device will then be removed. During removal, the device will be decontaminated using high pressure water, with the water flowing back into the tank. Finally, the video camera will be removed per standard tank farm procedures.

4.0 AUTHORIZATION BASIS

4.1 Interim Safety Basis (ISB)

The authorization basis for Tank Farm activities is Chapter 6.0 of the interim safety basis (ISB) document WHC-SD-WM-ISB-001 [Leach and Stahl 1995], and documents specifically referenced therein.

In turn, except for criticality in SSTs and dome loading in DSTs, the ISB identifies interim operational safety requirements (IOSRs) WHC-SD-WM-OSR-004 [Aguirre 1996], WHC-SD-WM-OSR-005 [Dougherty 1996], WHC-SD-WM-OSR-016 [Heubach 1996] as the authorization basis for AWTs, SSTs, and DSTs.

For SST criticality issues, the ISB identifies administrative control (AC) 5.12 in WHC-SD-WM-OSR-005 [Dougherty 1996] as the authorization basis. Authorization basis for criticality issues in DSTs is not indicated in Chapter 6.0 of the ISB, but is indicated in the DST IOSRs.

For DST dome loading issues, the ISB identifies JCO WHC correspondence 9456832. The JCO was never released as a supporting document, thus was never given a formal JCO number. SST dome loading is covered by AC 5.22 DOME LOAD and B 5.22 DOME LOAD in WHC-SD-WM-OSR-005 [Dougherty 1996].

4.2 Interim Operational Safety Requirements (OSRs)

WHC-SD-WM-OSR-005, AC 5.15 WATCH LIST TANKS, states that a program shall be established to include criteria for placing a tank on or removing a tank from the WATCH LIST, and for special sampling and monitoring requirements and frequencies.

The SMMS is considered one of the special monitoring techniques for helping to determine when a tank meets criteria for addition to or removal from the WATCH LIST, per AC 5.15 a.

The IOSR AC 5.15 also states that an operating specification document (OSD-T-151-00030) is currently in place to control activities involving WATCH LIST TANKS, as well as numerous safety studies that cover ferrocyanide, organic, vapor flammability issues; and upon approval (assumed to be WHC functional review), the results of these studies shall be incorporated into the established program (assumed to be OSD-T-151-00030).

OSR-005, Section B 5.0, lists physical parameters that are monitored and controlled (e.g., nuclear criticality, corrosion, heat load, hydrostatic load, dome load, tank and transfer line leakage, concrete temperature, and flammable gases) to keep the tanks conditionally safe.

Parameters that are or could be affected under accident conditions by SMMS activities are dome load, tank leakage, and flammable gases. Safety analyses referenced in the OSRs applicable to these parameters are as follows:

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Tank Type	Safety Analysis	Activity and/or Concern
Single-Shell:	SD-RE-TI-012 [RHO 1989] SD-WM-SAR-006 [WHC 1989]	Dome loading Tank leakage
Double-Shell:	SD-WM-SAR-016 [RHO 1986] JCO 9456832 [Lee 1994]	Tank leakage Dome loading
Flammable Gas:	WHC-SD-WM-SAR-034 [WHC 1989] LA-UR-92-3196 [LANL 1995] WHC-EP-0562 [Osborn 1994]	Hydrogen burn with oxygen Flammable gas ignition in 101-SY Tank vapor issue (flammable/toxic gases)
Ferrocyanide:	no references	
Organic:	no references	

4.3 Other Safety Related Controls

WHC-SD-WM-SARR-004 [Schlosser 1996] contain recently updated safety studies that have been performed for developing work safety controls for flammable gas tanks, using the latest characterizations of flammable gas tanks. These reports have been submitted to the DOE [Bacon 1996] for inclusion of certain sections into the authorization basis, but at this time are not considered part of the authorization basis.

The Bacon report breaks down sections of the SARRs that have already been implemented into the OSDs, controls to be implemented, and controls to undergo further evaluation. Controls already implemented in OSD-T-151-00030, or recommended to be implemented, are summarized in Section 7.0 of this report.

5.0 POTENTIAL HAZARDS

5.1 HAZOP

Los Alamos Technical Associates (LATA) has recently performed a Hazards and Operability Study (HAZOP) to classify potential hazards involved with installation, operation, and removal of the SMMS in Hanford waste tanks. A summary of results from that report is incorporated into this revision.

The results of the HAZOP were a number of postulated abnormal events which were ranked with respect to safety consequences. The first cut, qualitative, consensus estimates of the safety severity of the consequences were ranked according to the following alphanumeric system:

- SO No effect outside the immediate area with no safety concerns for the facility worker, the onsite worker, or members of the general public.
- SI Potential industrial injury, radiological dose consequences, or chemical exposure to the facility worker

- S2 Potential significant radiological dose consequences or chemical exposure to the onsite worker at the nearest adjacent facility
- S3 Potential significant radiological dose consequences or chemical exposure to the offsite population

Type S1 potential hazards are covered by controls in the Tank Farm Health and Safety Plan (HASP) WHC-SD-WM-HASP-002 [Hewitt 1995] and the Hanford Site Radiological Control Manual [HSRCM-1 1994], thus will not be discussed further in this report.

Type S1 Potential Hazards:

1. Heat exhaustion caused by hot weather and failure of the air conditioning in the data collection van.
2. Ignition of small fire resulting from offgassing from the batteries.
3. Toxic offgas from a riser affecting the individual in the van.
4. Carbon monoxide hazard (possible in cold weather due to proximity of data collection van and camera van).
5. Worker exposure to cold weather if van heater failed.
6. Fire caused by fuel spill during field refueling of data collection van.
7. Worker electrocution hazard due to improper grounding of van combined with electrical fault.
8. Worker radioactive contamination due to previous worker having entered the van with contaminated clothing. (Note that the van will be parked in a surface contamination area.)
9. Worker injury due to failure of lifting device (crane).
10. Worker injury due to electrical shorting caused by crane boom hitting electrical equipment.
11. Worker exposure to toxic gas from open riser.
12. Worker exposure due to recovery actions for improper positioning of deployment arm.
13. Worker exposure to radioactive contamination due to improper contamination control procedures during deployment arm installation.
14. Worker injury from catastrophic failure of decontamination system pump.
15. Worker injury from electrical short caused by spill of process water from the decontamination system.
16. Worker injury caused by high pressure water from the decontamination system.
17. Worker injury caused by difficulties in withdrawing deployment arm mast (specifically interference of lost decontamination system nozzle).
18. Worker contamination caused by inadequate operation of the decontamination system.
19. Worker radiation dose caused by separation of neutron source from probe.

Type S2 and S3 potential hazards are discussed at the end of each HAZOP potential hazard.

Type S2 Potential Hazards:

Type S2 potential hazards from the [LATA 1996] HAZOP are indicated below. Likelihood numbers in the responses were developed for this report.

1. HAZOP: Events which result in a spark in the tank headspace when flammable but not detonatable concentrations of gas are present.

Response: Flammable, but not detonatable gases could result from a slow leak of combustible gases. Should a spark occur in the vicinity of the gas leak prior to the gas being diluted by air to a nonflammable concentration, a small flame could persist as long as the gas was continuously released in small quantities. The likelihood of this type gas release in the area of the activity is judged to be 1E-1/yr with waste penetrating activities, and 1E-4/yr without waste penetrating activities.

- a. HAZOP: Grounding the Van Incorrectly

Response: SMMS activities are non waste penetrating thus the likelihood of continuous small plumes of flammable gas in the area of the activity is 1E-4. The likelihood that waste would not be grounded from pipes and instrument trees in the waste and overlying soil is judged to be 1E-3. The combined likelihood is 1E-7.

- b. HAZOP: Parking the Van With Non-spark-resistant Electrical Equipment Next to an Open Riser During an Episodic Release of Flammable Gases

Response: The likelihood of an episodic release of flammable gas that would expel flammable gases to the atmosphere around an open riser is judged to be 1E-4. The likelihood of the van being present during an atmosphere release (assuming 8 hours to perform the work) is calculated to be 8 hrs/8760 hrs per year = 9.1E-4. The combined likelihood is 9.1E-8.

- c. HAZOP: Ignition of Flammable Gases in the Tank Caused by a Fire in the Van Propagating Down a Riser

Response: This likelihood is the likelihood of b. above times the likelihood of a fire in the van (1E-3) or 9.1E-11.

- d. HAZOP: Propagation of a Fuel Fire During Field Refueling to a Tank Flammable Atmosphere

Response: This likelihood is the same as in c. above (9.1E-11).

- e. HAZOP: Failure of the Tank Electrical Safety Barriers Resulting in Igniting a Flammable Atmosphere

Response: The likelihood of tank electrical barriers failing is judged to be 1E-3. The likelihood of flammable gases is 1E-4. The combined likelihood is 1E-7.

(Continued)

- f. HAZOP: Ignition of an Undiscovered Flammable Atmosphere Due to Not Using Flammable Gas Controls;

Response: Discovered and undiscovered flammable but not detonable gases are equally likely. Therefore this case is the same as item a. above 1E-7).

- g. HAZOP: Ignition of a Flammable Gas Buildup in the Decontamination System Pump Casing (failure to isolate pump after decontamination) Propagating to the Tank;

Response: The likelihood of flammable gas in the tank or decontamination system pump casing is 1E-4. The likelihood of an ignition source in the pump casing is 1E-3. The total is 1E-7

- h. HAZOP: Ignition of a Flammable Atmosphere Due to Dropping Equipment

Response: The likelihood of dropped equipment causing flammable gas is judged to be 1E-1. The likelihood of dropping equipment is judged to be 2.7E-5 [Farley 1994]. The likelihood that the impact limiter would fail if equipment was dropped is judged to be 1E-3. The total is 2.7E-9.

- i. HAZOP: Ignition of a Flammable Atmosphere in the Winch Box Due to Failure of Electrical Barriers Between Non-intrinsically-safe Electrical Equipment and the Winch Box Atmosphere

Response: The likelihood of flammable gas in the tank or winch box is judged to be 1E-4. The winches are manually turned. The likelihood of a mechanical spark is 1E-3. The total is 1E-7.

2. HAZOP: A Criticality in the Tank Caused by Dropping the Neutron Source from the Probe in a Region Which is Only Slightly Subcritical.

Response: See Section 5.6 in this report.

3. HAZOP: Release of Radionuclides Caused by Pressurization of the Tank Resulting from Hooking Up Air Instead of Water to the Decontamination System.

Response: The likelihood of water fittings and air fittings being interchangeable is assumed to be 1E-1, as some are known to exist. The likelihood that a worker would hook up the wrong source under these conditions is 1E-2. The tank has a four inch diameter opening to the atmosphere through the HEPA filter, and several leak paths. Pressurization would force vapor space gases out the HEPA filter, the path of least resistance, and radionuclides would be filtered out. The likelihood that the filter would be blocked is judged to be 1E-3. The likelihood that radionuclides would be released from the above sequence of events is therefore $1E-1 * 1E-2 * 1E-3 = 1E-6$.

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(Continued)

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4. HAZOP: Toxic Release of Polychlorinated-biphenyl (PCB) Oil if Crane Boom Hits Transformer.

Response: This potential event would be an industrial accident and is controlled by safety requirements in WHC-SD-WM-HSP-002 [Hewitt 1995].

Type S3 Potential Hazards

The events which were judged in the LATA report [LATA 1996] to have potential for S3 (public) consequences consisted of tank dome collapse by various mechanisms, and are as follows:

1. HAZOP: Exceeding Dome Loading Limits Because of Misplacement of the Data Van (wrong spot on the tank or wrong tank).

Response: See Section 5.5

2. HAZOP: Exceeding Dome Loading Limits Because of Misuse or Misplacement of the Crane.

Response: See Section 5.5

3. HAZOP: Addition of Organic Material to Tank Due to Hooking a Fuel Line Up to the Decontamination Water Supply Piping (judged extremely unlikely, but assumed would result in energetic deflagration and possible dome collapse)

Response: The likelihood that a water supply line and fuel supply line would have the same connection is judged to be 1E-3. If the connections were the same, the likelihood that a worker would hook up the wrong supply line is judged to be 1E-2. The sequence of events is not incredible, therefore refueling of the monitoring van over a tank is not permitted.

4. HAZOP: Spark Source in Detonatable Atmosphere (see S2 for mechanisms) Resulting in Dome Collapse.

Response: See Sections 5.1 and 5.2

5.2 Non-HAZOP

The following discussions on the SMMS were developed before the HAZOP, but are still appropriate. They deal with the installation, operation, and removal of the SMMS instrument device in Hanford waste tanks. In some cases, existing equipment (e.g. manual tapes, HEPA filters, LOWs) may have to be temporarily removed before the instrument device can be installed, and/or risers inspected for obstructions. These activities and their associated hazards have been covered in other safety documents, but would be controlled by the same applicable safety controls in Section 7.0 of this report. Examples of such documents include the following USQ Safety Evaluations:

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- Riser Inspection Device, USQE TF-95-0082
- Manual Tapes in Flammable Gas Tanks, USQE TF-95-0075
- HEPA Filter Relocation, USQE 7-92-110-BY
- HEPA Filter Relocation, USQE 18-93-BYBX
- LOW Removal, USQE TF-95-0081
- Riser Examination, USQE 9-93-LAMP

The technical bases for controls, based on safety analyses which are applicable to SMMS installations and operations, are referenced as follows:

<u>Tank Type</u>	<u>Technical Bases</u>	<u>Activity and/or Concern</u>
All tanks:	WHC-SD-WM-HSP-002 [Hewitt 1995]	Vapor sampling/toxic gas, Industrial accidents
	HSRCM-1 [HSRCM 1994]	Radioactivity dose and contamination
Flammable Gas:	WHC-EP-0562, Rev. 1 [Osborn 1994]	Tank Vapor Issue (flammable/toxic gases)
	LAUR-92-3196, Rev. 14 [LANL 1995]	Vapor Space combustible gas > 25% of LFL
	WHC-SD-WM-SARR-004 [Schlosser 1996]	Plume gas release from waste intrusive activities with plume > 25% of LFL
Ferrocyanide:	WHC-EP-0691 Postma 1994 ^a	Waste > 220 °C
Organic:	WHC-SD-WM-SAD-009 [Farley/Grigsby]	Sparks/heat generation
	WHC-EP-0681 [Babad/Turner 1993]	Waste > 171 °C and moisture < 17 wt%
	WHC-SD-WM-SARR-033 [Webb 1995]	TOC > 4.5 wt%, moisture < 20 wt%, and temp. > 200 °C (392 °F)

After a tank is checked for flammable and toxic gases by Industrial Health & Fire Protection (IHFP) using safety criteria in WHC-SD-WM-HSP-002 [Hewitt 1995], the riser will be inspected for obstructions using one of the methods described in section 2.4 of this report. If direct viewing is selected, a Health Physics Technician (HPT) will determine if it is safe to peer directly into the open riser, or if leaded glass or mirrors will be required.

If deemed necessary by the Industrial Health, Safety, and Fire Protection (IHSFP) organization, the riser inspection may be performed inside a passively ventilated containment structure (tent, greenhouse, etc.) that has a HEPA filter, in order to minimize radionuclide release to the environment.

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5.1 Mechanical Sparks in Flammable Gas Tanks

Sparks have a high potential for igniting flammable gases. Many of the tanks are organic tanks, flammable gas tanks, or combination organic and flammable gas tanks. The hazard exist that a spark could ignite the gas and cause an explosion, and/or ignite the organics. A vapor space gas burn might lead to dome collapse and release of radionuclides to the atmosphere. An organic waste burn would breach the HEPA filter and release radionuclides.

Sparks could be created by metals striking other metals during instrument device installation (e.g., dropping device during crane lift). This is extremely unlikely (1E-4 to 1E-6) as all in-tank exterior device components are spark resistant, and an impact limiter will installed around the riser. It is deemed to be incredible (<1E-6) that the device would be dropped and create a spark, and a flammable gas release would occur at the same time.

5.2 Electrical Sparks in Flammable Gas Tanks

Electrical sparks could be created by shorts in the neutron probe, video camera, or inclinometer, or by a severed cable. The likelihood of this happening is judged to be unlikely (1E-2 to 1E-4). If a spark did occur in the neutron probe, and hydrogen gas had leaked into the probe, an explosion could occur in the probe but would not ignite gas outside the probe as the probe is designed to be explosion proof.

Explosion proof is defined by the NFPA [1993] as a container that will not rupture and will release combustion products at a controlled rate below the ignition temperature of the gas. Hydrogen in air ignites at 520 °C (968 °F).

The separate video camera used to position the SMMS probe is a purged system designed for Class-1 Division-1, Group-B environments [Farley 1996]. The SMMS inclinometer is designed for a Class-1, Division-1, Group-B environment. For non-flammable gas tanks, no safety classification is required.

5.3 Radionuclide Contamination of Probe

The probe bottom will rest on hard saltcake or soft sludge for moisture measurements. The potential exist for the probe to become significantly radioactively contaminated (5E-1), the decontamination unit fail (1E-3), the HPT fail to check for radioactivity as the device is being removed (1E-2), and workers to physically handle contaminated equipment and be exposed to the radioactivity in spite of it not being checked by the HPT (1E-2). The likelihood of this sequence (5E-8) is incredible.

5.4 Dropping Instrument Device Through Bottom of Tank

A SMMS instrument device could be dropped by the lifting crane during installation. The likelihood of dropping a load is extremely unlikely (1E-4 to 1E-6) when using critical lift procedures. If dropped, it is unlikely (1E-2 to 1E-4) that the impact limiter would fail. The likelihood of both a drop and impact limiter failure is incredible (<1E-6).

5.5 Dome Loading Types

- Construction loads (e.g., lifting loads, trucks, cranes, girders)
- Normal loads (e.g., gravity, soil, hydrostatic, thermal)
- Concentrated operational loads (trucks, cranes)
- Natural-hazard loads (flood, wind, seismic)
- Postulated accident loads (waste/vapor burn and/or explosion)

Maximum concentrated load limits from the IOSRs [Aguirre 1996, Dougherty 1996, Heubach 1996] are as follows:

200 series SSTs: 45.36 tonnes (50 tons) over a 3 m (10 ft) radius.
100 series SSTs: 90.72 tonnes (100 tons) over a 3 m (10 ft) radius.
All DSTs: 45.36 tonnes (50 tons) over a 3 m (10 ft) radius

OSD-T-151-00013, Section 13.2.1, parts C.2 and D give dynamic dome loading and deflection limits for concentrated loads over a 3 m (10 ft) radius. Dome deflections of greater than 0.6 cm (0.02 ft) may indicate excessive dome loading or possible structural failure.

The only potential significant dome loading from SMMS activities is from the lifting crane for lifting the instrument device, and driving the monitoring van over the dome. It is not planned for the crane to be positioned over the dome. The van, which will operate over the dome, weighs < 3.6 tonnes (4 tons), thus is well within safety limits. If the 27 tonne (30 ton) crane accidentally drove over the dome, and the van was on the dome at the same time, safety limits would still not be exceeded.

5.6 Criticality From Dropping Neutron Source Into Waste

The neutron source used in the SMMS is a 0.16 microgram Cf^{252} sealed source. The neutron flux through the wall of the source is approximately 3.5×10^7 n/sec, with an average energy of 2.2 MEV/n. These neutrons are subsequently moderated by the water in the waste.

Criticality Safety Analyses have shown that the waste tanks are over-moderated [Doto 1989]. The plutonium in the waste is so well diluted that the addition of the source will have negligible impact on the margin of safety of the system. The minimum critical plutonium concentration in an infinite solid waste matrix is 2.6 g/L. Analytical results from characterization data show fissile material concentrations are significantly less than 1 g/L. Per WHC-CM-4-29, section 2, item 5.2.1.3, less than 2 grams of a material with an atomic number greater than 95 ($\text{Cf} = 98$) is an exempt quantity and not subject to criticality controls. The source of 1.6×10^{-7} grams of californium is much less than an exempt quantity, thus its addition to the waste is not a criticality concern for tank farms.

5.7 Natural Phenomena Related Accidents

Natural phenomena related accidents would be those caused by such events as lightning, tornadoes, and earthquakes.

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(Continued)

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5.7.1 Lightning

Lightning could strike the top of the SMMS instrument device during installation or removal and discharge off the bottom, igniting flammable gas in the vapor space, or striking and igniting a dry waste surface.

The Hanford Site has an average of 10 days per year during which thunderstorms occur. The probability of a direct lightning strike on a tank is about once each 2,000 years (5E-4) [Cowley 1994].

During tank farm activities, adverse weather conditions are observed, and work on waste tanks is not conducted unless the Pacific Northwest Laboratory weather group states that lightning is not present within 81 km (50 miles) of the Hanford Site [Farley 1994]. The likelihood of not tracking the weather and heeding a weather warning (human error) is 1E-2. It is assumed that SMMS instrument device installation, operation, and removal would take about 40 hours each, and ten tanks would be surveyed each year. Since there are 8760 hours in a year, the annual likelihood of a lightning strike on a device during installation or removal would be $5E-4 * 1E-2 * 40/8760 * 10 = 2.3E-7/\text{yr}$ (incredible).

5.7.2 Tornadoes

The likelihood of a tornado on the Hanford site is 1E-5/yr/facility [DOE 1994]. There could be rupturing of the ventilation ducts and HEPA filter housings from such an event, release of radioactivity, and radiation exposure to workers, or injury from flying debris. The likelihood of workers failing to observe a tornado approaching and take cover is 1E-2. It is estimated that workers would be doing SMMS surveys for about 40 hours in each tank and ten tanks per year would be surveyed. Since there are 8760 hours in the year, the annual likelihood of a tornado caused accident would be $1E-5 * 1E-2 * 40/8760 * 10 = 4.6E-9/\text{yr}$ (incredible).

5.7.3 Earthquakes

The likelihood of a 0.25 g seismic event, one that could do significant damage in the tank farms, is 1E-4 per year [Tallman 1989]. There could be rupturing of the ventilation ducts and HEPA filter housings from such an event, release of radioactivity, and radiation exposure to duct inspection workers. It will be assumed that workers have pre-tremor warning of the earthquake. The likelihood that workers would continue to work on a tank with pre-tremor warning is 1E-2. It is estimated that workers would be doing SMMS surveys for about 40 hours in each tank and ten tanks per year would be surveyed. Since there are 8760 hours in the year, the annual likelihood of an earthquake caused accident would be $1E-4 * 1E-2 * 40/8760 * 10 = 4.6E-8/\text{yr}$ (incredible).

5.8 Industrial Accidents

Industrial accidents are controlled by adhering to the requirements in the tank farm Health and Safety Plan (HASP) [Hewitt 1995].

6.0 CONSEQUENCES

No consequences were calculated, as all potential accidents that could cause significant damage to tanks or harm to personnel were judged to be incredible.

7.0 CONTROLS

Controls are split between general controls that cover all tanks and specific controls that cover the different categories of watch list tanks.

7.1 General Controls

Radiation:

During SMMS installation and removal, or whenever a riser is open, a Health Physics Technician (HPT) shall be present to enforce ALARA principles, as specified in Hanford Site Radiation Control Manual [HSRCM-1 1994].

Toxic Gases and Hazardous Materials:

During SMMS installation and removal, and whenever a riser is open, a technician from Industrial Health, Safety, and Fire Protection (IHSFP) shall be present to implement safety controls concerning toxic gases and hazardous materials, as specified in the Tank Farm Health and Safety Plan (HASP), (WHC-SD-WM-HSP-002) [Hewitt 1995].

Dome Loading:

Before the SMMS support vehicle is positioned over the tank dome, it shall be ensured that the applicable OSRs for dome loading (both distributed and point loads) are satisfied for the tank on which the activity is occurring. This analysis will need to take into account all loads placed on the tank since the tank was certified to be in compliance with the OSRs. This includes new equipment, new concrete pads, new soil cover, etc., along with equipment needed to perform the activity such as cranes and trucks.

Crane Lifts:

- The crane and rigging that are used in SMMS instrument device installation and removal shall be load tested with loads that equal or exceed the weight of the heaviest assembly. The actual lift shall be treated as a critical lift.

Routine Maintenance and Surveillance

All tools and equipment used around the open riser that are small enough to fall through the riser shall be equipped with lanyards.

Identification of Watch List Tanks:

Appendix A in OSD-T-151-00030 identifies individual watch list tanks; and Appendix B tanks that are being considered for the watch list, and until proven otherwise, should be treated like watch list tanks.

7.2 Specific Controls for Flammable Gas Tanks**7.2.1 OSD-T-151-00030**

OSD-30 [WHC 1996], Section 30.2.A.4, In-tank inspection in Flammable Gas Tanks, is applicable to SMMS activities; and specifies that equipment design must follow the safety related criteria for TV cameras and light assemblies.

- Lighting to be UL listed for use in Class 1, Division 1, Group B; a flammable hydrogen atmosphere.
- All other electrical components located inside the tank that are not Class 1, Division 1, Group B will be purged and pressurized with instrument air or inert gas in accordance with the National Fire Protection Association, Inc. (NFPA), Article 496, Type X purging, to conform with the requirements of the National Electric Code (NEC), Article 501 for use in the flammable hydrogen atmosphere.
- Purge gas system to have redundant safety instruments to alarm and automatically shut off electrical power to the electrical components served by the purge gas system due to loss of gas pressure, if required by the safety classification of the equipment or the NFPA classification for the location where the equipment is installed, whichever is more stringent.
- In tank 101-SY radiation shielding of the replacement plug to be equal to original 42-in. shield plug.
- In-Tank inspection with a still camera requires approval by WTO & WTPE.

7.2.2 WHC-SD-WM-SARR-004 (most controls are also in OSD-T-151-00030)

WHC was directed by DOE-RL [Bader 1996] to include SARR-004 in ISB-001 [Leach and Stahl 1995] as authorization basis. SARR-004 [Schlosser 1996] was therefore updated and submitted to DOE-RL by WHC letter 9650576 [Bacon 1996] for approval. SARR-004 will not be authorization basis until approved by DOE-RL and referenced in the ISB. However, it is presently considered to be a qualified safety basis document.

Ventilation Controls for Flammable Gas tanks

The flammable gas SSTs intended to be on active ventilation are those in the SX tank farm. However, there is no requirement that the active ventilation system on flammable gas SSTs be functional. Therefore, this section will treat all flammable gas SSTs as being passively ventilated.

(Continued)

The tank ventilation system shall be operating before and during SMMS installations and removal (i.e., the breather filter must be functional). Exceptions to these requirements may occur occasionally for short periods while maintenance activities to the HEPA filters are being conducted. An example of the term "occasionally for short periods of time" is 8 hours, once a month (31 days).

On breaking tank containment in a particular riser for the first time, a 5-minute pause shall be observed. This allows any accumulated gases to be swept out of the riser.

Grounding/Bonding Prior to SMMS Activities in Flammable Gas and Organic Tanks

The riser flange cover shall be removed in such a way as to prevent possible ignition of flammable gas inside the riser because of static charges or mechanical sparks.

To prevent electrostatic sparks, the riser cover shall be electrically bonded to the tank in accordance with the appropriate NFPA Code requirements for the classified regions of the tank vapor space and ventilation system [NFPA 1993].

To prevent mechanical sparks, only spark-resistant tools shall be used, except for the initial loosening (one full turn) and the final tightening (final torquing) of the bolts.

All equipment inserted into the tank vapor space shall be electrically grounded and bonded in accordance with the appropriate NFPA requirements for the classified regions of the tank vapor space.

Hydrogen Concentration Control in Flammable gas tanks

Note: Because no specific time of intrusion control (similar to the "window" for 101-SY) is imposed, it is important to provide real-time measurements of the hydrogen concentration while activities are being performed. Until the standard hydrogen monitoring system (SHMS) is installed on each tank, this control can be satisfied by monitoring the tank using a hand-held CGM. The CGM would be positioned so that the sample is drawn from approximately the same location as the SHMS would draw its sample, i.e., near the waste surface.

If the SHMS and gas probe assembly are not installed or are not functioning, the flammable gas concentrations shall be taken with a CGM at three locations before starting the in-tank activity.

1. At the HEPA filter before any riser cover is removed.
2. After the riser bolts sealing the riser flange are loosened enough to take a gas reading from the riser, a reading shall be taken at the riser opening.
3. After complete riser cover removal, a reading shall be taken from the tank vapor space and every 15 minutes thereafter during the intrusive activity.

At each of these locations, the following instructions shall be followed. If the CGM reading is $\leq 25\%$ of the LFL, the SMMS installation may proceed. If the CGM reading exceeds 25% of the LFL, a flow-through bulb sample shall be taken for specific gas species analysis in the laboratory, the activity shall cease, and the tank shall be placed in safe shutdown mode. The activity shall not resume until results of the flow-through bulb sample are known, and the appropriate Safety and Tank Farm Project Management approvals are received. Note: This control only applies to installation and removal. If a system is installed, and meets requirements for Class-1, Division-1, Group-B, operations are permitted over 25% LFL.

If the SHMS is operating, continuous monitoring system shall be accomplished by viewing the strip chart recorder. Activities in the tank shall cease when flammable gas concentration exceed 25% of the LFL.

Time of Intrusion

SMMS installation work shall be done after a review group has looked at recent tank behavior and decided that the tank is behaving in a manner consistent with its historical norm.

This review group will have members from Waste Tank Safety Assurance, Operations (200 East or 200 West Area, as appropriate), Waste Tank Process Engineering (200 East or 200 West Area, as appropriate), Waste Tank Process Control, Tank Waste Remediation System Safety Analysis and Engineering, Waste Tank Plant Engineering (200 East or 200 West Area, as appropriate), and Flammable Gas Tank Safety Program Office.

If conditions exist outside of the normal behavior of the tank, a formal presentation will be made to the Plant Review Committee.

During SMMS activities, tank conditions shall be monitored for the entire time that the activity is being performed. This monitoring will include the tank waste level and the hydrogen concentration in the tank. The operator shall look for indications that a gas release might occur, e.g., a sudden decrease in waste surface level and/or an increase in the hydrogen concentration. If any measurements indicate that a gas release is imminent, the tank shall be placed in safe shutdown mode and the tank farm shall be evacuated.

7.3 Organic Tanks

No special controls are required for organic tanks (except C-103), as the SMMS activities will not affect fuel content of the waste, waste moisture, or waste temperature.

Specific Controls for Organic Tank 103-C (from WHC-SD-WM-SARR-001)

Ignition Sources:

Fire, flaming objects, or hot materials $> 120^\circ\text{C}$ (248°F) shall not be permitted in the vicinity of an open riser. The objective of this control is to preclude the introduction of ignition sources at the pool-air interface.

(Continued)

The prohibited materials do not include small filaments included in lighting or electronic equipment because such filaments are both small and enclosed within solid boundaries.

Electronic equipment used in tank C-103 e.g., flood lights and cameras, shall be suspended by electrical supply cords whose length is too small to permit the equipment or its supply cord from approaching within 1.52 m (5 ft) of the pool surface.

Porous materials which could serve as wicks at the organic-air interface shall be prevented from entering the tank, since a wick-stabilized flame is easier to ignite than a fire on an open pool [Postma 1994b].

Vehicles operating at grade level over tank C-103 must employ fuels (e.g., propane) or fuel tank protection (e.g., skid plate, tank location) that greatly reduces the chance for an accident in which ignitable liquid fuel could enter tank C-103.

7.4 Ferrocyanide Tanks

No special controls are required for ferrocyanide tanks, as the SMMS activities will not affect fuel content of the waste, waste moisture, or waste temperature.

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9.0 USQ SAFETY REVIEW QUESTIONS:

- A. Does the PROPOSED CHANGE represent a change to the facility as described in the AUTHORIZATION BASIS documentation?

☐ N/A ☒ No ☐ Yes/Maybe

Basis: The authorization basis is identified in Section 4.0 of this report. This temporary installation does not constitute a change, according to guidelines in DOE 5480.21 [DOE 1991], since:

- a. It does not add, delete, or convert an automatic or manual feature of the system, structure, or components important to safety.
- b. It does not introduce new system interactions.
- c. It does not change the seismic qualifications of the tank, environmental qualifications, or quality classifications of the system, structure, or components important to safety.

- B. Does the PROPOSED CHANGE represent a change to procedures as described in the AUTHORIZATION BASIS?

☐ N/A ☒ No ☐ Yes/Maybe

Basis: There are presently no procedures for in-situ monitoring of moisture in the surface solids in the single-shell waste tanks.

- C. Does the test or experiment represent a test or experiment not described in the AUTHORIZATION BASIS documentation?

☐ N/A ☐ No ☒ Yes/Maybe

Basis: This is a new configuration for neutron activation moisture monitoring of tank waste to determine if the waste meet conditionally-safe safety criteria. DOE 5480.21 [DOE 1991] states that one-of-a-kind tests used to measure the effectiveness of new techniques or a new system configuration that might affect systems important to safety will require a safety evaluation before they can be conducted.

UNREVIEWED SAFETY QUESTION SAFETY REVIEW FOR
(Continued)

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D. Does the change, test or experiment impact:

- Implemented OSRs or IOSRs? ☐ N/A ☒ No ☐ Yes/Maybe
- Approved IOSR Compliance Implementation Plans? ☐ N/A ☒ No
☐ Yes/Maybe

Basis: Except for the general restriction against drying out the waste in Conditionally Safe Ferrocyanide tanks in WHC-EP-0691, there are presently no Authorization Basis requirements that identify safe moisture levels in the SST waste, or requirements for keeping waste moisture at specified levels, as these are still being developed. Operation of the SMMS to monitor moisture levels is within the bounds of the current OSRs and IOSRs, and will thus have no impact on any of them, nor will it impact any CIP.

Based on the above, a Safety Evaluation ☒ DOES ☐ DOES NOT
need to be performed for this change

USQE No. 1 W. G. Farley

Print Name

Signature

Date

USQE No. 2 J. S. Schofield

Print Name

Signature

Date

UNREVIEWED SAFETY QUESTION SAFETY REVIEW FOR

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Figure 1 - SMMS Schematic Diagram

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Figure 2 - Deployment Arm and Neutron Probe

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FIG. 3. SIMS ELECTRONIC BLOCK DI-GRAFI SHOWING D-F-A ADDITION SYSTEM

UNREVIEWED SAFETY QUESTION EVALUATION FORM

(Per WHC-IP-0842)

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USQ Tracking Number: TF-95-0089

Area: ☒ East ☒ West

Facility: ☐ 242-A ☒ DST ☒ SST ☐ LERF
☐ Aging Waste ☐ Other

EQUIPMENT DESCRIPTION: See section 2.0

REFERENCE DOCUMENT(S):

ECN No.

PCA No.

Work Pkg No.

Other (Specify) See section 8.0

TITLE: SURFACE MOISTURE MONITORING OF HANFORD TANK WASTE BY NEUTRON ACTIVATION

1. Does the PROPOSED CHANGE, test, experiment or DISCOVERY increase the probability of occurrence of an accident previously evaluated in the AUTHORIZATION BASIS documentation?

☒ No ☐ Yes

Basis: The authorization basis is outlined in Section 4.0 of this report. Accidents are not discussed in the first tier of the authorization basis (ISB-001) [Leach and Stahl 1995] or the second tiers of the authorization bases, OSR-004 for AWTs [Aguirre 1996], OSR-005 for SSTs [Dougherty 1996], OSR-016 for DSTs [Heubach 1996]. Accident probabilities are discussed in third tier authorization basis documents SAR-006 [WHC 1989a, SAR-034 [WHC 1989b], and SAD-009 [Farley/Grigsby 1994]. Those related to SMMS installation and operation are as follows:

SAR-006 lists the only credible accidents as loss of seal loop fluid and breach of HEPA filter or ventilation ductwork due to natural phenomenon.

SAR-034 lists the likelihood of dome failure from heavy equipment and earthquakes, crane load drops, hydrogen accumulation and ignition, leaks of liquid waste to soil, and occupational personal exposure, and industrial accidents.

SAD-009 lists the likelihood of workers being exposed to contaminated equipment during equipment removal, and exposure to toxic gases. This document was signed by DOE but is not currently included as part of the Authorization Basis.

The SMMS test will not increase the probability of accidents analyzed in the above safety documents.

2. Does the PROPOSED CHANGE, test, experiment or DISCOVERY increase the consequences of an accident previously evaluated in the AUTHORIZATION BASIS documentation?

☒ No ☐ Yes

Basis: Consequences could be increased by structural changes to waste containment or vapor confinement, changes to the waste source term, increase worker exposure time to radiation or toxic gases, or adverse changes in industrial work procedures. All significant accidents involved with SMMS installation and operation were deemed to be incredible in Section 5.0 of this report, therefore, consequences were not calculated. However, since SMMS installation and operation will not significantly affect any of the above safety parameters, there is no increase in consequences previously evaluated.

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(Continued)

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Does the PROPOSED CHANGE, test, experiment or DISCOVERY increase the probability of occurrence of a malfunction of EQUIPMENT previously evaluated in the AUTHORIZATION BASIS documentation?

☒ No ☐ Yes

Basis: Equipment important to safety are tank structure, the ventilation system, flammable gas monitoring system, waste level monitoring system, and temperature monitoring systems, and pressure monitoring systems. Since SMMS activities will not affect any of the above, they will not increase the probability of malfunction of this equipment.

4. Does the PROPOSED CHANGE, test, experiment or DISCOVERY increase the consequences of a malfunction of ITS EQUIPMENT previously evaluated in the AUTHORIZATION BASIS documentation?

☒ No ☐ Yes

Basis: Since the equipment important to safety (ITS) will not be effected, consequences of accidents associated with this equipment will not be effected.

5. Does the PROPOSED CHANGE, test, experiment or DISCOVERY create the possibility of an accident of a different type than any previously evaluated in the AUTHORIZATION BASIS documentation?

☒ No ☐ Yes

Basis: Type accidents previously analyzed were loss of tank containment or confinement from dropped equipment, flammable gas ignition, breach of dome or ventilation system, criticality, radiation and toxic gas exposure, and industrial accidents. No new type of accident is anticipated from SMMS activities.

6. Does the PROPOSED CHANGE, test, experiment or DISCOVERY create the possibility of a malfunction of EQUIPMENT of a different type than any previously evaluated in the AUTHORIZATION BASIS documentation?

☒ No ☐ Yes

Basis: Since the SMMS will not affect equipment important to safety, it is not expected to increase the possibility of malfunction of the equipment.

UNREVIEWED SAFETY QUESTION EVALUATION FORM

(Continued)

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7. Does the PROPOSED CHANGE, test, experiment or DISCOVERY reduce the margin of safety as defined in the basis for any Technical Specification/Operational Safety Requirement?

☒ No ☐ Yes

Basis: Margins of safety are stipulated in the IOSRs [Aguirre 1996, Dougherty 1996, Heubach 1996] OSR-005 for maximum waste level, maximum waste temperature, vapor space pressure, vapor space flammability, and moisture content of ferrocyanide waste. Since SMMS activities will not affect any of the above, it can not affect the margins of safety.

8. Does the PROPOSED CHANGE, test, experiment or DISCOVERY require a new or revised OSR, IOSR or a compensatory measure required by a Compliance Implementation Plan?

☒ No ☐ Yes

Basis: OSR-005 adequately covers all safety issues, thus no changes are required. IOSR compliance plan WHC-IP-0954, Rev. 4 [Twiselton 1995], was reviewed to determine if compensatory (remediation) measures were required to cover SMMS activities, and it was judged that done were needed.

USQE No. 1 W. G. Farley

Print Name

USQE No. 2 J. S. Schofield

Print Name

Signature

Date

Signature

Date

PRC REVIEW (If Required)

Meeting No.: _____ Date _____

PRC Chairman

Concurrence:

Signature

Date

Subj: MSD Audit Comments, USQ for SMMS
From: 96-07-25 10:08:52 EDT
From: George_F_Jr_Vargo@RL.gov
To: HiLineEngr@aol.com

File: SMMS-US.REV (10811 bytes)
DL Time (14400 bps): < 1 minute

Dean,

Please coordinate this request with Jim Klos of the TWRS Authorization Basis function and Gary Dukelow. WHC has processed the cited USQ consistent with applicable WHC requirements. Presently, RL USQ review and resolution of DOE RCR comments is not mandated by the procedure. These efforts require work not presently planned nor funded. This issue has been brought to RL attention.

Sheldon Stahl, Manager
TWRS SAR Engineering

Folks,

The Record Comment Review document forwarded in this cc:mail contains comments on the USQ document produced for the SMMS. These comments resulted from an audit of the USQ, which audit was requested by Rich McNulty of RL.

I am forwarding these comments quickly in hopes that they can be resolved very rapidly and the need for a revised USQ averted.

It appears that the best approach would be to have Wayne, or someone else in his absence, review the comments immediately and recommend an approach which best fits the situation. This may allow us to negotiate a resolution with RL prior to the comments coming over formally, as was indicated by Rich.

In reviewing the comments quickly myself, I am convinced that Rich feels that additional safety documentation will need to be prepared in addition to revisions to the USQ.

Please review the comments and let Det Wegener (SMMS PRT Leader) or myself know what you think as soon as possible, since the WHC ORR Team is presently working the ORR and this could affect closure of the review. By the way, comments by anyone are welcome.

Dean

Forward Header

Subject: MSD Audit Comments, USQ for SMMS
From: Richard R McNulty at ~DOE4
Date: 7/24/96 12:39 PM

Please see attached comments. Formal transmittal will be be

to McCluskey, WSD with recommendation to require rework of
USQ evaluation

Thanks, Rick

----- Headers -----

From: George_F_Jr_Vargo@ccmail.rl.gov Thu Jul 25 10:09:55 1996
Return-Path: George_F_Jr_Vargo@ccmail.rl.gov
Received: from touchet.rl.gov (TOUCHET.RL.GOV [130.97.128.16]) by emin16.mail.aol.com (8.6.12/8.6.12) with ESMTP id KAA08101 for <HiLineEngr@aol.com>; Thu, 25 Jul 1996 10:09:54 -0400
Received: from ccmail.rl.gov (ccmail.rl.gov [130.97.241.32]) by touchet.rl.gov (8.7.5/8.7.3) with SMTP id HAA06041 for <HiLineEngr@aol.com>; Thu, 25 Jul 1996 07:01:54 -0700 (PDT)
From: George_F_Jr_Vargo@RL.gov
Received: from ccMail by ccmail.rl.gov
(IMA Internet Exchange 1.04b) id 1f77fe30; Thu, 25 Jul 96 07:08:35 -0700
Mime-Version: 1.0
Date: Thu, 25 Jul 1996 07:05:42 -0700
Message-ID: <1f77fe30@ccmail.rl.gov>
Return-receipt-to: George_F_Jr_Vargo@RL.gov
To: HiLineEngr@aol.com
Subject: MSD Audit Comments, USQ for SMMS
Content-Type: multipart/mixed; boundary="IMA.Boundary.517303838"

DISTRIBUTION SHEET

To	From				
Distribution	B. D. Board				Date 12/11/99
Project Title/Work Order					EDT No. N/A
Surface Moisture Measurement of Tank Waste					ECN No. 165790

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
B. D. Board	A3-37	X			
A. M. Horner	L6-57	X			
M. L. McElroy	S7-07	X			
D. G. Panther	L6-39	X			
R. L. Schlosser	A3-37				X
T. I. Stokes	L6-37				X
G. F. Vargo	H5-09				X
W. T. Watson	H0-38				X
Central Files	A3-88	X			

ENGINEERING CH

1. ECN 165790

Proj.
ECN

2

2. ECN Category (mark one) Supplemental ☐ Direct Revision ☒ Change ECN ☐ Temporary ☐ Standby ☐ Supersedeure ☐ Cancel/Void ☐	3. Originator's Name, Organization, MSIN, and Telephone No. B. D. Board, 8M100, A3-37, 376-8422	3a. USQ Required? ☐ Yes ☒ No	4. Date 11/29/95
	5. Project Title/No./Work Order No. Surface Moisture Measurement of Tank Waste	6. Bldg./Sys./Fac. No. 306E	7. Approval Designator SQ
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-GN-SAD-301, Rev 0-D	9. Related ECN No(s). N/A	10. Related PO No. N/A
11a. Modification Work ☐ Yes (fill out Blk. 11b) ☒ No (NA Blks. 11b, 11c, 11d)	11b. Work Package No. N/A	11c. Modification Work Complete N/A Cog. Engineer Signature & Date	11d. Restored to Original Condition (Temp. or Standby ECN only) N/A Cog. Engineer Signature & Date

12. Description of Change

Revise Safety Assessment Document for the 306E Building as follows:

1. Replace pages i-iii with attached pages i-iii.
2. Replace pages 64-67 with attached pages 64-68.
3. Add pages C-1 through C-4 (attached).

13a. Justification (mark one)

Criteria Change ☒ Design Improvement ☐ Environmental ☐ Facility Deactivation ☐
As-Found ☐ Facilitate Const ☐ Const. Error/Omission ☐ Design Error/Omission ☐

13b. Justification Details

Re-evaluated hazard classification of facility with source based procedure. Updated numbers and requirements.

14. Distribution (include name, MSIN, and no. of copies)

See attached distribution sheet.

DEC 18 1995		RELEASE STAMP	
DATE:	21	STAMP:	20

[illegible]

Appendix E

Structural Analysis

battelle

Pacific Northwest Laboratories
Battelle Boulevard
P.O. Box 999
Richland, Washington 99352
Telephone (509)

375-6694

September 5, 1995

Troy Stokes
WHC
PO Box 1970
MSIN H5-09
Richland, Washington 99352

Dear Troy:

Jim Fort and I have reviewed the hydrogen-air combustion calculation performed by A. Dabiri per your request. We found his calculated combustion pressure of 440 psi to be approximately the theoretical upper limit which is obtained by assuming stoichiometric detonation (~30% H₂ by volume). This represents the highest achievable pressure, and is, therefore, suitable for use as a conservative design pressure.

In addition to reviewing Dabiri's methodology, we performed two separate analyses to verify his result. The first of these utilized an undocumented educational software package which solves the theoretical equations to predict the detonation products. The program, EQLBRM, is an educational PC software written in 1988 by Prof. David Pratt of the University of Washington.

The second method was based on experimental results for H₂-air combustion. The data of Lewis & Friauf as reported in "Principles of Combustion" by K. K. Kuo, 1986, Wiley & Son's, page 260 was used, together with the theoretical equations, to determine the detonation stagnation pressure.

For both of the methods, different reactants and buffers were considered which correspond to various stoichiometries. Combustion pressures ranging from 370 - 410 psi were computed for stoichiometric conditions. The lower value is from software program and the upper value is based on the experimental data. The resulting pressure from rich or lean detonation is lower.

Please note that 440 psi is an extremely conservative value. If it is found to be difficult to design the canister to handle these pressures, lower, more realistic values could be provided since detonation is very unlikely (experimentally determined lower detonation limit is 18% H₂ by volume). More realistic pressures would be derived assuming adiabatic burning of pre-mixed H₂-air using realistic values for H₂ concentrations.

September 5, 1995

Page 2

Please let me know if you have any questions concerning our findings.

Sincerely,

A handwritten signature in dark ink, appearing to be 'P. Meyer', followed by a horizontal line.

Perry A. Meyer
Research Scientist

PAM/kr

cc: James M. Bates
James A. Fort
File/LB

2.2.4

**Westinghouse
Hanford Company**

**Internal
Memo**

From: Spent Nuclear Fuel Evaluations
Phone: 376-4193
Date: November 28, 1995
Subject: SMMS Structural Evaluation for Accident Conditions

SMMS-95.016

To: D. B. Graves L6-01

cc:	P. R. Deichelbolher	S7-12
	W. G. Farley	S7-71
	C. E. Hanson *	H5-09
	L. S. Krogsrud	R3-08
	R. P. Omberg *	R3-85
	T. I. Stokes	H5-09
	G. F. Vargo Jr.	H5-09
	SLH File/LB	

* without attachment

References: (1) T. I. Stokes, et al, Handout: 60% Design Briefing - Surface Moisture Measurement System (SMMS), October 4, 1995.

The attached analysis addresses the structural integrity and related requirements of the Surface Moisture Measurement System (SMMS) deployment assembly and the Hanford Site high-level waste (HLW) tanks component(s) to which it interfaces with during design basis accidents. The only requirement for these accident conditions is that the HLW tanks are not damaged to the extent that an unacceptable safety/environmental condition is produced (e.g. a leak in the tank). Damage to the SMMS assembly is acceptable, so long as this damage does not cause an unacceptable condition on the HLW tank. Operational and Natural Phenomena accidents addressed herein are the: 1) drop of the SMMS deployment assembly during installation/removal; and 2) Earthquakes. The results of the attached analysis show that the SMMS assembly and interfacing tank riser will maintain their structural integrity under the above accident conditions. A summary of these analyses is given below.

Crane Drop of SMMS Deployment Assembly

The SMMS deployment assembly (assumed upper bound weight of 1350 lbs) is assumed to free drop at least 36 feet (length of the mast and arm) onto a waste tank riser. This accident condition is an extremely unlikely event (10^{-4} to 10^{-6} , Ref), but is nevertheless designed for with the use of an impact limiting device. The impact limiter system consists of two impact limiters (a long 35" and a short 8") which are stacked vertically on the decontamination unit which is mounted to a HLW tank riser. The pair of limiters is used for vertical drop of 40 ft or less. The long limiter is removed/installed as required, as the short limiter is designed for free drops of up to 6.7 feet. A free drop of 11 inches can be safely

D. B. Graves
November 28, 1995
Page 2

accommodated without any impact limiter(s), due to the elastic response of rubber bumpers in decontamination unit.

The SMMS device is expected to be mounted to either 4" or 12" risers on waste tanks BY-103, 104, 105, 106, 108, 110, B-103, TX-105, 118. This includes the use of multi-port risers. The attached analysis showed that for multi-port riser with adapter plate flanges less than 1 inch in thickness, unacceptable stresses can develop at the impact limiter design load. Hence, for these risers, a bridging system is used which consist of aluminum I-beams and jack stands which provides additional support for the lower impact plate.

The impact limiter system works like a typical impact system on nuclear shipping cask. The kinetic energy at impact is converted into plastic work in crushing (up to one-half the length) the plastic foam filler. The maximum impact force is primarily related to the plastic foam material crush strength and the cross sectional area. The crush load limit for this design has been set to 32,200 lbs, which is less than 50% of the strength of the weakest riser (4"). This relatively low load should also provides margin with respect to the 60-100 ton combined concentrated load limit for waste tanks. Furthermore, at this load, which is equivalent to 23.4 g's, the SMMS deployment assembly is shown to maintain its structural integrity, and will not become a projectile(s) which could potentially penetrate the bottom of the HWL tanks.

Earthquake

The reference safety assessment showed that the .25 g seismic event is incredible for the SMMS during the tank insertion period, and hence need not be evaluated. Here, a lower magnitude earthquake of 0.12 g's, and that consistent with Safety Class 2 component, of which a HLW tank riser without liquid waste in it can be considered, is evaluated. Analysis was based on equivalent static method, assuming 10% of critical damping, a 2.0 Importance factor, conservative higher modes contribution, and conservative support conditions.

Results of the seismic evaluation showed that all risers, considered for SMMS deployment assembly insertion, will maintain their structural integrity during the postulated events. The SMMS deployment assembly was also show to remain intact.

S. L. Hecht
Spent Nuclear Fuel Evaluations

Attachment

(1) Drawing _____ (3) Page 1 of 19
(4) Building _____ (5) Rev. _____ (6) Job No. _____
(7) Subject SMMS: SAFETY STRUCTURAL ANALYSIS
(8) Originator S.C. HECHT Date 11-21-95
(9) Checker _____ Date _____

(10)

IMPACT LIMITING SYSTEM

THE SMMS INSTRUMENT (WT ~~4~~ 1350 LB) CAN BE DROP INTO THE TANK RISER AT A MAXIMUM OF ~36 FT. HENCE THE POTENTIAL ENERGY (PE) IS

$$PE = WH = (1350 \text{ LB})(36 \text{ FT})(12 \text{ in/ft}) = 5.83 \times 10^5 \text{ in-lb}$$

IT IS DESIRABLE TO LIMIT THE MAXIMUM FORCE TO SOME ACCEPTABLE VALUE. THIS WAS CHOSEN TO BE APPROXIMATELY 30,000 LB, WHICH LOAD IS LESS THAN 50% OF THE MINIMUM STRENGTH OF ANY UNSUPPORTED RISEL STRENGTH TO WHICH IT IS MOUNTED (SEE PG 7). ADDITIONALLY

THERE IS 100 TON COMBINED CONCENTRATED LOAD LIMIT ON MOST TANKS, WITH A FEW AT A 60 TON LIMIT (WNC-SD-WM-DSR-01B)

THE PRINCIPLE OF THE IMPACT LIMITER (URAN) IS TO LIMIT THE LOAD TO A ACCEPTABLE VALUE, WHILE ABSORBING ALL THE KINETIC ENERGY (KE) OF IMPACT ($KE = PE$). THIS IS DONE BY DOING PLASTIC WORK (W_p) ON CRUSHING PLASTIC FORM. WHICH IS EQUAL TO THE $PE = KE$.

$$W_p = \int F \cdot ds = \epsilon \cdot A \cdot l_c$$

where ϵ is the crush strength of plastic form
~ CONSTANT UP TO 50% COMPRESSION

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(10)

(1) Drawing _____ (3) Page 3 of 19
(4) Building _____ (5) Rev. _____ (6) Job No. _____
(7) Subject SMMS
(8) Originator ABH Date 11-21-95
(9) Checker _____ Date _____

(10)

CONSIDER BUCKLING OF SMALLEST PANEL (MOST RESISTANT TO BUCKLING): CAL. BUCKLING CRITICAL STRESS (S') VIA METHOD GIVEN IN (ROARK, 1ST EDITION, VOL. 1)

FOR 9" X 8" PANEL $a/b = .89 \Rightarrow K = 7.8$

$$S' = \frac{KE}{1-\nu^2} \left(\frac{t}{b} \right)^2 = \frac{(7.8)(30 \times 10^6)}{1-.3^2} \left(\frac{.015}{9} \right)^2 = 714 \text{ psi}$$

$$A \approx 2(18+9)(.015) = .081 \text{ each half.}$$

$$F' = S'A = (714)(.081) = 1,160 \text{ lbs}$$

- USE TWICE THIS VALUE TO ACCOUNT FOR FORM SUPPORT

$$\therefore F' = 2,320 \text{ lbs}$$

Then the TOTAL MAXIMUM IMPACT FORCE IS:

$$F = F_f + F' = 29,870 + 2,320 = \underline{32,200 \text{ lbs}}$$

THE CORRESPONDING INERTIAL LOADS ON G'S GENERATED

$$\text{is } G = \frac{32,200}{1350} = \underline{23.8 \text{ g's}}$$

- ONCE THE IMPACT LIMITER (WALL) IS REMOVED THEN THE SMMS INSTRUMENT CAN DROP OFF FOOT ONTO THE RISER SYSTEM, (8" SHORT UNIT + 3" SPACE) TO ACCOMMODATE THIS ACCIDENT CONDITION A RIBBLE BUMPER SYSTEM () IS USED, WITH IN DECONTAMINATION UNIT

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(1) Drawing _____ (3) Page 4 of 19
(4) Building _____ (5) Rev. _____ (6) Job No. _____
(7) Subject SMMS
(8) Originator ADH Date 11-21-95
(9) Checker _____ Date _____

(10)

IN THE DECONTAMINATION UNIT THERE ARE 2 - 0.8 inch
Thick RUBBER SPACER STACKED IN 4 SERIES
ARRANGEMENT. GRAPH DATA SHOWS THAT THE STIFFNESS
OF BEAMS IN THE UNIT TO BE $9,100 \text{ lb/in}$ AT
10% COMPRESSION AND IS FAIRLY LINEAR.
THEREFORE FOR THE TWO ELASTOMER
IN SERIES $K_{10\%} = 9,100/2 = 4,550 \text{ lb/in}$
RUBBER STRAIN HARDENS CONSIDERABLY UNDER COMPRESSION GREATER
50% AS SHOWN IN THE FIGURE BELOW AS TAKEN FROM
MANTILL

Typical elastomeric stress-strain curves in extension and compression.

ITERATIVE SOLUTIONS SHOW THAT APPROXIMATELY 80% COMPRESSION IS
REQUIRED FOR THE LOAD LIMITATION AND ENERGY REQUIREMENTS.

HERE $K_{AVE}^{80\%} = 3.1 \text{ K}$ $K_{INST}^{80\%} = 4.7 \text{ K}$

(KAVE IS USED TO DETERMINE ELASTIC ENERGY STORAGE, K_{INST} USED TO
DETERMINE MAXIMUM FORCE)

$$\therefore K_{AVE}^{70\%} = (3.1)(4,550) = 14,105 \text{ lb/in}$$

$$K_{INST}^{70\%} = (4.7)(4,550) = 21,485 \text{ lb/in}$$

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(1) Drawing _____ (3) Page 5 of 19
(4) Building _____ (5) Rev. _____ (6) Job No. _____
(7) Subject SMMS
(8) Originator DOB Date 11-21-95
(9) Checker _____ Date _____

(10)

THE ASSUMPTION THAT ALL THE KINETIC ENERGY AT IMPACT
IS CONVERTED INTO ELASTIC STRAIN ENERGY OR WORK
IS CONSERVATIVELY USED. HERE FOR A 11" MAX
DROP.

$$PE = Wh = (1350)(11) = 14,850 \text{ in-lb}$$

$$W_e = \int f \cdot ds$$

at 80% COMPRESSION THE ASSUMPTION OF A LINEAR SYSTEM,
(I.E. $F = KX$), IS REASONABLE AND ONLY SLIGHTLY IN ERROR
(SLIGHTLY APPROXIMATE 10% NON CONSERVATION; AREA UNDER CURVE)
ASSUMING AN ELASTIC OR ELASTICALLY CONSERVATIVE (NO LOSS) SYSTEM
SHOULD MORE THAN MAKE UP FOR THE LINEAR ASSUMPTION

Hence

$$W_e = \int f \cdot ds = \int_0^x Kx \cdot dx = \frac{Kx^2}{2}$$

∴ Equating PE and W_e we get:

$$x = \sqrt{\frac{2PE}{K_{avg}}} = \sqrt{\frac{(2)(14,850)}{17,100}} = 1.45 \text{ in}$$

$$\text{Length of rubber, } L, \text{ required} = x / 0.8 = 1.81$$

$$\text{Actual} = (2)(.8) = 1.6 - \text{WITHIN 13\% - O.K.}$$

Then the maximum force generated is

$$F = Kx = (21,100)(1.45) = 31,000 \text{ lb} - \text{ACCEPTABLE}$$

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(1) Drawing _____ (3) Page 6 of 19
(4) Building _____ (5) Rev. _____ (6) Job No. _____
(7) Subject SMMS
(8) Originator [Signature] Date 11-21-95
(9) Checker _____ Date _____

(10)

STRESS/STRENGTH OF RISER UNDER IMPACT LOAD.

A REVIEW OF ~~THE~~ ^{AND MULTI-PORT} RISER ON TANKS WHICH ARE
PRIME CANDIDATES FOR SMMS INSULATION, (9)
BY-103, 104, 105, 106, 108 & 110, B-103, TX-105, TX-116
INDICATES THAT THERE ARE SEVERAL RISER (TYPES)
WHICH ARE OF CONCERN. OF THESE, ONE TYPE
WAS SHOWN VIA STRESS ANALYSIS TO BE UNACCEPTABLE.

THIS UNACCEPTABLE RISER IS 42" MULTI-BOLT RISER
INITIALLY USED FOR TANK VENTILATION, ON TANK BY-110
RISER R. THIS RISER HAS A 1/4" IN STEEL PLATE
FLANGE, THAT GIVES A 18.12" IN RISER. EVEN WITH
THE DESIGN INCORPORATING A CHANNEL SUPPORT, THE
MAXIMUM CALCULATED ELASTIC STRESS IS 388,000 PSI,
WELL IN EXCESS OF THE YIELD STRENGTH. FOR THIS
CASE A SYSTEM OF ALUMINUM I-BEAM & STAYS
(DRAW) WHICH WILL BRIDGE THE RISER IS
USED. THE BEAM IS NOT A STANDARD STRUCTURAL
SHAPE - NEED CALC. I & S.

$$I = I_o + ad^2$$

$$I_o = \frac{bh^3}{12} = \frac{(1.25)(8-.82)^3}{12} = 7.71$$

$$I_o \neq 0$$

$$a^2 = (11)(5) = 2105$$

$$I = 7.71 + (2)(2105)(4-.25)^2 = 66.8 \text{ in}^4$$

$$S = I/c = 66.8/4 = 16.7 \text{ in}^3$$

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(1) Drawing _____ (3) Page 7 of 19
(4) Building _____ (6) Job No. _____
(7) Subject SMM 5 Date 11-21-95
(8) Originator ADH Date _____
(9) Checker _____

(10)

THE LONGEST SPAN (BRIDGE) IS EXPECTED TO BE 12 FT WITH EACH BEAM TAKING $\frac{1}{2}$ THE IMPACT LOAD OF 15,900 lbs. WE HAVE:

$$M_{max} = \frac{1}{4} WL = (.25)(15,900)(12 \times 12) = 579,600 \text{ in-lbs}$$

$$S_{max} = M/S = 579,600 / 16.7 = 34,700 \text{ psi}$$

THE BEAMS ARE MADE OF AL 6061-T6, WITH $S_y = 40 \text{ ksi}$,
AND $S_u = 45 \text{ ksi}$ (METAL HANDBOOK)
 $\therefore$ DESIGN IS ACCEPTABLE.

OF THE INDIVIDUAL RISER, THE 4" DOMR RISER FOR BT-PA, 105, and 106 (SEE DRAW H-2-1319) IS LOWEST STRENGTH. THIS RISER (ALSO 12" on BT-10B) IS ANCHORED IN THE DOMR CONCREAT WITH 8- $\frac{3}{4}$ " BARS WITH $\frac{1}{4}$ " in fillet weld. HERE

$$A_s = 8\pi D_h \delta t (3/4)(1/4) = 4.712$$

$$T_{av} = P/A = 32,200 / 4.712 = 6,830$$

$$S_{ys} = \frac{1}{2} S_y = 15,000 \text{ min}$$

$$S.F. = 15,000 / 6,830 = 2.20$$

CHECK STRENGTH OF RUBA PIPE (4" SHD 40)

$$A = 3.117 \text{ in}^2$$

$$\sigma = P/A = 32,200 / 3.117 = 10,200 \text{ psi}$$

$$S_{y \text{ min}} = 30,000 - 0 \text{ O.K.}$$

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(1) Drawing _____ (3) Page 8 of 19
(4) Building _____ Job No. _____
(7) Subject SHAMS
(8) Originator AKP Date 11-21-95
(9) Checker _____ Date _____

(10)

CHECK OTHER 42" MULTI-PORT RISER.

THESE USUALLY HAVE 2 RISER. THE FLANGE ADAPTOR PLATE VARIES FROM 1/4 TO 1/2 INCH THICK.

TO ANALYZE THIS SITUATION A ELASTIC-FINITE ELEMENT ANALYSIS (FEA) WAS MADE, FOR A 0.25 INCH THICK PLATE THE FEA UTILIZED THE ALGOR (ALGOR, HEBB) COMPUTER CODE. THE MODEL IS SHOWN IN FIG 1, REPRESENT A TYPICAL FLANGE ADAPTOR WITH A 12 AND 18 INCH RISER. THE MODEL USE PLATE-SHELL WITH 2 INTERATION POINT THROUGH THE THICKNESS AND 2 DIAGONALLY. A 30,000 LB DISTRIBUTED LOAD WAS APPLIED AROUND THE 12 3/4 INCH HOLE. THE RESULTS SHOWN (SEE FIG. 1) THAT THE ELASTICALLY CALCULATED σ_e IS 547,000 PSI - WELL IN EXCESS OF ALLOWABLE. TO ASSESS OTHER THICKNESSES WE REALIZED THAT $\sigma \propto \frac{1}{t^2}$; SO THAT FOR A 1 INCH THICK PLATE THE STRESS IS $(\frac{1}{4})^2$, OR 1/16 TH OF THE VALUE SHOWN IN THE FIGURE. HENCE FOR 32,200 LB LOAD ON A ONE-INCH THICK MULTIPORT RISER WE GET

$$\sigma_e = (547,000) \left(\frac{1}{4}\right)^2 \left(\frac{32,200}{30,000}\right) = 36,700 \text{ PSI}$$

THIS IS A ACCEPTABLE VALUE AS THE A-36^{STEEL} MINIMUM YIELD STRESS $S_y = 36 \text{ KSI}$, $S_u = 58 \text{ KSI}$

SO MULTI-PORT RISER USING 1" OR THICKER ADAPTOR ARE ACCEPTABLE.

(1) Drawing _____ (3) Page 9 of 19
(4) Building _____ (6) Job No. _____
(7) Subject SMMS
(8) Originator DP Date 11-21-95
(9) Checker _____ Date _____

(10)

ADDITIONAL IMPACT LIMITER^{SYSTEM} CONCERNS UNDER DROP LOAD.

AS THE TOP IMPACT PLATE ON THE SMMS INSTRUMENT IS 21 INCHES IN DIAMETER, THE CORNERS OF THE IMPACT LIMITER ARE NOT DIRECTLY LOADED BY THE UPPER IMPACT PLATE AND MUST REPLY ON THE STRENGTH OF THE IMPACT LIMITER TOP PLATE 0.12 INCH 304. SHOULD THIS PLATE FAIL - THE IMPACT LIMITER WOULD LOSE SOME EFFECTIVENESS AND POTENTIALLY ALLOW HIGHER LOADS TO DEVELOP.

TO ASSESS THIS SITUATION, A ELASTIC FEA USING THE ALGOR MODEL WITH SHELL ELEMENTS WAS DEVELOPED (SEE FIG. 2). THE RESULTS OF THIS ANALYSIS (LOADING = 118 PSI FROM PRESSURE) SHOWS THAT THE MAXIMUM CALCULATED $\sigma_e = 57,500$ PSI ON THE 304ST PLATE AS $S_u(\min) = 70,000$ PSI (NBS) = ACCEPTABLE CONDITION.

TOP PLATE STRESS

CONSERVATIVE
ASSUME P OVER
TOTAL SURFACE.

OP-21, ID=4.5 (Griff=1, p_y 175 Case 10)

 $\frac{a}{b} = \frac{21}{4.5} = 4.67$
 $K_1 = 1.19$

$$\sigma_1 = \sigma_{max} = \frac{k_1 w}{t^2} = \frac{k_1 p \pi (a^2 - b^2)}{.88^2} = \frac{(1.19)(118)\pi \left(\frac{21^2}{4} - \frac{4.5^2}{4} \right)}{.88^2} = 59,920 \text{ psi}$$

$S_{u \min} = 70,000 \text{ psi} \Rightarrow \text{OK,}$

BOTTOM PLATE IS ACCEPTABLE VIA INSPECTION + C.T.,
THICKNESS IS THE SAME - BETTER SUPPORTED.

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(1) Drawing _____ (3) Page 10 of 19
(4) Building _____ i) Job No. _____
(7) Subject SMMS
(8) Originator [Signature] Date 11-21-95
(9) Checker _____ Date _____

(10)

IT IS ALSO REQUIRED THAT BULBPOINTS OF THE SMMS REMAIN INTACT UNDER THE PROP. CONDITION, I.E. CAN WITHSTAND THE 23.4 g load.

CHECK COMPONENT / ATTACHMENT

Extension JOINT

6 - 5/16-24 UNC screws $Q_{\text{R}} = .0529 \text{ in}^2$
 $q_T = (L)(.0529) = .398$

$P = (W) a_w = (194 \text{ lb})(23.4) = 4,540$

$\sigma_A = P/A = 4,540 / .398 = 13,040 \text{ psi}$

414 STEEL BOLT ($S_u > 100 \text{ ksi}$) $\Rightarrow$ O.K.

ELBOW JOINT

PINS $F = W \pi = (88)(23.9) = 2,060$

$A_{\text{PINS}} = (2) \frac{\pi}{4} (.375)^2 = .221$

$T_{\text{AVG}} = 2,060 / .221 = 9,300$

$S_{\text{MIN}} = S_y / 2 = 30,000 / 2 = 15,000 \Rightarrow$ O.K.

TIME IN TAB (MOST ATTACHMENT STRANGER BY INSPECTION)

$A(2 \text{ TABS}) = (2)(11.374)(.086) = 0.108$

$\sigma_A = 2,060 / .108 = 19,100 \text{ psi} - \text{O.K.}$

SMALL TENSILE OUT $l = \sqrt{.5^2 - (.375)^2} = .461$

$q_s = 2l \pi t = (2)(.461)(.086) = 0.16$

$T = 2,060 / .16 = 16,250 > 15,000 \text{ psi, however.}$

$S_{U_3} = \frac{1}{2} S_u = (.5)(70,000) = 35,000 \Rightarrow$ O.K.

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MAST SUPPORT

$$\text{MAST + ARM WLGHT } 445 + 87 = 532 \text{ lbs}$$

THE INERTIAL FORCE IS $W R = (532)(23.9) = 12,400 \text{ lbs}$
 THIS IS REACTED BY THE WELD FROM THE 3" SVD 40 (3.5" OD)
 MAST TO ROTATION PLATE / BEARING. THESE ARE 2-
 3/16 ALL-AROUND FILLER WELDS

$$\sigma = \frac{1.4 F}{\pi D e} = \frac{(1.707)(12,400)}{\pi (3.5)(3/16)} = 9,250 \text{ psi}$$

O.K.

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(10)

SEISMIC ANALYSIS

OBJECTIVE IS TO DETERMINE IF THERE IS UNACCEPTABLE DAMAGE TO THE TANK RISER/TANK. RISER IS CONSIDERED SATFY CASE 2 COMPONENT*. ANALYSIS IN ACCORDANCE WITH UCLL-15910 AND HWS-SDC-41. INVESTIGATE POTENTIAL DAMAGE TO WORST CASE 4" AND MULTI-PORT RISERS

4" - RISER

ASSUME THAT SOIL AROUND TANK DOESN'T LATERALLY SUPPORT RISER. DO WORST CASE IS CONSIDERED LONGEST OR SHORTEST RISER LENGTH ABOVE CONCRETE TANK DOME.

THIS IS 19'-2" RISER (TANK B-103), - WITH BOLTON DECONTAMINATION UNIT UNSUPPORTED LENGTH $\approx 17'$.

RISER IS 4 IN - S&W 40 PIPE, $A = 3.17 \text{ in}^2$, $I = 7.23 \text{ in}^4$

$$S = I/2.25 = 3.21 \text{ in}^3$$

HARA

$$K = \frac{3EI}{L^3} = \frac{(3)(3.17 \times 10^6)(7.23)}{[(17)(12)]^3} = 76.7 \text{ lb/in}$$

$$W = 1350 + 150 (\text{Accom} + \text{Plate}) = 1500 \text{ lb} \Rightarrow m = W/g = 1500/386.4 = 3.88 \text{ slugs}$$

$$W_n = \sqrt{\frac{K}{m}} = \sqrt{\frac{76.7}{3.88}} = 4.44 \text{ rad/sec}$$

$$f_n = \frac{1}{2\pi} W_n = .71 \text{ Hz (LONG RISER)}$$

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* Per WAC-EP-0572 "INITIAL Implementation of Defence WAREHOUSE FACILITIES SAFETY BOARD RECOMMENDATION 90-2, for HANFORD SITE HIGH-LEVEL WASTE TANK - IIR of CODE + STD, BD-6400-060.1 (12/87)

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THE SHORTEST RISER 9'-4" above ground -
CONSIDER 12' WITH BOLTS.

$$K_s = \frac{3EI}{L^3} = 21.8 \text{ k/ft}$$

$$f_n = \frac{1}{2\pi} \sqrt{\frac{K}{m}} = 1.19 \text{ Hz.}$$

FROM UCRL-15910; DAMPING IS 10% OF CRITICAL.

FROM HWS-SDC-4.1 FOR A Safety Class 2
COMPONENT DESIGN TO A 0.12 g free field H₀, AND
WITH A IMPORTANCE FACTOR (I) OF 2.0, THE

HORIZONTAL ACCELERATION (g) RESPONSE IS (FROM TABLE 4-SDC-4.1)

LONG RISE $f_n = .71$ $a'_1 = 0.0939 \text{ g's}$

SHORT RISE $f_n = 1.19$ $a'_1 = 0.16 \text{ g's}$

∴ THE DESIGN ACCELERATION IS

$$a_d = (a'_1 \cdot (2) \cdot (1.3) \cdot (1.5)) = 3.9 a'_1$$

↑
↑ HIGHER MODE CONTRIBUTION (NR RG 4000)
↑ HORIZONTAL CONTRIBUTION (UCRL-15910)
I from UCRL-15910

LONG RISE $a_d = (3.9)(0.0939) = 0.36 \text{ g's}$

SHORT RISE $a_d = (3.9)(0.16) = 0.62 \text{ g's}$

THE MAXIMUM FORCE GENERATED IS $F = W a_d$,
SO THAT

LONG RISE $F = (1500)(.36) = 540 \text{ lbs}$

SHORT RISE $F = (1500)(.62) = 930 \text{ lbs}$

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THE CORRESPONDING MAXIMUM MOMENT AT THE
PIPE-CONCRETE INTERFACE IS

$M = FL$ SO THAT FOR THE

$$\text{LONG RISKER: } M = (540)(17 \times 12) = 110,000 \text{ in-lb}$$

$$\text{AND SHORT RISKER } M = (930)(12 \times 12) = 134,000 \text{ in-lb}$$

IS THE SHORT RISKER IS LIMITING

HERE

$$\sigma_b = M/S = 134,000 / 3.21 = 41,700 \text{ psi}$$

THE ULTIMATE STRENGTH OF ASTM A36 IS 60,000 PSI (ALSO)
IN DESIGN IS ACCEPTABLE ($S_y = 35 \text{ ksi}$)

NOTE VERTICAL COMPONENT CONSIDERED NEGLECTABLE @ 4500 PSI

MULTI-PORT RISER

FOR CASES WHERE THE MULTI-PORT RISER
FLANGE IS 1" THICK OR GREATER, THE LOWER
IMPACT PLATE IS NOT SUPPORTED VIA I-BEAMS
AND INERTIAL LOAD (HORIZONTAL) CAN CAUSE THE
ENTIRE UNIT TO ROTATE, THUS APPLYING A BENDING
MOMENT ON THE RISER, SUCH THAT,

HERE, TYPICALLY A 4" OR LARGER PIPE IS ATTACHED
VIA A FLANGE TO A 48 IN RISER. THE LENGTH
OF THE PIPE IS $\sim 2\frac{1}{2}$ FT. AS THESE 48 IN RISER
ARE MUCH STIFFER THAN A 4" EVALUATION AND THE
LENGTH OF A 4" ATTACHED PIPE $\ll$ THAT EVALUATION
 f_n WILL BE HIGHER THAN PREVIOUS EVALUATION.

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HANCE FOR CONSERVATISM = USE THE PEAK RESPONSE FROM TABLE 4 (SEE 4.1) OR 0.20 g's.

i. as in the case for the 4" WISER.

$$q_y = 3.9 g' = (3.9)(0.2) = 0.78 g's.$$

i. CONSIDER THE FULL 1500 LB ACTING AT THE ELEVATION WHERE THE SHIMS BOLT TO THE PLATE UNIT, OR 4.5 FT ABOVE THE MPR FLANGE (2)

$$i. M_{Hinge} = (W) R_D L = (1500)(.78)(4.5 \times 12) = 63,200 \text{ in-lb}$$

THIS IS LESS THAN THAT CONSIDERED FOR THE 4" SHD PNE PREVIOUSLY. HOWEVER CONSIDER WELD & FILLIT.

$$\sigma = \frac{5.66 M}{h D^2 \pi} \quad (\text{ROTHERS})$$

$$\sigma = \frac{(5.66)(63,200)}{(125)(4.5)^2 \pi} = 22,500 \text{ PSI} \quad (\text{ACCEPTABLE})$$

2-30,000

NOW CONSIDER BENDING IN THE FLANGE (21" THICK)

MODIFY SLOD GIVEN IN GRIPPLER TABLE 2-CASE B
L → DIST AS SHOWN;
SHOULD BE CONSERVATIVE AS STIFFNESS & INTENT.

$$\sigma = \frac{K_1 M}{A t^2} ; \frac{l_0}{a} = \frac{6}{12} = .5 \Rightarrow K_1 = 1.14 \quad (\text{GRIPPLER})$$

$$\sigma = \frac{(1.14)(63,200)}{(12)(1)^2} = 6,000 \text{ PSI} - \text{ACCEPTABLE}$$

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(10)

CHECK SMMS ASSEMBLY DURING EARTHQUAKE

ASSURE THAT COMPONENT THAT CAN FALL TO THE
BOTTOM OF THE TANK, AND POTENTIALLY RUPTURE
THE TANK BOTTOM, REMAIN INTACT

CONSIDER TOP OF MAST AND WELD CONNECTIONS:

$$\sigma_{max} = M/S = 40,300 \text{ PSI}$$

$$S_{U \text{ MIN}} = 304 \text{ KSI} = 70 \text{ KSI} \quad \text{O.K.}$$

CHECK WELD - 2-3/16 all around fillet

$$\sigma = \frac{5.66 M}{2 h D^2 \pi} = \frac{(5.66)(69,600)}{(2)(3/16)(3.5)^2 \pi} = 11,600 \text{ O.K.}$$

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(7) Subject SMMS
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(10)

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SAFETY REQUIREMENTS

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Superview

command (CONSOLID - /bin/csh)

ALGOR-V

STRESS-3D

Step Up/

Hidden 1

Light

Fast

Aux post

General

Load box

Smoothed

Max abs

Bitmap

De dither

[Esc]

Von Mises

5.5e+05
5.0e+05
4.5e+05
4.1e+05
3.7e+05
3.2e+05
2.8e+05
2.3e+05
1.9e+05
1.4e+05
95105.9
49869.0
4631.17

FIGURE 1. RESULTING ELASTIC STRESS ON 1/4 IN THICK 42 IN MULTI-PORT RISER FLANGE - 30,000 LB LOAD AT 12 IN HOLE.

Superview

◆ ALGOR-V
STRESS-88
disp Opt
Hidden 1
Light
-post
Aux post
General
Ipad box
*Smoothed
Max abs
Bitmap
Do other
[Esc]

Help 20mode
3inp 45inp
5Cur 6Swts
7Bag 8Menu
9Top 0Draw
Other method = Von Mises [Stress]
Display Max=671.362, Min=57538.9
[Auto range] [No Trills]
File-boxer S-N LC 1/1 Vu= 5

Von Mises

57538.9
52799.9
48060.9
43322.0
38583.0
33844.1
29105.1
24366.1
19627.2
14888.2
10149.2
5410.32
671.362

FIGURE 2

IMPACT LIMITER TOP PLATE (.12 IN) AT MAX LOAD - UNSUPPORTED CORNER

X= 0.0000 Y=-0.8866 Z=17.5812

SMMS16-002
2.2.3

December 22, 1995

Westinghouse Hanford Company
P. O. Box 1970
Richland, WA 99352
Attention: George Vargo

Subject: Review of Calculations

Ref.: "SMMS Structural Evaluation for Accident Conditions", Dated November 28, 1995

Contract: Task Order #25, WHC Contract No. MW6-SWV-370248

Gentlemen:

We have reviewed the calculations in the SMMS Structural Evaluation, 11/28/95, and have made the following observations:

1) Impact Limiting System [pg. 1-5]

The formulas used are correct. Our calculations agreed with those in the document within three figures. The only differences we saw were in the rounding some of the numbers at the third significant figure.

2) Stress/Strength of Riser under Impact Load [pg. 6-8]

The formulas used are correct. Our calculations generally agreed with those in the document within three figures. The only difference we saw in our calculations were in the stress in the beams which we calculated as 35.5 ksi. This is 2% higher than the 34.7 ksi in the calculation, but still acceptable being less than the 40 ksi yield of the beams.

3) Strength of SMMS Deployment System under Impact Load [pg. 9-11]

The formulas used are correct. Our calculations generally agreed with those in the document within three figures. The only difference we saw in our calculations were in the stress in the 5/16"-24 screws which we calculated as 15.3 ksi [with a slightly smaller minor diameter] vs. the 13.0 ksi calculated. The safety factor is still >6, so the design is ok.

4)Seismic response of Risers [pg. 12-16]

The formulas used are correct. Our calculations agreed with those in the document within three figures.

Although we did not have access to all of the referenced documents, we believe that the numbers referenced are all reasonable, as are the assumptions in the calculations.

Sincerely Yours,

Dr. Van Nguyen
Chief Engineer

Fred P. Johansen, PE
Task Manager

cc:
Rex Ballard

**Westinghouse
Hanford Company**

**Internal
Memo**

From: Spent Nuclear Fuel Evaluations
Phone: 376-4193
Date: November 28, 1995
Subject: SMMS Structural Evaluation for Accident Conditions

To: D. B. Graves L6-01

cc: P R. Deichelbolher S7-12
W. G. Farley S7-71
C. E. Hanson * H5-09
L. S. Krogsrud R3-08
R. P. Omberg * R3-85
T. I. Stokes H5-09
G. F. Vargo Jr. H5-09
SLH File/LB

* without attachment

References: (1) T. I. Stokes, et al, Handout: 60% Design Briefing -
Surface Moisture Measurement System (SMMS),
October 4, 1995.

The attached analysis addresses the structural integrity and related requirements of the Surface Moisture Measurement System (SMMS) deployment assembly and the Hanford Site high-level waste (HLW) tanks component(s) to which it interfaces with during design basis accidents. The only requirement for these accident conditions is that the HLW tanks are not damaged to the extent that a unacceptable safety/environmental condition is produced (e.g. a leak in the tank). Damage to the SMMS assembly is acceptable, so long as this damage does not cause a unacceptable condition on the HLW tank. Operational and Natural Phenomena accidents addressed herein are the: 1) drop of the SMMS deployment assembly during installation/removal; and 2) Earthquakes. The results of the attached analysis show that the SMMS assembly and interfacing tank riser will maintain their structural integrity under the above accident conditions. A summary of these analyses are given below.

Crane Drop of SMMS Deployment Assembly

The SMMS deployment assembly (assumed upper bound weight of 1350 lbs) is assumed to free drop at least 36 feet (length of the mast and arm) onto a waste tank riser. This accident conditions is a extremely unlikely event (10^{-4} to 10^{-6} , Ref), but is nevertheless designed for with the use of a impact limiting device. The impact limiter system consist of two impact limiters (a long 35" and a short 8") which are stacked vertically on the decontamination unit which is mounted to a HLW tank riser. The pair of limiters is used for vertical drop of 40 ft or less. The long limiter is removed/installed as required, as the short limiter is designed for free drops of up to 6.7 feet. A free drop of 11 inches can be safely

D. B. Graves
November 28, 1995
Page 2

accommodated without any impact limiter(s), due to the elastic response of rubber bumpers in decontamination unit.

The SMMS device is expected to be mounted to either 4" or 12" risers on waste tanks BY-103, 104, 105, 106, 108, 110, B-103, TX-105, 118. This includes the use of multi-port risers. The attached analysis showed that for multi-port riser with adapter plate flanges less than 1 inch in thickness, unacceptable stresses can develop at the impact limiter design load. Hence, for these risers, a bridging system is used which consist of aluminum I-beams and jack stands which provides additional support for the lower impact plate.

The impact limiter system works like a typical impact system on nuclear shipping cask. The kinetic energy at impact is converted into plastic work in crushing (up to one-half the length) the plastic foam filler. The maximum impact force is primarily related to the plastic foam material crush strength and the cross sectional area. The crush load limit for this design has been set to 32,200 lbs, which is less than 50% of the strength of the weakest riser (4"). This relatively low load should also provides margin with respect to the 60-100 ton combined concentrated load limit for waste tanks. Furthermore, at this load, which is equivalent to 23.4 g's, the SMMS deployment assembly is shown to maintain its structural integrity, and will not become a projectile(s) which could potentially penetrate the bottom of the HWL tanks.

Earthquake

The reference safety assessment showed that the .25 g seismic event is incredible for the SMMS during the tank insertion period, and hence need not be evaluated. Here, a lower magnitude earthquake of 0.12 g's, and that consistent with Safety Class 2 component, of which a HLW tank riser without liquid waste in it can be considered, is evaluated. Analysis was based on equivalent static method, assuming 10% of critical damping, a 2.0 Importance factor, conservative higher modes contribution, and conservative support conditions.

Results of the seismic evaluation showed that all risers, considered for SMMS deployment assembly insertion, will maintain their structural integrity during the postulated events. The SMMS deployment assembly was also show to remain intact.

S. L. Hecht
Spent Nuclear Fuel Evaluations

Attachment

(1) Drawing _____ (3) Page 1 of 19
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(7) Subject SYNTHESIS: SAFETY STRUCTURAL ANALYSIS
(8) Originator S.L. HECHT [Signature] Date 11-21-95
(9) Checker _____ Date _____

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IMPACT LIMITING SYSTEM

THE SPMS INSTRUMENT (WT ≈ 1350 LB) CAN BE DROP INTO THE TANK RISER AT A MAXIMUM OF ≈ 36 FT. HENCE THE POTENTIAL ENERGY (PE) IS:

$$PE = W \cdot h = (1350 \text{ LB})(36 \text{ FT})(12 \text{ IN/FT}) = 5.832 \times 10^5 \text{ IN-LB}$$

IT IS DESIRABLE TO LIMIT THE MAXIMUM FORCE TO SOME ACCEPTABLE VALUE. THIS WAS CHOSEN TO BE APPROXIMATELY 30,000 LB, WHICH LOAD IS LESS THAN 50% OF THE MINIMUM STRAIN OF FREE UNSUPPORTED RISEL STRENGTH TO WHICH IT IS MOUNTED (SEE PG 7). ADDITIONALLY

THERE IS 100 TON COMBINED CONCENTRATED LOAD LIMIT ON MOST TANKS, WITH A FEW AT A 60 TON LIMIT (WMC-SD-WM-OSR-01B)

THE PRINCIPLE OF THE IMPACT LIMITER (DRAW) IS TO LIMIT THE LOAD TO A ACCEPTABLE VALUE, WHILE ABSORBING ALL THE KINETIC ENERGY (KE) OF IMPACT ($KE = PE$). THIS IS DONE BY DOING PLASTIC WORK (W_p) IN CRUSHING PLASTIC FORM. WHICH IS EQUAL TO THE $PE = KE$.

$$W_p = \int F \cdot ds = \sigma \cdot A \cdot l_c$$

where σ is the crush strength of plastic foam
 $\approx$ CONSTANT UP TO 50% COMPRESSION.

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(8) Originator S.L. HOGHT Date 11-21-95
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THE AREA OF THE FOAM IS:

$$A = L^2 = \frac{\pi}{4} D^2 = 18^2 - \frac{\pi}{4} (9.5)^2 = 253 \text{ IN}^2$$

THE FOAM FR-305 HAS A σ_c OF 118 psi (^{Ref} GUNTER PAPER)
(CONSTANT AT UP TO 50% COMPRESSION)

∴ THE FORCE (F_f) DUE TO CRUSHING FOAM IS

$$F_f = \sigma_c A = (118)(253) = \frac{29,854}{29,870} \text{ lbs}$$

THE LENGTH OF THE FOAM TO CRUSH TO REDUCE THE PE.
IS

$$PE = F_f L_c \text{ OR } L_c = PE / F_f$$

$$L_c = 5.83 \times 10^5 \text{ IN-LB} / 29,870 \text{ LB} = 19.5 \text{ IN (19.535 IN)}$$

$L_c \leq 50\%$ & TOTAL LENGTH (FOR CRASH σ_c)

$$\text{ii } L = 2L_c = \underline{\underline{39 \text{ inches}}}$$

∴ TOTAL FOAM LENGTH SET AT 43 inches for
roughly a 10% margin.

THE IMPACT LIMITER CONSIST OF A LONG, 35 inch UNIT AND A SHORT, 8 inch UNIT. THESE ARE STACKED TOGETHER FOR DROP UP TO 36 FT. THE LONG UNIT IS REMOVED TO LOWER DEFLECTION TO 35' - 1". THE SHORT 8 inch UNIT REMAINS AND IS CAPABLE OF ABSORBING ENERGY OF THE REMAINING DROP AS FOAM OF $(3' / 36') (43 \text{ inch}) = 3.6 \text{ inches}$ IS REQUIRED. — WITH A RIBBON IN THE DRUM UNIT LIMITS THE LOAD FOR THE DROP WHEN THE SHORT UNIT IS REMOVED.

THE TOTAL FORCE GENERATED BY CRUSHING THE IMPACT LIMITER IS THAT DUE TO FOAM CRUSHING (F_f) PLUS THAT REQUIRED TO BUCKLE THE SHEET METAL ENCLOSURE, AS PROVIDED IN THE FOLLOWING.

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CONSIDER BUCKLING OF SIMPLEST PANEL (MOST RESISTANT TO BUCKLING): CAL. BUCKLING CRITICAL STRESS (S') VIA METHOD GIVEN IN (ROCKIE, STARR, LOC 1)

FOR 9" x 8" PANEL $a/b = .89 \Rightarrow K = 7.8$

$$S' = \frac{KE}{1-\nu^2} \left(\frac{t}{b} \right)^2 = \frac{(7.8)(30 \times 10^6)}{1-.3^2} \left(\frac{.015}{9} \right)^2 = 714 \text{ psi}$$

$$A \approx 2(18+9)(.015) = .081 \text{ each half.}$$

$$F' = S'A = (714)(.081) = 1,160 \text{ lbs}$$

- USE TWICE THIS VALUE TO ACCOUNT FOR FOAM SUPPORT

$$\therefore F' = 2,320 \text{ lbs}$$

Then the TOTAL MAXIMUM IMPACT FORCES IS:

$$F = F_f + F' = 29,870 + 2,320 = \underline{32,200 \text{ lbs}}$$

THE CORRESPONDING INERTIAL LOADS ON G'S GIVEN BY

$$\text{IS } G = \frac{32,200}{1350} = \underline{23.9 \text{ g's}}$$

- ONCE THE IMPACT LIMITER (FOAM) IS REMOVED THEN THE SMMS INSTRUMENT CAN DROP/DROPT OFF ONTO THE RISER SYSTEM, (8" SHORT UNIT + 3" SPACE) TO ACCOMMODATE THIS ACCIDENT CONDITION A RUBBER BUMPER SYSTEM () IS USED, WITH THE DECONTAMINATION UNIT

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IN THE DISCRIMINATIVE UNIT THERE ARE 2 - 0.8 inch
Thick RUBBER SPACER STACKED IN 2 SERIES
ARRANGEMENT. GRAVES DATA SHOWS THAT THE STIFFNESS
OF A AVG. IN THE UNIT TO BE 9,100 lb/in AT
10% COMPRESSION. ^{THIS IS FAIRLY LINEAR.} THEREFORE FOR THE TWO PLASTICALLY
IN SERIES $K_{eff-10\%} = 9,100/2 = 4,550$ lb/in
RUBBER STRAIN HARDENS CONSIDERABLY UNDER COMPRESSION GREATLY
50% AS SHOWN IN THE FIGURE BELOW AS TAKEN FROM
MANTOLL

Typical elastomeric stress-strain curves in extension and compression.

ITERATIVE SOLUTIONS SHOW THAT APPROXIMATELY 80% COMPRESSION IS
REQUIRED FOR THE LOAD LIMITATION AND THEREBY REQUIRE MAINTS
HRRR $K_{HRR-80\%} = 3.1 \times 10^6$ $K_{inst-80\%} = 4.7 \times 10^6$
(K_{AVE} IS USED TO DETERMINE ELASTIC ENERGY STORAGE, K_{inst} USED TO
DETERMINE MAXIMUM FORCE)

$$\therefore K_{AVE-75\%} = (3.1)(4,550) = 14,100 \text{ lb/in}$$

$$K_{inst-75\%} = (4.7)(4,550) = 21,400 \text{ lb/in}$$

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THE ASSUMPTION THAT ALL THE KINETIC ENERGY AT IMPACT
IS CONVERTED INTO ELASTIC STRAIN ENERGY OR WORK
IS CONSERVATIVELY USED. HERE FOR A 11" MAX
DROP.

$$PE = Wh = (1350)(11) = 14,850 \text{ in-lb}$$

$$W_k = \int f \cdot ds$$

at 80% COMPARE THE ASSUMPTION OF A LINEAR SYSTEM,
(I.E. $F = KX$), IS REASONABLE AND ONLY SLIGHTLY IN ERROR
(SLIGHTLY APPROXIMATELY 10% NON CONSERVATION; AREA UNDER CURVE)
ASSUMING A ~~AN~~ ELASTIC OR NON CONSERVATIVE (NO. LOSS) SYSTEM
SHOWED MORE THAN MAKE UP FOR THE LINEAR ASSUMPTION

HAVE

$$W_k = \int f \cdot ds = \int_0^x Kx \cdot dx = \frac{Kx^2}{2}$$

∴ EQUATING PE 2d W_k WE GET:

$$x = \sqrt{\frac{2 \cdot PE}{K_{avg}}} = \sqrt{\frac{(2)(14,850)}{17,100}} = 1.45 \text{ in}$$

$$\text{Length of rubber, } L, \text{ required} = x / 0.8 = 1.81$$

$$\text{ACTUAL} = (2)(.8) = 1.6 - \text{WITHIN 13\% - O.K.}$$

Then the maximum force generated is

$$F = Kx = (21,700)(1.45) = 31,465 \text{ lb} - \text{ACCEPTABLE}$$

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STRESS/STRENGTH OF RISER UNDER IMPACT LOAD.

"^{AND MULTI-PORT}
A REVIEW OF ~~4MP~~ RISER ON TANKS WHICH ARE
PRIME CANDIDATE FOR SMMS INSERTION, (9)
BY T-103, 104, 105, 106, 108 & 110, B-103, TX-105, TX-118
INDICATES THAT THERE ARE SEVERAL RISER (TYPES)
WHICH ARE OF CONCERN. OF THESE, ONE TYPE
WAS SHOWN VIA STRESS ANALYSIS TO BE UNACCEPTABLE.

THIS UNACCEPTABLE RISER IS 42" MULTI BOLT RISER
INITIALLY USED FOR TANK VENTILATION, ON TANK BY-110
RISER 12. THIS RISER HAS A 1/4" IN STEEL PLATE
FLANGE, THAT WELDED TO A 18x12" IN RISK. EVEN WITH
THE DESIGN INCORPORATING A CHANNEL SUPPORT, THE
MAXIMUM CALCULATED ELASTIC STRESS IS 388,000 PSI,
WELL IN EXCESS OF THE YIELD STRENGTH. FOR THIS
CASE A SYSTEM OF ALUMINUM I-BEAM & STAYS
(DRAW) WHICH WILL BRIDGE THE RISER IS
USED. THE BEAM IS NOT A STANDARD STRUCTURAL
SHAPE - NEED CALC. I & S.

$$I = I_c + ad^2$$

$$J_o^A = \frac{bh^3}{12} = \frac{(25)(8-.82)^3}{12} = 7.71$$

$$I_o^B \approx 0$$

$$a^3 = (.1)(5) = 2.05$$

$$I = 7.71 + (2)(2.05)(+-.2.5)^2 = 66.8 \text{ in}^4$$

$$S = \pm I/c = 66.8 / 4 = 16.7 \text{ in}^3$$

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THE LONGEST SPAN (BRIDGE) IS EXPECTED TO BE 12 FT WITH EACH BEAM TAKING $\frac{1}{2}$ THE IMPACT LOAD OR 15,900 lbs. WE HAVE:

$$M_{max} = \frac{1}{4} WL = (.25)(16,100)(12 \times 12) = 579,600 \text{ in-lbs}$$

$$S'_{max} = M/S = 579,600 / 16.7 = 34,700 \text{ psi}$$

THE BEAMS ARE MADE OF AL 6061-T6, WITH $S_y = 40 \text{ ksi}$,
AND $S_u = 45 \text{ ksi}$ (METAL HANDBOOK)
 $\therefore$ DESIGN IS ACCEPTABLE.

— OF THE INDIVIDUAL RISER, THE 4" DOMR RISER FOR BY-PA, 105, AND 106 (SEE DRAW H-2-1319) IS MOST STRENGTH. THIS RISER (ASLO 12" x BY-105) IS ANCHORED IN THE DOMR CONCRETE WITH 8- $\frac{3}{4}$ " BARS WITH $\frac{1}{2}$ " PIN FILLED WALL. HERE

$$A_s = 8 + D_h - 8 + (3/4)(1/4) = 4.712$$

$$\tau_{av} = P/A = 32,200 / 4.712 = 6,830 \text{ psi}$$

$$S_{ys} = \frac{1}{2} S_y = 15,000 \text{ min}$$

$$S.F. = 15,000 / 6,830 = 2.20$$

CHECK STRENGTH OF RISK PIPE (4" SHD 40)
 $A = 3.117 \text{ in}^2$

$$\sigma = P/A = 32,200 / 3.117 = 10,200 \text{ psi}$$

$$S_{y \text{ min}} = 30,000 - 0 \text{ O.K.}$$

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CHECK OTHER 42" MULTI-PORT RISER.

THESE USUALLY HAVE 2 RISER. THE FLANGE ADAPTER PLATE VARIES FROM 1/4 TO 1/2 INCH THICK.

TO ANALYZE THIS SITUATION A ELASTIC-FINITE ELEMENT ANALYSIS (FEA) WAS MADE FOR A 0.55 INCH THICK PLATE THE FEA UTILIZED THE ALGOR (ALGOR, HIGHT) COMPUTER CODE. THE MODEL IS SHOWN IN FIG 1, REPRESENT A TYPICAL ^{BOLTED} FLANGE ADAPTER WITH A 12 AND 18 INCH RISER. THE MODEL USES PLATE-SHELL WITH 2 INTERIOR POINT THROUGHOUT THE THICKNESS AND 2 SURFACES. A 30,000 LB DISTRIBUTED LOAD WAS APPLIED AROUND THE 12 3/4 INCH HOLE. THE RESULTS SHOWN (SEE FIG. 2) THAT THE ELASTICALLY CALCULATED σ_e IS 547,000 PSI - WELL IN EXCESS OF ALLOWABLE. TO ASSESS STAIN THICKNESSES WE REALIZED THAT $\sigma \propto \frac{1}{t}$; SO THAT FOR A 1 INCH THICK PLATE THE STRESS IS $(\frac{1}{4})^2$, OR 1/16 TH OF σ_e VALUE SHOWN IN THE FIGURE. HENCE FOR 30,000 LB LOAD ON A ONE-INCH THICK MULTI-PORT RISER WE GET

$$\sigma_e = (547,000) \left(\frac{1}{4} \right)^2 \left(\frac{30,000}{30,000} \right) = 36,700 \text{ PSI} \quad \left(\frac{36,700}{58,000} \right)$$

THIS IS A ACCEPTABLE VALUE AS THE A-36 TYPE MATERIAL MINIMUM $S_y = 36 \text{ KSI}$, $S_u = 58 \text{ KSI}$

SO MULTI-PORT RISER USING 1" OR THICKER ADAPTER ARE ACCEPTABLE.

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ADDITIONAL IMPACT LIMITER ^{STRT} CONCENTRS UNDER DROP LOAD.

AS THE TOP IMPACT PLATE ON THE SMMS INSTRUMENT IS 21 INCHES IN DIAMETER, THE CORNERS OF THE IMPACT LIMITER ARE NOT DIRECTLY LOADED BY THE UPPER IMPACT PLATE AND MUST RELY ON THE STRENGTH OF THE IMPACT LIMITER TOP PLATE 0.12 INCH ^{STRT} 304ST. SHOULD THIS PLATE FAIL - THE IMPACT LIMITER WOULD LOSE SOME EFFECTIVENESS AND POTENTIALLY ALLOW HIGHER LOADS TO DEVELOP.

TO ADDRESS THIS SITUATION, A ELASTIC FEA USING THE ABAQUS MODEL WITH SMALL ELEMENTS WAS DEVELOPED (SEE FIG. 2). THE RESULTS OF THIS ANALYSIS (LOADING = 118 PSI from pressure) SHOWS THAT THE MAXIMUM CALCULATED $\sigma_c = 57,500$ PSI ON THE 304ST PLATE AS $S_u(\min) = 70,000$ PSI (WAKE) = ACCEPTABLE CONDITION

TOP PLATE STRESS

CD = 21, ID = 15 (Griffel, pg 175 Case 10)
CONSERVATIVE ASUMES P OVER TOTAL SURFACE. $p = 118$ PSI $a/b = 21/15 = 4.67$

$$\sigma_1 = \sigma_{max} = \frac{k_1 W}{t^2} = \frac{k_1 \pi (a^2 - b^2)}{.88^2} = \frac{(1.1)(118)\pi \left[\left(\frac{21}{2} \right)^2 - \left(\frac{15}{2} \right)^2 \right]}{.88^2} = 59,990 \text{ PSI}$$

$$S_{u \text{ min}} = 70,000 \text{ PSI} \Rightarrow \text{O.K.},$$

BOTTOM PLATE IS ACCEPTABLE VIA INSPECTION $\pm$ (C.)
THICKNESS IS THE SAME - BETTER SUPPORTED.

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IT IS ALSO REQUIRED THAT COMPONENTS OF THE SMMS REMAIN INTACT UNDER THE DIPA CONDITION, (E. CAN WITHSTAND THE 23.4 g load.

CHECK COMPONENT / ATTACHMENT

PITCH DIA = .2799

MINOR DIA = .2508

Extension Joint

6 - 5/16-24 UNC SCREWS $q_{EX} = .0529 \text{ in}^2 \rightarrow .0494$

$q_T = (4)(.0529) = .398 \rightarrow .296$

$P = (W) a_u = (19 + 16)(23.4) = 4,540$

$\sigma_A = P/a = 4,540 / .398 = 13,040 \text{ psi} \rightarrow 15,315 \text{ psi}$

HIGH STRENGTH BOLT ($\sigma_u > 100 \text{ ksi}$) $\Rightarrow$ O.K.

ELBOW JOINT

Pin

$F = W a = (88)(23.9) = 2,060$

$A_{PES} = (2) \frac{\pi}{4} (.375)^2 = .221$

$T_{AVG} = 2,060 / .221 = 9,310 \rightarrow 9,326$

$\sigma_{SMMS} = \sigma_y / 2 = 30,000 / 2 = 15,000 \Rightarrow$ O.K.

TIE IN TAB

$A(2TAS) = (2)(1 - .374)(.086) = 0.108 \text{ in}^2$

$\sigma_A = 2,060 / .108 = 19,100 \text{ psi} \rightarrow$ O.K.

$\rightarrow 19,162$

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MAST SUPPORT

MAST + ARM WELGH $445 + 87 = 532 \text{ lbs}$ 12488 (lbs)
 THE INERTIAL FORCE IS $WQ = (532)(23.9) = 12,400 \text{ lbs}$
 THIS IS REACTED BY THE WELD FROM THE 3" SVD 40 (3.5" OD)
 MAST TO ROTATION PLATE / BEARING : THERE ARE 2 -
 3/16 ALL-AROUND FILLET WELDS

$$\sigma = \frac{1.414 F}{\pi d t} = \frac{(1.707)(12,400)}{\pi(3.5)(3/16)} = \frac{4282}{4,250 \text{ psi}}$$

OK.

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SEISMIC ANALYSIS

OBJECTIVE IS TO DETERMINE IF THERE IS UNACCEPTABLE DAMAGE TO THE TANK RISER/TANK. RISER IS CONSIDERED SAFETY CRITICAL COMPONENT*. ANALYSIS IN ACCORDANCE WITH UCLL-15910 AND HWS-SOC-41, INVESTIGATE POTENTIAL DAMAGE TO WORST CASE 4" AND MULTI-FOOT RISERS

4" - RISER

ASSUME THAT SOIL ABOVE TANK DOESN'T LATERALIZE SUPPORT RISER. i.e. WORST CASE IS CONSIDERED LONGEST & SHORTEST RISER LENGTH ABOVE CONCRETE TANK DOME.

THIS IS 19'-2" RISER (TANK B-103), - WITH BOLTED DECONTAMINATION UNIT UNSUPPORTABLE LENGTH $\approx 17'$. 7.29
RISER IS 4" - SMD 40 PIPE, $A = 3.14 \text{ in}^2$, $I = 7.23 \text{ in}^4$
 $S = I/2.25 = 3.21 \text{ in}^3$ — 4.5" DIA $\Rightarrow R = 2.25$
HATCH

$$K = \frac{3EI}{L^3} = \frac{(3)(3.14 \times 10^6)(7.23)}{[(17)(12)]^3} = 76.7 \text{ lb/in}$$

$$W = 1350 + 150 (\text{Deck + Piping}) = 1500 \text{ lb} \Rightarrow m = W/g = 1500/386.4 = 3.88 \text{ slugs}$$

$$W_n = \sqrt{\frac{K}{m}} = \sqrt{\frac{76.7}{3.88}} = 4.44 \text{ rad/sec}$$

$$f_n = \frac{1}{2\pi} W_n = .71 \text{ Hz} \quad (\text{LONG RISER})$$

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* Per WAC-EP-0572 "Initial Implementation of Defense Nuclear Facilities Safety Board Recommendation 90-2 for Hazard Site (TANK B-103) - TR 1-1-1-570, FD 6400 (EO 11287)

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THE SHORTEST RISER 9'-4" above ground -
CONSIDER 12' WITH BOLTS.

$$K_s = \frac{3EI}{L^3} = 218 \text{ lb/in} \quad (218 \text{ OK})$$

$$f_n = \frac{1}{2\pi} \sqrt{\frac{K}{m}} = 1.19 \text{ Hz} \quad (1.19 \text{ OK})$$

FROM UCRL-D910; DAMPING IS 10% OF CRITICAL.

FROM HWS-SDC-4.1 FOR A SAFETY CLASS 2
COMPONENT DESIGN TO A 0.12 g FREE FIELD HAZ. AND
WITH A IMPORTANCE FACTOR (I) OF 2.0, THE

HORIZONTAL ACCELERATION (a) RESPONSE IS (FROM TABLE 4-SDC-4.1)

LONG RISE	$f_n = .71$	$a' = 0.0939 \text{ g's}$
SHORT RISE	$f_n = 1.19$	$a' = 0.16 \text{ g's}$

∴ THE DESIGN ACCELERATION IS

$$q_D = (a' \cdot (2) \cdot (1.3) \cdot (1.5)) = 3.9 a'$$

$$\text{LONG RISE } q_D = (3.9)(0.093) = 0.36 \text{ g's}$$

$$\text{SHORT RISE } q_D = (3.9)(0.16) = 0.62 \text{ g's}$$

THE MAXIMUM FORCE GENERATION IS $F = W q_D$
SO THAT

$$\text{LONG RISE } F = (1500)(.36) = 540 \text{ lbs}$$

$$\text{SHORT RISE } F = (1500)(.62) = 930 \text{ lbs}$$

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THE CORRESPONDING MAXIMUM MOMENT AT THE
PIPE-CONCRETE INTERFACE IS

$$M = FL \quad \text{SO THAT FOR THE}$$

$$\text{LONG RISK: } M = (540)(17 \times 12) = 110,000 \text{ in-lb}$$

$$\text{SHORT RISK: } M = (930)(12 \times 12) = 134,000 \text{ in-lb}$$

IS THE SHORT RISK IS LIMITING

IT IS

$$\sigma_b = M/S = 134,000 / 3.21 = 41,700 \text{ psi}$$

THE ULTIMATE STRENGTH OF ASTM A36 IS 60,000 psi (TENSILE)
IS DESIGN IS ACCEPTABLE ($S_y = 35 \text{ ksi}$)

NOTE VERTICAL COMPONENT CONSIDERED NEGLECTABLE AT 4500 psi

MULTI-PORT RISER

FOR CASES WHERE THE MULTI-PORT RISER
FLANGE IS 1" THICK OR GREATER, THE LOWER
IMPACT PLATE IS NOT SUPPORTED VIA I-BEAMS
AND INERTIAL LOAD (HORIZONTAL) CAN CAUSE THE
ENTIRE UNIT TO ROTATE, THUS APPLYING A BENDING
MOMENT TO THE RISER, SUCH THAT,

HERE, TYPICALLY A 4" OR LARGER PIPE IS ATTACHED
VIA A FLANG TO A 48 IN RISER. THE LENGTH
OF THE PIPE IS $\sim 2\frac{1}{2}$ FT. AS THESE 48 IN RISER
ARE MUCH STIFFER THAN A 4" EVALUATION AND THE
LENGTH OF A 4" ATTACHED PIPE IS THAT EVALUATION
 f_n WILL BE HIGHER THAN PREVIOUS EVALUATION.

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HANCE FOR CONSERVATISM AND USE THE PEAK RESPONSE FROM TABLE 4 (SEE 4.1) OR 0.20 g's.

i. as in the case for the 4" RISER.

$$q_y = 3.9 \text{ g} = (3.9)(0.2) = 0.78 \text{ g's.}$$

i. CONSIDER THE FULL 1500 LB ACTING AT THE ELEVATION WHERE THE STAYS DET TO THE PCCW UNIT, CL 4.5 FT ABOVE THE MPR FLANGE (2)

$$i. M_{HNG} = (W) R_D L = (1500)(.78)(4.5 \times 12) = 63,180$$

THIS IS LESS THAN THAT CONSIDERED FOR THE 4" SHA PNR PREVIOUSLY. HOWEVER CONSIDER WELD ~~4~~ FILLIT.

$$\sigma = \frac{5.66 M}{h D^2 \pi} \quad (\text{ROTHERFORD})$$

$$\sigma = \frac{(5.66)(63,200)}{(125)(4.5)^2 \pi} = 22,491 \text{ psi} \quad (\text{ACCEPTED})$$

22,500
2.30,000

NOW CONSIDER BENDING IN THE FLANGE (2" THICK)

MODIFY SLOWS GIVEN IN GRAFIR TABLE 2-CASE 7
R → dist to skew;
SHOULD BE CONSERVATIVE AS STIFFNESS < INTENT.

$$\sigma = \frac{K_1 M}{a^2} ; \frac{r_o}{a} = \frac{6}{12} = .5 \Rightarrow K_1 = 1.14$$

$$\sigma = \frac{(1.14)(63,200)}{(12)(1)^2} = 6,000 \text{ psi - ACCEPTABLE}$$

6,002

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CHECK SWMS ASSEMBLY DURING EARTHQUAKE

ASSURE THAT COMPONENT THAT CAN FALL TO THE
BOTTOM OF THE TANK, AND POTENTIALLY RUPTURE
THE TANK BOTTOM, REMAIN INTACT

CONSIDER TOP VA MAST AND WELD CONNECTIONS:

$$M_{MAX} = Fg$$

See PG 13
MAX ACCEL FROM TABLE 4

$$F = 3.9 a' W = (3.9)(1.2)(445) = 347 \text{ lb}$$

$$M = FL = (347)(16.7 \text{ ft}) = 69,600 \text{ in-lb} \quad 69,530$$

$$3 \text{ in} - \text{SCH } 90 \text{ PIPE} = J = 3.02 \quad OD = 3.5$$

$$A = 2.23$$

$$S = F/c = \frac{3.02(2)}{2.5} = 1.72$$

are c.g. 2/3 way $W = 445$
Down $d_s (25)(\frac{2}{3}) = 16.7 \text{ ft} = L$

$$\sigma_{MAX} = M/S = 70,300 \text{ PSI}$$

$$S_{MIN} = 304 \text{ ksi} = 70 \text{ ksi}$$

O.K.

CHECK WELD - 2 - 3/16 all around fillet's

$$\sigma = \frac{5.66 M}{2 h D^2 \pi} = \frac{(5.66)(69,600)}{(2)(3/16)(3.5)^2 \pi} = 11,600 \text{ O.K.}$$

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(4) Building _____ , Job No. _____
(7) Subject SMH-5
(8) Originator MAH Date 11-21-95
(9) Checker _____ Date _____

(10)

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SAFETY REQUIREMENTS

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FIGURE 1. RESULTING ELASTIC STRESS ON 1/4 IN THICK 42 IN MULTI-PORT RISER FLANGE - 30,000 LB LOAD AT 12 IN HOLE.

Von Mises

5.5e+05
5.0e+05
4.6e+05
4.1e+05
3.7e+05
3.2e+05
2.8e+05
2.3e+05
1.9e+05
1.4e+05
95106.9
49869.0
4631.7

ALGOR-V

STRESS-DI

disp Opt

Hidden I

Light

Post

Aux post

General

load box

eSmoothed

Max obs

Bitmap

On dither

[Esc]

Help 2Undo

3Step 4Sweep

5Clear 6Swic

7Bip 8Menu

9Time 10Arrow

Superview

ALGOR-V
STRESS-III
disp Opt
Hidden I
Light
*Post
Aux post
General
Iqnd box
*Smoothed
Max abs
Blank
Do other
[Esc]

Help 2Undo
3Imp 4Snap
5Cur 6Swic
789g 8Menu
9Top 0Draw

Either method = Von Mises [Stress]
Display Max=671.362, Min=57538.9
[Auto range] [No frills]
File-box: 5-M LC 1/ 1 Vu= 5 X= 0.0000 Y=-0.8856 Z=17.5812

Von Mises
57538.9
52799.9
48060.9
43322.0
38583.0
33844.1
29106.1
24366.1
19627.2
14888.2
10149.2
5410.32
671.362

FIGURE 2

IMPACT LIMITER TOP PLATE (.12 IN) AT MAX LOAD - UNSUPPORTED CORNER

DON'T SAY IT ---DATE April 3, 1996TO Troy StokesFROM James M. Bates *JMB*

Here is a copy of the letter about hydrogen-air combustion calculations performed by A. Dabiri that you requested.

If you have any questions, feel free to call me at (509) 375-2539. Thank you.

JMB

September 5, 1995

Troy Stokes
WHC
PO Box 1970
MSIN H5-09
Richland, Washington 99352

Dear Troy:

Jim Fort and I have reviewed the hydrogen-air combustion calculation performed by A. Dabiri per your request. We found his calculated combustion pressure of 440 psi to be approximately the theoretical upper limit which is obtained by assuming stoichiometric detonation (~30% H₂ by volume). This represents the highest achievable pressure, and is, therefore, suitable for use as a conservative design pressure.

In addition to reviewing Dabiri's methodology, we performed two separate analyses to verify his result. The first of these utilized an undocumented educational software package which solves the theoretical equations to predict the detonation products. The program, EQLBRM, is an educational PC software written in 1988 by Prof. David Pratt of the University of Washington.

The second method was based on experimental results for H₂-air combustion. The data of Lewis & Friauf as reported in "Principles of Combustion" by K. K. Kuo, 1986, Wiley & Son's, page 260 was used, together with the theoretical equations, to determine the detonation stagnation pressure.

For both of the methods, different reactants and buffers were considered which correspond to various stoichiometries. Combustion pressures ranging from 370 - 410 psi were computed for stoichiometric conditions. The lower value is from software program and the upper value is based on the experimental data. The resulting pressure from rich or lean detonation is lower.

Please note that 440 psi is an extremely conservative value. If it is found to be difficult to design the canister to handle these pressures, lower, more realistic values could be provided since detonation is very unlikely (experimentally determined lower detonation limit is 18% H₂ by volume). More realistic pressures would be derived assuming adiabatic burning of pre-mixed H₂-air using realistic values for H₂ concentrations.

September 5, 1995
Page 2

Please let me know if you have any questions concerning our findings.

Sincerely,

A handwritten signature in black ink, appearing to read 'P. Meyer', followed by a horizontal line.

Perry A. Meyer
Research Scientist

PAM/kr

cc: James M. Bates
James A. Fort
File/LB

**Westinghouse
Hanford Company**

**Internal
Memo**

From: Spent Nuclear Fuel Evaluations
Phone: 376-4193
Date: April 4, 1996
Subject: SMMS Structural Evaluation for Normal Operating and Handling Conditions

To: D. B. Graves L6-01

cc:	B. L. Coverdell	H5-57
	P. R. Deichelboher	S7-12
	W. G. Farley	S7-71
	S. K. Farnsworth	H5-57
	C. E. Hanson *	H5-09
	L. S. Krogsrud	R3-08
	R. P. Omberg *	R3-85
	G. A. Ritter	H0-38
	T. I. Stokes	H5-09
	G. F. Vargo Jr.	H5-09
	SLH File/LB	

* without attachment

- References:
- (1) Memo, S. L. Hecht to D. B. Graves, "SMMS Structural Evaluation for Accident Conditions", November 28, 1995
 - (2) T. I. Stokes, et al, Handout: 60% Design Briefing - Surface Moisture Measurement System (SMMS), October 4, 1995.
 - (3) Hanford Plant Standard - SDC-4.1, Standard Arch-Civil Design Criteria - Design Loads for Facilities, Rev 11, September 6, 1989.
 - (4) ASME BOILER & PRESSURE VESSEL CODE - SECTION III. Rules for Construction of NUCLEAR POWER PLANT COMPONENTS,
 - (5) Hanford Site Hoisting and Rigging Manual, RL-92-36, Rev. 0, 1992

The attached analysis addresses the structural integrity and related requirements of the Surface Moisture Measurement System (SMMS) deployment assembly and the Hanford Site high-level waste (HLW) tanks component(s) to which it interfaces with during normal operations and handling. Structural assessment for design basis accident conditions (with the exception of the postulated detector hydrogen explosion, which is addressed, herein) were previously provided in reference 1. In the evaluation of the SMMS for structural integrity, it is required that the calculated stresses/strains for normal conditions comply with required or industry standard limits and safety factors. Additionally, the calculated deformations are required to

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April 4, 1996
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be within limits as to meet functional requirements of the SMMS and tank systems. This should preclude any damage to the SMMS assembly and interfacing tank components. The results of the attached analysis show that the SMMS assembly and interfacing tank riser will maintain their structural integrity under the normal operating and handling conditions, addressed herein. A summary of these analyses, along with a discussion of loadings, assumptions and acceptance criteria, are given below.

DESIGN LOADINGS/EVENTS AND ASSUMPTIONS

The SMMS deployment device is classified as a Safety Class 3 component. The interfacing tank riser is classified as a Safety Class 2 component. The natural phenomena design loads, evaluated herein, for these Safety Class components is the 80 MPH wind loads (per HPS-SDC-4.1, Standard Arch-Civil Design Criteria; Design Loads for Facilities - Ref. 3). Normal loadings considered are operational, operational wind, and installation loads. Normal operation arm motion loads are conservatively address by considering a postulated off-normal accident condition the where the arm actuator cable system is overloaded (by roughly a factor of 10) to failure. Each of these loadings, with corresponding stresses and allowable limits, are addressed. The assembly is assumed to be at a uniform constant temperature, with the maximum expected temperature not exceeding 150 F. Analyses are based on description given in Reference 2 and Drawings H-14-100459, 100460, 100461.

ACCEPTANCE CRITERIA

Allowable values of calculated stresses and or strains used in the evaluation given herein are those given in the American Society of Mechanical Engineers (ASME), Boiler and Pressure Vessel Code - Section III; Nuclear Vessels⁽⁴⁾. Other criteria are utilized in cases where they are more appropriate than the ASME code. For example, for crane lifting, the criteria given in the Hanford Site Hoisting and Rigging Manual⁽⁵⁾ are employed. These are cited in the particular application. As ductile construction material are used in the design, and the loading is not cycled a significant number of times, peak stress and associated fatigue damage are not generally considered. Deformations are evaluated as to their impact on the functional requirements of the SMMS device and the tank riser system interface requirements. Material properties, upon which allowables are based, are taken as minimum values, unless certified material property data exist for the actual metal or component used. Generally, most components are constructed of 304 or 316 stainless steel (SS), unless otherwise specified.

LOADS, STRESSES AND DESIGN MARGINS (SUMMARY)

In the attachment, evaluations are made as to the loading, stresses and structural integrity of the SMMS deployment device under various loading conditions. Loads are calculated when necessary for respective conditions. Stresses are determined for the critical locations and are compared against allowable limits.

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Normal Operation and Handling Conditions

These loading conditions include those which are expected and are designed to. These include normal operations and normal, expected, handling loads. Structural integrity evaluation for these conditions is per criteria given in ASME B&PV Section III, for Design Conditions, unless otherwise stated. The components are to remain intact and totally functional and continue normal operations after these loading conditions are experienced.

Wind Loading (see attachment pages 2-4)

The design wind load, for safety class 2 and 3 components are those loads associated with 80 and 70 mph winds⁽³⁾, respectively. The Tank Farms have placed 15 mph wind speed operating limits on crane lifts, so as crane lifts are not allowed during higher wind speeds. It is currently expected, that during SMMS operations, if higher than allowed wind speeds are expected, or experienced, the SMMS device will be lowered and positioned in a parked location. This parked position is expected to be approximately at the appropriate tank riser interface. Hence, two different design conditions were considered. These are: (1) a maximum 80 mph load in the parked position, and (2) an operating wind load, which can be at any crane controlled vertical location. This operating load is assumed to be twice, the crane operating limit (to account for gusts), or 30 mph.

80 mph wind at parked position

While the SMMS device need only be designed for a 70 mph wind (safety class 3), the analysis assumed a wind speed of 80 mph, as it is the required design conditions for the interfacing riser. Here it is conservatively assumed that the line from the crane does not provide any horizontal resistance.

The maximum (orientation dependent) wind load or drag on the enclosure box was calculated at 242 lbs. This produces a maximum bending stress on the SMMS mast (at the riser system interface) of 4,840 psi. This primary bending stress is well below the 30,000 psi ASME Section III allowable limit. For the riser, a maximum stress of 14,900 psi is predicted at tank dome interface. As the allowable stress limit for this condition is 24,000 psi, an acceptable condition exists.

30 mph wind at any operating position

The SMMS deployment device was assumed to be at the highest elevation which can transmit a bending moment to the riser system. Any horizontal constraint from the crane is conservatively neglected.

The maximum (orientation dependent) wind load or drag on the enclosure box was calculated at 34 lbs. This produces a maximum bending stress on the SMMS mast (at the riser system interface) of 8,600 psi. This primary bending stress is well below the 30,000 psi ASME Section III allowable limit. For the riser, a maximum stress of 4,940 psi is predicted at tank dome interface, well below the allowable stress limit of 24,000 psi.

Handling Loads - Horizontal-to-Vertical Lift (see attachment pgs. 5-10)

The SMMS deployment device is transported to and within the tank farm in a horizontal position. This relatively flexible 35-39 ft. long assembly is then lifted to a vertical orientation, so it can be lowered into the waste tank riser. To do this lift requires the use of one or more crane(s).

A finite element analysis (FEA) was used for the analysis of the main structure(s) for the proposed horizontal lift conditions. The FEA model, shown in figure 1 and 2 of the attachment, is comprised of beam elements. The pipe sections are modeled exactly for bending characteristics, whereas the control box regions were modeled primarily to represent the masses at these location only. Hence, stresses at these, non pipe, locations, are erroneous, as they are not expected to be significant. Pseudo areas and densities were used to account for the mass distributions. Loading was induced via gravitational body forces (1 g) and displacement boundary elements were applied to simulate lift conditions ($U_y = 0$).

Four different cases were considered. These were two different proposed lifting configurations for each geometric type, i.e., long and short. Lifting points are assumed to be at: 1) just above the slot on the mast, and 2) at the enclosure box. Two cases consider a lift from the lifting arms only, whereas, the other two cases assume an additional lift point at the enclosure box region, at the top of the box. Results of these analyses, showed that the maximum principal stress, σ_1 , or the absolute value of the minimum principal stress, $|\sigma_3|$, in the pipe was in the worst cases predicted at 13,850 psi (see fig. 2 in attachment). The allowable principal stress, per the rules given in the Hanford Site Hoisting and Rigging Manual^[5], is $S_u/3$. For the 304L SS pipe, with $S_u = 42.8$ ksi (from mat'l certs), the allowable principal stress is 14,270 psi. As the calculated stresses are less than the allowable value, the proposed lift scenarios are acceptable.

The crane attachment lifting arms were also evaluated. Maximum loads were assumed, i.e., no lift force at the top of the enclosure box. For the horizontal position, the predicted maximum principal stress on the lifting arm is 5,010 psi, well below the allowable limit of 10,000 psi. The attachment bolts have a predicted maximum shear stress of 17,160 psi. This too, is below the allowable shear stress of 20,000 psi for the high strength bolts. For the vertical lift position, the bolts are now in tension, and here $\sigma_1 = 13,100$ psi, considerably less than the 40,000 psi limit. For bending, the arm is in the weak direction (due to holes) and the predicted $\sigma_1 = 9,740$ psi, which is below the 10,000 psi limit.

Arm Actuation Loading (see pages 11-24 in attachment)

For normal operation, the loading, via cable force, is low (< 100 lbs) and not expected to be a problem. However, a potential conservative bounding accident conditions scenario is postulated. Here, upon an operator lifting the arm to the full up position, via cranking on cable winch, the torque limiter/winch system fails and allows the cable system to reach a load of 1100 lbs (for the current torque limit setting, the maximum cable force is less than 1030 lbs) and subsequently the cable is assumed to instantaneously go slack, which is highly unlikely, and allows the arm to fall. This

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conservative assumption should more than qualify the system for normal operation, provided all components other than the cable shear pin remain intact. This accident is referred to in the report and attachment as either the "cable system accident" or "cable accident".

The full load conditions assumes failure (of the cable system), hence the evaluation is made to assure the failed SMMS device can be removed from the HLW tank, intact. Just prior to the postulated cable system failure, the maximum load is reacted by the component in the load path. The arm stop in the up-position reacts the load (via couple) so that the 1 inch 316SS axle develops an average shear stress (double shear) of 8,210 psi. The failure strength of the axle in shear is 15,000 psi. The bending moment developed at the arm elbow cause a bending stress in the mast pipe of 23,800 psi, which is below the minimum yield strength of the mast material (42.7 ksi). The cable lift arm on the SMMS arm assembly, in the maximum loaded up-position, will develop a maximum bending stress of 23,900 psi, an acceptable value considering a minimum yield strength of the 304SS material of 30,000 psi.

Once the cable system fails, the arm accelerates downward, due to gravitational potential energy (PE) and stored elastic strain energy in the deflected arm. This available potential energy of 5,600 in-lbs becomes kinetic energy (KE) and impacts the stop on the mast elbow joint. The calculations show that the mast will plastically deform and absorb the KE in plastic work (or strain energy), before the elbow stop system fails (.5 in dia pin shearing). This prediction included an elastic-plastic FEA on the lower mast system (see fig 5 in the attachment). Predictions showed that a permanent set of 0.7 inches, over the lower 57 inches of the mast, would be required to absorb the KE. The calculated plastic deformations occur in the upper 14 inches of the slotted section of the mast. Analysis shows that it would require up to approximately 200 lbs of additional withdrawal force to pull the 0.7 inch bent 3.5 inch mast through a 4 inch riser, which is doable. A maximum effective stress of 44,320 psi and corresponding equivalent plastic strain of 2.5% were predicted. The failure strain for this material is 46%, hence there is a large margin to failure.

Off-Normal Accident Conditions (Explosion within the Detector Housing) (see page 25 in attachment)

This postulated accident condition was not addressed in Reference 1, and hence is provided herein. It is postulated that a spark from the detector electrical system ignites entrapped hydrogen gas within the detector housing, causing a peak pressure of 510 psi. It is desirable to show that the housing will retain structural integrity, and hence the event will not propagate to the tank environment.

A maximum primary hoop stress of 6,510 psi was calculated to the thinnest cylindrical section. The bottom flat-head (1/8th inch plate) was calculated to have a maximum bending stress (based on fixed boundary conditions) of 57,300 psi. As the thickness of the cylindrical section is the same as the end-plate, the maximum discontinuity bending stress in the cylindrical tube should be slightly lower than that predicted for the flat-head. Since these stresses are lower than the minimum ultimate strength of 75,000 psi for the 302/304SS material, design is acceptable.

CONCLUSION

The SMMS deployment device and interfacing tank components were shown to be structurally acceptable for design loading (normal and anticipated) conditions. The minimum Safety Factor on allowable stress was determined to be 1.03 (Design Margin = 0.03 or 3% over designed). Calculated deformation were found to be acceptable, so as to assure that the SMMS deployment device will function as intended or can safely be removed from a tank.

Computer Runs

Input and output files of the SUN4 (SPARC) ALGOR FEA runs made for the SMMS analysis are stored on a compressed UNIX TAR file, smms.tar.Z. This file can be found on the Hanford Common File System (CFS), in directory /v92627/fem.

S. L. Hecht, Principal Engineer
Spent Nuclear Fuel Evaluations

Reviewed by:

B. L. Coverdell, Advanced Engineer
Analytical Services

Attachment

DNS

Page 1 of 26

Subject SMMS STRUCTURAL ANALYSIS

Originator S.L. HECHT

Date 3/96

Checker B.L. Correll

Date 4-5-96

ATTACHMENT

SMMS STRUCTURAL EVALUATION FOR NORMAL
OPERATING AND HANDLINE CONDITIONS

CONTENTS

PAGES

WIND LOADING

2-4

HANDLING (LIFTING) LOADS

5-10

ARM ACTUATION LOADING

11-24

DETECTOR HOUSING ALIGNMENT

25

MATERIAL CERTIFICATION

26

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(1) Drawing _____ (3) Page 2 of 25
(4) Building _____ (6) Job No. _____
(7) Subject SMMS
(8) Originator S.L. Hunt ML Date 3/96
(9) Checker BLC Date 4-5-96

(10)

WIND LOADS

80 MPH in PARCH POSITION (SAFETY CLASS 2)

$$D (\text{drag}) = C_D A_p V_f^2 / 2 \quad \text{on Box } 42" \times 41" \text{ cross section}$$

$$C_D = f(R_o)$$

$$R_o = V_f d / \nu$$

$$\nu = 0.000143 \text{ ft}^2/\text{sec}, \quad P = .00251 \text{ lb-sec}/\text{ft}^2$$

$$d = 42/12 = 3.5 \text{ FT}$$

$$V_f = (80 \text{ mi/hr}) (1.467 \text{ hr/3600 sec}) (5280 \text{ ft/mi}) = 117 \text{ ft/sec}$$

$$R_o = (117)(3.5) / 0.000143 = 2.9 \times 10^5$$

$$L/d = 2, \quad C_d = 1.18 \quad [7]$$

$$\therefore A = (42)(41) / 144 = 11.96 \text{ FT}^2$$

$$\therefore D = (1.18)(11.96)(.00251)(117)^2 / 2 = 242 \text{ lbs.}$$

THE MAINT INTERACTS WITH THE FIRST "RIGID"
RESTRAINT - I.E. THE TOP OF THE EPPRAH RING, WHICH
IS APPROX 12" BELOW BOX. THE MAXIMUM MOMENT
HERE IS:

$$M = \left(\frac{42}{2} + 12 \right) (242) = 7,990 \text{ in-lb}$$

$$\sigma_b = \frac{M c}{I} = \frac{(7,990)(1.75)}{2.87} = 4,840 \text{ psi}$$

$$\tau_a = P/A \approx \text{negligible}$$

$$\sigma_{\text{allow}} = 1.5 S_{yt} = (1.5)(50,000) = 75,000 \text{ [2]}, \therefore \text{ok.}$$

1. HUGHES & BRIGHTON, THEORY & EXPERIMENTS OF FLUID DYNAMICS,
SCHAUINSCH 1967

2. ASME RPTV Code Section III

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(1) Drawing _____ (3) Page 3 of 25
(4) Building _____ (4) Rev. _____ (6) Job No. _____
(7) Subject SMMS
(8) Originator SLH WPH Date 3/96
(9) Checker BIP Date 4-5-96

(10)

THE STRESS ON THE RISER 4" SHP' 40 IS

ASSUME M_{MAX} AT SOIL-RISER INTERFACE $d \approx 9\frac{1}{2}$ FT MAX

$$M_{MAX} = (242)(9.5)(12) = 27,600 \text{ in-lb}$$

$$F_{RISER} = \frac{\pi}{64} (D_o^4 - D_i^4) - \frac{\pi}{64} (4.5^4 - 4.026^4) = 7.23 \text{ in}^4$$

$$\sigma_{MAX} = \frac{M_C}{I} = \frac{(27,600)(2.25)}{7.23} = 8,590 \text{ psi}$$

CONSIDER MAX. MOMENT AT TANK-DOME RISER INTERFACE
(VERY CONSERVATIVE). THIS IS AT AN ADDITIONAL 7 FT

BELOW GRADE (TANK 2+1): HAVE

$$M_{MAX} = (247)(76.5)(12) = 47,900 \text{ in-lb}$$

$$\text{AND } \sigma_b = \frac{M_C}{I} = \frac{(47,900)(2.25)}{7.23} = 14,900 \text{ psi}$$

ALLOWABLE PER ASME Sec III DIV 1 NB 3200

RISER IS ASTM A53 ($S_y = 30 \text{ ksi}$, $S_u = 48 \text{ ksi}$) [3]

$$S_m = 48,000/3 = 16,000$$

$$\text{ALLOWED } (P_L + P_b) = (1.5)(S_m) = 24,000$$

$$(P_L + P_b)_{ALLOW} > \sigma_b \Rightarrow \text{DESIGN IS OK.}$$

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3. METAL'S HANDBOOK, Vol 1 9th ED. ASM 1975

(1) Drawing _____
(4) Building _____
(7) Subject SMMS
(8) Originator SLH
(9) Checker SLC

(3) Page 4 of 25
i) Job No. _____
Date 3/74
Date 4-5-96

(10)

CONSIDER MAX OPERATING WIND $\sim$ 2×15 MPH = 30 MPH.

$$\text{Now } Re = (30/80)(2.9 \times 10^5) = 1.09 \times 10^5$$

$$C_d \text{ same as before} = 1.18$$

$$\text{then } D = (30/80)^2 (242) = 34.16 \quad (14\%)$$

AS THE SMMS DEVICES IS INSTALLED/REMOVED CONSIDERATION
CONSIDER NO HORIZONTAL SUPPORT FROM THE CRANE.

Now for the mast, the maximum distal moment is
is $33 \text{ m} + \text{length of mast} = 380 \text{ in}$

$$\therefore M_{\text{max}} = Fd = (34)(380) = 12,920 \text{ in-lb}$$

$$\sigma_{\text{max}} = \frac{Mc}{I} = \frac{12,920 (1.75)}{2.89} = 7,820$$

At the slot region this can increase by $\pm 10\%$
to 8,600 psi.

THIS ALLOWABLE $\approx 1.5 \text{ Sm} = (1.5)(20,000) = 30,000$
Design is OK.

ON RISK

$$\text{MAX MOMENT ARM} = 347 + \left(\frac{-34677}{12} \right) (12) = 467 \text{ in}$$

$$M_{\text{max}} = (34)(467) = 15,880 \text{ in-lb}$$

THIS IS CONSIDERABLY LESS THAN THE 17,900 in-lb
MOMENT EVALUATED FOR THE 80 MPH. Design is OK.

$$\left(\sigma = \frac{15,880}{47,920} \right) (11,900) = 4,140$$

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Subject SMMS
Originator SLH [Signature] Date 3/96
Checker BIP Date 4-5-96

LIFTING LOADS

CONSIDER BOTH HORIZONTAL AND VERTICAL POSITIONS
DURING CRAWL LIFE

HORIZONTAL

OVERALL SMMS DEVICE RESPONSE VIA FEA
OTHER COMMENTS - LIFT ARMS ETC (Pgs 5-9)

VERTICAL

ALL FORCE AT LIFT ARMS
(Pgs 9-10)

FEA

ALGOR ^{4.5} FEM (See figures 1 & 2)

BRAM ELEMENTS

PSUDO DENSITY AND REAL (A) FOR WEIGHT
1(G) - SIMPLY SUPPORTED

CONSIDER STANDARD AND EXTENDED ^(KG) LENGTH
TWO LIFT CONDITIONS AT BOX (see below)

CASES AND RESULTS

	<u>GROM & COILING</u>	<u>MAT DIP (IN)</u>	<u>Stress (PSI)</u>
1A	SHORT { 3 POINT LIFT	2.32	10,740
1B		3.84	13,850
2A	LONG { 3 POINT LIFT	2.43	10,740
2B		4.17	13,850

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VS

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Subject SINUS
Originator SLH MM Date 3/96
Checker BJR Date 4-5-96

$$ALLOWANCE = S_y/3$$

$$S_y = 42,700 \text{ (CERT'S)}$$

$$S_{all} = 42,700/3 = 14,270 \rightarrow OK.$$

RESULTS FOR CASE 1B IS SHOWN IN
FIG. 2.

4. S.L. HIGHT, ALGOR COMPUTER CODE QA, WHC-SD-EN-CS40-321,
AUG. 1991

5. ALGOR LINEAR STRESS & VIBRATION ANALYSIS PROCEDURE, REF.
MANUAL, JULY 1992 ALGOR INC. PITTSBURGH PA.

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FIG 1. PARAMETERS FOR FEA MODEL
110120000 LIFT.

75 -rw-r--r-- 1 root 75948 Jul 14 1994 libM77.so.2.0
02402 1 1 14 1994 14M77

◆ ALGOR-V
STRESS-01
disp 1pt
Hidden 1
Light
*Post
Aux post
General
lgnd box
*Smoothed
Max abs
Bitmap
Do dither
[Esc]

Beam-Truss

13848.5
12694.5
11540.4
10386.4
9232.37
8078.33
6924.28
5770.23
4616.18
3462.14
2308.09
1154.04
2.3e-10

FIGURE 2

Help 2Undo
3Inp 4Snap
5Cur 6Swic
78ig 8Menu
9Top 0Draw

Bither method = Beam: Worst [Stress]
Display Max=232831e-10, Min=13848.5
[Auto range] [No frills]
File:lib77_horz S=N LC 1/ 1 Vu= 1 X=-4.4295 Y=52.8920 Z= 0.0000

NS

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Subject SMM5

Originator SLH

Date 3/96

Checker SLH

Date 4-5-96

CHECK LIFTING ARMS.

IN VERTICAL

ASSUME TOTAL WT TAKEN BY ARMS (2), SO THAT EACH ARM SRA $1150/2 = 575$ LBS, FOR HORIZONTAL USE
WT FROM FEA = $920/2 = 460$ LBS

CONSIDER THE LENGTH OF FIG TWO

HORIZONTAL POSITION

$$\frac{F_A}{2} \Rightarrow S = \frac{9.0 - 9.3}{6}$$

$$S = \frac{2^3 - 1.5^3}{6} = 0.771 \text{ in}^3$$

$$\sum M_A = 0 : (3) F_B = 460 \cdot (11.4)$$

$$F_B = 1,750$$

$$\sum F_y = 0 : F_A = -1,750 + 460 = -1,290$$

$$M_{MAX} = (8.9) (460) = 3,860 \text{ in-lb}$$

$$S = M/S = 5,010 \text{ psi} \quad \leftarrow \frac{S_y}{3} = \frac{30,000}{3} = 10,000 \text{ OK}$$

BOLT ARE 7/16-20 UNC - ASTM A193 GR BB, $S_y = 120 \text{ KSI}$

$$A_s = \frac{\pi}{4} (1.3602)^2 = 0.102 \quad T = \frac{P_A}{A_s} = \frac{1,750}{0.102} = 17,160 \text{ psi}$$

$$T_{ALLOWABLE} = (S_y/2)/3 = (120,000/2)/3 = 20,000 \text{ psi}$$

$T_{ALL} > T \Rightarrow$ design is O.K.

VERTICAL POSITION - FULL WEIGHT

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Subject SHIPS
Originator SLH [Signature] Date 3/96
Checker RFP Date 4-5-96

$$\sum M_A = 0: 1.84 F_B + 1.84 = (575)(13.2)$$

Assume 3AD is RIGID:

$$F_C = \frac{4.84}{1.84} F_B$$

$$\text{So that } 1.84 F_B + \left(\frac{4.84}{1.84}\right)(4.84) F_B = 7,590$$

$$F_D = 520; F_C = \left(\frac{4.84}{1.84}\right)(520) = 1,390$$

$$\sum F_y = 0 \quad F_A = 575 - 520 - 1390 = -1385$$

$$\text{Axial Load in Bolt} \quad A_T = 0.1063 \text{ in}^2$$

$$\sigma = \frac{1,390}{0.1063} = 13,100 \text{ psi}$$

$$\sigma_{all} = S_y/3 = 120,000/3 = 40,000 \text{ psi} \quad \sigma_{all} > \sigma \Rightarrow \text{OK}$$

Max Moment on BAR

$$= (575)(8.4) = 4,830 \text{ in-lb}$$

At Point of Max. Moment on there is a hole. ARM. TOPS
REMOVE S, I

$$\text{Solved by } \frac{1}{2} A d^2 = (1.937 + 15)(.25) \left[\frac{1}{2} (.125)^2 \right] = .275$$

$$S = S_{gross} - S_{holes} = .77 - .275 = .495$$

(conservative)

$$\sigma_M = M/S = 4,830/.495 = 9,740 \text{ psi}$$

$$\text{ALLOWABLE} = S_y/3 = 100,000 \Rightarrow \text{OK}$$

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Subject SMMS: STRESS OF ARM ELEVATION SYSTEM

Originator SLH

Date 3/96

Checker RJE

Date 4-5-96

ARM ELEVATION SYSTEM

CONSIDER THE MAXIMUM CABLE LOAD = BREAKING STRENGTH OF CABLE SYSTEM (SHEATH-TYPE) $F_c \leq 1100$ LBS. - THIS IS ACCIDENT LOADS
SINCE THERE IS A TORQUE LIMIT ON CABLE WINCH.

OTHER LOAD ARE DUE TO GRAVITY.

(1) WEIGHT OF ARM $\approx 96^{\#}$

(2) WEIGHT OF PROBE - REACTION BY ARM
IN LOCAL X' DIRECTION - LIKE
PULLEY-CABLE SYS.

1. TWO CASES ARE EVALUATED

A. ARM FULLY RAISED,
CABLE AT $F_c = 1100$ LBS.

B. CABLE BREAKS AND
ARM FREE FALLS -
HITS PIVOT STOP.

$$a = 33$$

$$b = 72$$

$$c = 50$$

$$d = 57$$

$$e \approx 40$$

$$\theta = \tan^{-1}\left(\frac{c}{b}\right) = 57^{\circ}$$

$$\phi = \tan^{-1}\left(\frac{d}{b}\right) = 38^{\circ}$$

$$\psi = \tan^{-1}\left(\frac{2 - 2.75/2}{1.75}\right)$$

$$\psi = 20^{\circ}$$

SPR
FULLY LOADED

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INS

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Subject STATS

Originator SLH

Date 3/96

Checker BSE

Date 4-5-96

0.2

$$\begin{aligned} \text{at A } F_x^a &= F_c \cos(\theta + 4) = 1100 \cos(57 + 20) = -247 \text{ lb} \\ F_y^a &= 1100 \sin(77) = 1070 \text{ lb} \end{aligned}$$

$$\begin{aligned} \text{at B } F_x^b &= W \sin \varphi = 96 \sin(20) = -30 \text{ lb} \\ F_y^b &= -96 \cos(20) = -90 \text{ lb} \end{aligned}$$

at C F_x' only

$$F_x' = W_p / \sin 20 = -28 / \sin(20) = -82 \text{ lb}$$

Reaction at Pivot "O"

$$F_{x_0} = 247 + 33 + 82 = +362 \text{ lb}$$

$$F_{y_0} = -1070 + 90 = -980 \text{ lb}$$

$$M_0 = (-1070)(33) + 90(40) = -31,700 \text{ in-lb}$$

couple length $d =$

$$d = \sqrt{1.7^2 + 2^2} = 2.66$$

$$F_{\text{due to couple}} = F = M/d = 31,700 / 2.66 = 11,900 \text{ lb}$$

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IS

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Subject SAMI
Originator SLH MPH Date 3/96
Checker BEP Date 4-5-96

MOMENT ON MAST PIPE (304, $S_y = 42.7$ KSI)
 $I = (2.89)(.9) = 2.6$ (See pg)

$$\sigma_c = \frac{MC}{I} = \frac{(31,700)(1.95)}{2.6} = 23,800 < S_y \text{ OK.}$$

CABLE LIFE ARM SYSTEM

SHEAR IN PIN AT CABLE ATTACH.

$$T = 2 \frac{\pi}{4} (.187)^2 = .0547$$

$$T = P/A = \frac{1100}{.0547} = 20,000 \text{ PSI}$$

$$\text{ALLOW} = \frac{S_u}{2} = 85,000/2 = 42,500 \text{ OK}$$

$$F_B (1.625) = 1100 (4.75)$$

$$F_B = 3,215$$

$$F_A = F_B - 1100 = 2115$$

$$M_{MAX @ B} = (1100)(4.75 - 1.625) = 3,490 \text{ IN-LB}$$

$$S = \frac{bh^2}{6} \approx \frac{(.6)(1.2)^2}{6} = .144 \text{ IN}^3$$

$$\sigma = M/S = 23,900 < S_y_{min} (30,000) = \text{OK.}^{(2)}$$

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IS

Page 14 of 25

Subject SMMMS

Originator SLH

Date 3/96

Checker BEP

Date 4-5-96

Shear in AXIAL

CONSERVATIVE: ASSUME ALL F_x, F_y vector at 1" pin

$$F_{max} = \sqrt{(11,700 + 980)^2 + 360^2} = 12,900 \text{ lbs}$$

1" pin in double shear

$$\tau_{avg} = \frac{F}{A} = \frac{12,900}{(2)(\pi/4)(1)^2} = 8,210 \text{ psi}$$

$$S_{ys} = \frac{1}{2} S_y = 15,000 \text{ psi for 316 SS 2 RT.}$$

$$\therefore S_{ys} > \tau_{avg} \Rightarrow \text{OK.}$$

CASE B

ASSUME THE CABLE FAILS AND THE ARM IS
RELEASED AND FALL TO REST AT THE ELBOW STOP.

USE ENERGY METHODS:

P.D. BEFORE CABLE FAILURE:

due to gravity - height.

$$PE = Wh$$

weight concentrated at eq. $\approx 40"$

$$h = 40(1 + \sin 20) = 53.7 \text{ in}$$

$$P.E._g = WH = (96)(53.7) = 5,150 \text{ in-lbs}$$

due to elastic energy stored in deflected arm

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JNS

Page 15 of 25

Subject SMAWS
Originator SLH MM Date 3/96
Checker BEP Date 4-5-96

$P_{E1} = W = \int F \cdot ds$: elastic system - linear

$$\therefore W = F \delta_{max} / 2; \delta = F/k, \therefore W = F^2 / 2k$$

CANTILEVER BEAM:

$$k = \frac{3EI}{L^3}; I = \frac{\pi}{64} (d_o^4 - d_i^4) = \frac{\pi}{64} (3.5^4 - 3.09^4) = 2.89 \text{ in}^4$$

$$k = (3)(30 \times 10^6)(2.89) / 33^3 = 7240 \text{ lb/in}$$

$$\text{From previous } F = F_g = 1070$$

$$\therefore P_{E1} = F^2 / 2k = (1070)^2 / (2)(7240) = 80 \text{ in-lb}$$

ADDITIONALLY BENDING OF THE MAST FROM THE TRANSMITTED MOMENT ALSO ADD TO ELASTIC SPRING BACK - WHIPPING OF THE ARM.

HERE ASSUME MINIMUM ^{EFFECTIVE} MAST LENGTH (BELOW RISER) WHICH IS CONSISTENT WITH CONSERVATIVE PRESENTMENT (SEE PG 1).

$$\text{HERE } \theta = \frac{M_o L'}{EI} = \frac{(31,700)(57)}{(30 \times 10^6)(2.89)} = 2.08 \times 10^{-2}$$

$$\delta_y = L \theta =$$

$$\text{and } P_{E2} = \frac{F \delta_y}{2} = F L \theta / 2$$

$$= (1070)(33)(2.08 \times 10^{-2}) / 2 = 368 \text{ in-lb}$$

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Subject SMAG
Originator SLH MM Date 3/96
Checker BLE Date 4-5-96

$$PE_{\text{Total}} = PE_{\text{grav}} + PE_{e_1} + PE_{e_2}$$

$$= 5,150 + 80 + 370 = 5,600 \text{ in-lb}$$

THIS POTENTIAL ENERGY IS THEN CONVERTED INTO KINETIC ENERGY (KE) AND IS REJECTED BY THE PIVOT STOP SYSTEM. ^{IN CLIPPING A SECTION OF THE MAINS (CONSERVATIVELY ASSUMING SHORTEST LENGTH)} THIS ELASTIC REACTION CAN BE DETERMINED

By

$$F = \sqrt{2(KE)K}$$

where F is the force at the c.g. acting to the arm.

$$K \text{ at c.g. is } K = \frac{3EI}{L^3} = \frac{(3)(30 \times 10^6)(2.89)}{(40+51)^3} \quad \leftarrow \text{CONSERVATIVE MIGHT BE SLIGHTLY LESS}$$

$$= 285 \text{ lb-in}$$

$$\therefore F = \sqrt{(2)(5,600)(285)} = 1,790 \text{ lbs}$$

The moment at the elbow is:

$$M_0 = (1,790)(40) = 7.16 \times 10^4 \text{ in-lb}$$

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Subject SHIMS

Originator SLH

Date

3/96

Checker RJP

Date

4-5-96

THIS IS REACTED BY A COUPLE OF AXIAL-STOP PIN

$$d = \sqrt{3^2 + .925^2} = 3.14 \text{ in}$$

$$\therefore F = M/d = 22,800$$

THE STOP PIN (1/2 in - 316 Pin) IS THE WEAK LINK.

$$A_{pin} \text{ (double shear)} = 2 \frac{\pi}{4} (.5)^2 = .393$$

ASSUMING AN AVERAGE $S_u = 85 \text{ Ksi}$, AND TRESCA FAILURE CRITERIA: THE PIN WILL FAIL AT A FORCE OF:

$$F = a S_u / 2 = (.393)(85,000)/2 = 16,700 \text{ IN-LBS}$$

$\therefore$ THE PIN WILL SHEAR, HOWEVER, LOADING AND ENERGY WILL BE TRANSMITTED TO THE MAST

$$\text{Here } F_{max} = \left(\frac{16,700}{22,800} \right) (1,790) = 1,260 \text{ LBS}$$

THE MAXIMUM MOMENT AT THE RISER INTERFACE IS

$$M_{max} = FL = (1,260)(40.57) = 122,000 \text{ IN-LBS}$$

THE MAX BENDING STRESS (σ_b) AT THIS LOCATION IS:

$$\sigma_b = \frac{Mc}{I} = \frac{(122,000)(1.75)}{2.89} = 74,000 \text{ PSI}$$

$\sigma_b > S_y$ (42.7 ksi) $\therefore$ THE MAST WILL PLASTICALLY DEFORM.

BEFORE PIN SHEARS -

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Subject SMMS
Originator SLH MM Date 3/90
Checker BJP Date 4-5-96

EVEN IF THE PIW FAILED (WHICH IS SHOW NOT TO APPEAR)
THE ENERGY GOING INTO THE MAET - AND A UPPER-
BOUND FOR PLASTIC DEFORMATION CALC. IS

$$E = \left(\frac{16,700}{23,800} \right)^2 (5,600) = 3,000 \text{ IN-16S}$$

A FINITE ELEMENT ANALYSIS (FEA) IS USED TO
DETERMINE THE RESPONSE TO THIS CONDITION.

CRITICAL IS THE AMOUNT OF ENERGY FOR
SITE MAET, SO AS TO DETERMINE IF
IT CAN BE WITHDRAWN FROM THE TANK.

THE FINITE ELEMENT MODEL (FEM) IS A 1/2 SECTION OF
SYMMETRY OF THE TANK 57 INCHES OF THE MAET.
THIS INCLUDE THE IN-1/2 INCH SCOT RUNNING ALL BUT THE
BOTTOM INCH. THE MODEL IS SHOWN IN FIGURE 1.
THE FEM USE THE ALGOR ACCURATE PROGRAM AND
USE 3D SHELL WITH 4 NODE AND DRAUGHT 2X2X2
INTEGRATION.

VON-MISES WITH BI-LINER STRESS-STRAIN ELASTO-PLASTIC
MATERIAL MODEL WAS USED, WITH $S_y = 42,700 \text{ PSI}$
 $E_T = 92 \times 10^3 \text{ PSI}$ (VANDER CAETS), THIS IS EXPECTED
TO BE QUARLEY SOFT (AND PRODUCE LARGE DEFORMATION)
AS) E_T IN A AVERAGE OVER THE TOTAL PLASTIC STRAIN
RANGE.

LOADING WAS APPLIED AS NORMAL FORCES TO GIVE
THE SHEAR AND MOMENT AND THE BEND JOINT.

LOADING WERE TAKEN SO AS THE FIRST STEP IS
JUST A YIELD AND SUBSEQUENT STEPS WERE IN
2.5% INCREMENTS OF THE LOAD TO FIRST YIELD.

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Subject SMMAS
Originator SLH [Signature] Date 3/96
Checker BEP Date 4-5-96

RESULTS ARE SHOWN IN FIGURES 3 to 5.

FIGURE 3 GIVES THE REACTIVE SHIP BE TROUGH THE APPLIED LOAD AND THE PLASTIC STRAIN ENERGY IN THE PIPE. THE LOAD IS SHOWN AS A PERCENT OF THE FULL LOAD CALCULATED ON A ELASTIC BASIS, (S.), $F_H = 1,790$ in-lb and $M = 7.16 \times 10^4$ in-lb at the ELBOW. AS ALGOR DOES NOT DIRECTLY CALCULATE THE PLASTIC STRAIN ENERGY, THIS HAS DONE BY HAND BY SUMMING THE ENERGY IN ELEMENTS IN WHICH PLASTIC STRAIN WERE CALCULATED, IS

$$E_p = \sum_{i=1}^n \left(\frac{\sigma_i - S_y}{2} \right) (\epsilon_i^p) (V_i); \text{ where } V_i \text{ is the Volume of the element}$$

THE ONSET OF PLASTIC DEFORMING OCCURE AT 25% of the LOAD. THE TOTAL AVAILABLE ENERGY (KE-IMPACT) WAS PREVIOUSLY DETERMINED TO BE 5,600 in-lbs. AT THIS VALUE, THE CORRESPONDING LOAD IS 32% of the MAXIMUM OR. $M = 2.69 \times 10^4$ in-lb, $F = 670$ lbs.

THIS IS AT A VALUE WHICH IS BELOW THE STRENGTH OF THE 1/2 INCH PIPE. $\therefore$ THE ENERGY WILL GO INTO PLASTICALLY DEFORMING THE PIPET.

6. ALGOR ACCUTACK REFERENCE MANUAL, ALGOR INC, PITTSBURG 1987.

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FIGURE 3
ELASTIC-PLASTIC FEA RESULTS - SMMS CABLE ACCIDENT

FIGURE 4

PLASTIC DEFORMATION - SMMS CABLE ACCIDENT

ALBOK-V

STRESS-III

disp Upd

Hidden I

Light

*Post

Aux post

General

legend box

*Smoothed

Max abs

8frame

De dither

[Esc]

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Von Mises

44371.3
40852.7
37834.1
33815.5
30297.0
26778.4
23289.8
19741.3
16222.7
12704.1
9185.57
5667.00
2148.43

SMMS CABLE ACCIDENT - LOWER MAST SECTION
MAXIMUM LOAD AT 5600 IN-LBS PLASTIC STRAIN ENERGY

DEFORMED SHAPE FACTOR = 100

FIGURE 5

Help 2Undo

3Rep 4Snap

5Cur 6Swic

7Big 8Menu

9Top 0Draw

Other method = Von Mises [Stress]

Min=2148.43, Max=44371.3

[Auto range] [No frills]

File=ast.plt S=N 26/ 51 Vu=107 X=-25.477 Y=-26.845 Z=17.6515

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Subject SHMS

Originator SLH

Date 3/96

Checker BJP

Date 4-5-96

FIGURE 4, GIVE THE RELATIONSHIP BETWEEN, ϵ_p AND PERMANENT DEFORMATION (SAT THE END OF THE MAST. FOR ~~THE~~ $\epsilon_r = 5600$ IN-15,

$\delta_p = 0.7$ INCHES. AS MOST OF THE PLASTIC DEFORMATION OCCURS NEAR THE TOP OF MAST (SEE FIG) I.E., 10 INCHES TO 14 INCHES ON SLOT SIDE. CONSIDER A "POG-LAG KINK", SO THAT THE ANGLE OF THE BEND (AT 57") IS:

$$\theta = \sin^{-1} \left(\frac{0.7}{57} \right) = 0.70^\circ$$

THE DIAMETRIC CLEARANCE BETWEEN THE MAST (3.500) AND THE 4" RISER ($\delta = 0.026$) IS .526 INCHES, LESS THAN THE 0.70.

THE INTERFERENCE IS THEN ≈ 0.174 INCHES. CONSIDER THE LONGEST RISER 5.19 FT THAN

$$\begin{aligned} & \text{57"} \quad \delta = 0.026 \\ & \text{57"} \quad \delta = 0.026 \\ & \text{57"} \quad \delta = 0.026 \\ & \text{57"} \quad \delta = 0.026 \\ & \text{57"} \quad \delta = 0.026 \\ & \text{57"} \quad \delta = 0.026 \\ & \text{57"} \quad \delta = 0.026 \\ & \text{57"} \quad \delta = 0.026 \\ & \text{57"} \quad \delta = 0.026 \\ & \text{57"} \quad \delta = 0.026 \end{aligned}$$

$$F = \frac{27 E I L \delta}{46 (a + 2b) \sqrt{3e (a + 2b)}} = 91 \text{ lbs}$$

ASSUMING A COEFFICIENT OF FRICTION OF 1

$$F_{\text{pull}} = (1)(91) = 91 \text{ lbs} \Rightarrow \text{negligible to weight}$$

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7. R.J. ROARK "FORMULAE FOR STRESS + STRAIN", 4th ED, TABLE III G-12

Subject SMMS

Originator SLH

Date 3/96

Checker BEP

Date 4-5-96

Consider shear RISE in $Q = 2$ most corner section
 $= (57)(2) = 114 \text{ in.}$

here $\delta = \delta_p/2 = .087$ $\theta = \theta/2$ end side

from ROUNDED TUBES Case II

$$F = \frac{48 E I \delta}{L^3}; L = 114$$

$$F = \frac{(42)(30 \times 10^6)(2.89)(.087)}{(114)^3} = \underline{\underline{244 \text{ lbs}}}$$

WITH THE REACTION FORCE = F. Then THE WITHDRAWAL FORCE F_w is

$$F_w = \mu 2F; \mu = 0.12 \text{ stick or stick-slip; (MARKS)}$$

$$F = (42)(2)(244) = 205 \text{ lb.}$$

FIGURE 5 IS A DEFORMED (X100) CANTOUR EFFECTIVE
 STRESS/PLASTICITY PLOT AT THE LOAD STEP (26) NARRE THAT
 WHICH ABSORBS THE AVAILABLE ENERGY (5600 IN-LL)

THE MAXIMUM σ_e IS 44,370 PSI WHICH IS
 EQUIVALENT TO ϵ_e OF 0.025, WHICH IS WELL BELOW
 THE FAILURE VALUE OF 0.46.

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Subject SMMS - ACCIDENT

Originator SL HECHE

Date 3/96

Checker BJP

Date 4-5-96

ACCIDENT

DETECTOR HOUSING - POSTULATED EXPLOSION WITHIN

Pressure = 510 psi PEAK PRESSURE

Thin Section of cylinder

$$OD = 5.318, ID = 3.068 \Rightarrow t = .125, r_m = 1.597$$

$$\sigma_r = \frac{Pr}{t} = \frac{(510)(1.597)}{.125} = 6,510 < \sigma_y - OK$$

END PLATE $r = 1.53, t = .125$

FIXED AT ENDS

Center $\sigma_r = \sigma_t = \frac{3Pr^2}{8t^2} ((m+1)) \quad m = \frac{1}{3} = 3.33 \quad \text{Ref 7, TABLE X-Case 6}$

$$\sigma_t = \frac{3(510)(1.53)^2}{8(.125)^2} ((3.33+1)) = 37,300 \text{ psi}$$

edge $\sigma_r = \sigma_m = \frac{3Pr^2}{t^2} = (3.75)(510) \left(\frac{1.53}{.125} \right)^2 = 57,305 \text{ psi}$

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SANDVIK

MATERIAL CERTIFICATE

SANDVIK, INC. SCRANTON WORKS
P.O. BOX 1320, SCRANTON, PA. 18501 PH. 717-507-5191
PLANT LOCATION: INTERSTATE 81, WAVERLY EXIT 59

CUSTOMER PURCHASE ORDER NO.	SANDVIK ORDER NO.	ITEM	SPECIAL CODE	MARKS	CERTIFICATE NO.	CERTIFICATE DATE
71507800	771866	61572		Y&Y=0000-57000	020788	11/27/77

SOLD TO: TUBE SALES

WESTINGHOUSE HANFORD
c/o ARHCO REC.

SPECIFICATION AND MATERIAL:

ASTM A-312, ASME SA-312

SANDVIK SEAMLESS STAINLESS STEEL ANNEALED PIPE TYPE 316 3 SCH 40 97'5"

Analysis, %

Heat	C	Si	Mn	P	S	Cr	Ni	Mn
742583	.048	.60	1.70	.007	.013	17.5	13.3	2.68

Mechanical Tests

Heat	Yield Str. psi	Tensile Str. psi	Elong. 2" %	Hydr. Pres. Test psi
742583	42,800 44,400	87,300 89,600	46 47	1960

FLATTENING TEST: OK

OK TO ASTM A-312

FEB 09 1990

For Bengt H. Berg, Quality Assurance Manager

Bengt H. Berg

(P-A-SA-1, REV. 1) dm
Supersedes P-A-1 and P-SA-1

WIC-SO-MM-SDD-070, REV 0
Page E-82

Science Applications International Corporation
An Employee-Owned Company

April 9, 1996

Westinghouse Hanford Company
Richland, WA 99352
Attention: Mr. Jim Bussell

Subject: Overpressure calculations for SMMS probe body

Reference: Task #25, SW6-SWV-370248

Sir:

Attached are the overpressure calculations performed by Dr. Ali Dabiri. The maximum pressure expected from a hydrogen burn at 1 atm. is 440 psi. This is calculated for a Chapman-Jouguet detonation, Figure 7.9, from Shapiro, "Dynamics and Thermodynamics of Compressed Fluid Flow, Vol. 1".

Also attached is a letter from PNL, Mr. Perry Meyer, verifying that this is an upper limit number, with 370 psi being a lower bound value.

Sincerely Yours,

A handwritten signature in dark ink, appearing to read "Fred P. Johansen".

Fred P. Johansen, PE
Program Manager

Max Pressure from Hydrogen Ignition in 3MMS Probe Body

WHC-SD-WM-SDD-070, REV 0
Page E-84

$$T_1 = 520^\circ R = 61^\circ F$$

$$\Delta T_1 / T_1 = 6$$

$$\Delta T_1 = 6 \times 520 = 3120^\circ R$$

$$= 2661^\circ F$$

$$= \underline{1460^\circ C}$$

$$\Delta T_0 / T_1 = 7$$

$$\Delta T_0 =$$

$$= 3640^\circ F$$

$$= 3181^\circ C$$

$$= \underline{1749^\circ C}$$

For hydrogen $T_0 = 2045^\circ C$

$$\Delta T_0 = 2045 - 20 = 2025^\circ C = 3677^\circ F = 4136^\circ R$$

$$\frac{\Delta T_0}{T_1} = \frac{4136}{520} \approx 8$$

From Fig 7.9 of Shapiro Book [Dynamic & Thermodynamics
of Compressible Fluid Flow Vol. #1]

$$\frac{P_0}{P_1} \approx 30$$

$$P_1 = 14.7 \text{ psi}$$

$$P_0 = 440 \text{ psi}$$

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Page E-85

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FLOW IN DUCTS WITH HEATING OR COOLING

Ch. 7

of the mechanism by which a wave starting from rest ultimately reaches the stage of detonation.⁴³ The enormous flame propagation speeds in a detonation wave are possible because the detonation is a combination of an adiabatic compression shock and a subsequent slow burning. The shock precedes the flame zone and raises the temperature and pressure of the unburned gas to such high values that the kinetics of the chemical reaction are augmented to the point where the flame zone propagates rapidly enough to keep pace with the shock front.

FIG. 7.9. Thermally-choked combustion waves ($M_2 = 1$), for $k = 1.4$. Solid curves show maximum flame speed M_2 for slow combustion, and minimum flame speed M_2 for detonation. The latter is the detonation Mach Number always observed in experiments. Dashed curve shows, for detonation with $M_2 = 1$, the stagnation pressure ratio for an observer at rest with respect to the unburned gas.

THE CHAPMAN-JOUQUET RULE. The observed fact that $M_2 = 1$ for a detonation wave is often called the *Rule of Chapman and Jouquet*. In order to find the corresponding detonation speed M_1 , we set $(T_0/T_0^*)_2$ equal to unity, and substitute for $(T_0/T_0^*)_1$ in Eq. 7.26 the value given by Eq. 7.16. Carrying out these operations, and simplifying, we obtain

$$\left(\frac{T_{02} - T_{01}}{T_1} \right)_{M_2=1} = \left(\frac{\Delta H}{c_p T_1} \right)_{M_2=1} = \frac{(1 - M_1^2)^2}{2(k+1)M_1^2} \quad (7.27)$$

The two values of M_1 which may be found from this equation correspond to the maximum flame-front speed for slow combustion and the

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Art 7.5

THE RECOVERY FACTOR

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minimum speed for detonation. These speeds are plotted in Fig. 7.9 as a function of the energy parameter $\Delta H/c_p T_1$.

One measure of the potentialities for damage of a steady detonation wave is the rise in stagnation pressure experienced by an obstacle over which the wave passes. Denoting by p_{02}' the stagnation pressure of the burned gas in a coordinate system where the unburned gas is at rest, it may be shown that

$$\left(\frac{p_{02}'}{p_1}\right)_{u_{cr-1}} = \frac{1 + kM_1^2}{k+1} \left[1 + \frac{k-1}{2} \left(\frac{M_1^2 - 1}{1 + kM_1^2}\right)^2\right]^{\frac{k}{k-1}} \quad (7.28)$$

This ratio is also plotted in Fig. 7.9 for a Chapman-Jouguet detonation. In the usual hydrocarbon detonation, T_1 is about 520°R, $\Delta T_0/T_1$ is about 6, and the speed of sound is about 1000 ft/sec. From Fig. 7.9 it may be seen that the flame-front speed is then about 5500 ft/sec and the stagnation pressure increases to about 25 atmospheres. The temperature after an adiabatic shock traveling at 5500 ft/sec is found from the diatomic normal shock tables to be about 3000°R; thus, as indicated previously, there is considerable preheating effect available for increasing the flame speed to values necessary for detonation.

The temperatures in an atomic explosion are said to be measured in millions of degrees. If $\Delta T_0/T_1$ is assumed to equal 10^4 for such an explosion, Fig. 7.9 indicates a wave speed of the order of magnitude of 200,000 ft/sec and a stagnation pressure of the order of magnitude of 40,000 atmospheres!

7.5. The Recovery Factor

When a fluid flows through a pipe having an insulated wall, the temperature at the wall (called the adiabatic wall temperature, T_{aw}) is neither the average stagnation temperature T_0 nor the average static temperature T of the stream. In a gas flow the adiabatic wall temperature usually lies between T and T_0 . The factors influencing T_{aw} and theoretical methods for predicting its value are discussed in detail in Volume II, Chapters 27, 28, and 29. For the present we shall introduce some elementary considerations and shall summarize some experimental results of value for practical computations of pipe flow.

Physical Mechanism of Frictional Heating. The temperature assumed by an insulated wall, past which flows a high-speed gas stream, is controlled by complex phenomena in the boundary layer. Fluid layers far from the wall deliver viscous shear work to layers near the wall. The consequent temperature rise of the inner layer is necessarily accompanied by heat conduction through the fluid away from the wall,

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DON'T SAY IT --- Write It!

DATE: April 16, 1996

TO: Sam Hecht

H0-40

FROM: Brad Coverdell

H5-57

Telephone: 376-1921

CC: S. K. Farnworth H5-57
D. B. Graves L6-38

SUBJECT: Alternate Calculations for SMMS Analysis

Sam,

Attached are three sets of alternate calculations used to support the checking of the Surface Moisture Measurement System (SMMS) Analysis. The alternate calculations were completed to confirm three sections of the SMMS analysis; the applied wind loading, the static hoisting analysis, and the arm elevation system.

The alternate calculations for wind loading (attachment 1) were completed to ensure that the calculated wind loading in the SMMS analysis (242 lbf) bounds the required loading as specified by American Society of Civil Engineers, *Minimum Design Loads for Buildings and Other Structures*. This design guide must be used if the object is being design to the *Standard Arch-Civil Design Criteria - Design Loads for Facilities*, which the SMMS is.

The alternate calculations for both the static hoisting analysis and the arm elevation system analysis (attachments 1 & 2 respectively) were completed using the finite element analysis (FEA) program ANSYS. This was done for several reasons; the software quality assurance for the FEA software ALGOR is not up to date, the input files were not made available for checking and the FEA software ALGOR was not readily available to the checker.

The static hoisting analysis is comprised of two separate FEAs; the first analysis represents a two point hoist and the second represents a three point hoist. Each FEAs contains a geometry plot, deflection plot and stress plot. The results taken from the deflection and stress plots for both analyses show that the SMMS can be hoisted in either a two or three point configuration, however, a three point hoist is preferable.

The attached arm elevation system analysis contains FEA model input and output. The first and second attached plots are of the model geometry and bilinear material properties respectively. The purpose of these plots is to give the individual an idea of the FEA model. The third page of the attachment shows a summation of the deflections, plastic strain energy and von Mises stress at loads step 66 which corresponds to 66% of the total load or 1,181 lbf. From the remain three

plots of deflection, plastic strain energy and von Mises stresses it was determined the arm elevation system analysis is adequate.

WMC-SD-WM-SDD-070, REV 0
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Attachment 1

Wind Analysis Calculations

ICF KAISER
HANFORD COMPANY

Calc. No. _____
Revision 0
Page No. 1 of _____

ent: _____
Subject: _____
Location: 200 E /

WO/Job No. _____
Date: 10/02/95 By: B. L. Coverdell
Checked: _____ By: _____
Revised: _____ By: _____

PURPOSE:

Determine the maximum wind loading on the SMMS given ASCE 7-95, drawing H-14-100495 (WHC 1996) and that it is safety class 3/2 equipment.

DESCRIPTION:

In order to perform a simple stress analysis of the SMMS, the wind force on it must be determined. Conservatively using safety class 2, the maximum wind speed to use is 80 mph per KEH 1996. Below are the remaining calculations necessary to determine the maximum wind loading on the structure.

WIND CALCULATIONS

Exposure category is C from KEH 1996.

$I = 1.0$ Importance factor from KEH 1996.

$V = 80$ Fastest wind speed from KEH 1996.

$K_z = 0.85$ Velocity pressure exposure coefficient from ASCE 7-95, Page 17, Table 6-3.

$K_{zt} = 1$ The velocity pressure exposure coefficient, ASCE 7-95, Page 17.. No hills or escarpments within several miles.

$q_z = 0.00256 \cdot K_z \cdot K_{zt} \cdot (I \cdot V)^2$ $q_z = 13.926$ The velocity pressure from ASCE 1995, Page 11, Equation 3.

$G_h = 0.85$ Gust effect factor from ASCE 7-95, Page 34, 6.6.1.

$h = 42$ $D = 41$ Respective height and length of the airflow controller.

$\frac{h}{D} = 1.024$ Used to determine C_f in ASCE 1995.

$C_f = 1.0$ Force coefficient from ASCE 1995.

$A_f = \frac{h \cdot D}{144}$ $\frac{A_f}{144} = 0.083$ Cross-sectional area of the SMMS.

$P_z = C_f \cdot G_h \cdot q_z$ $P_z = 11.837$ Calculated maximum pressure.

$P_z = \text{if}(P_z < 10, 10, P_z)$ $P_z = 11.837$ If pressure less than 10 lbf/ft² use 10 lbf/ft² else use calculated pressure.

$F_w = P_z \cdot A_f$ $F_w = 141.556$ Wind load to be applied.

SEISMIC CALCULATIONS:

Hecht 1995 determined that other load conditions (such as wind loading and the arm extensions system failure) would bound any seismically induced loading on the SMMS.

RESULTS/CONCLUSIONS:

The maximum wind load on the SMMS per ASCE 7-95 is: $F_w = 141.556$

REFERENCES:

ASCE 1995, *Minimum Design Loads for Buildings and Other Structures*, Revision 7-95, American Society of Civil Engineers, New York, New York.

Memo, S. L. Hecht to D. B. Graves, *SMMS Structural Evaluation for Accident Conditions*, November 28, 1995.

KEH 1996, *Design Loads for Facilities*, GC-LOAD-01, ICF Kaiser Hanford Company, Richland, Washington.

WHC 1996, *SMMS Deployment Device Assembly*, drawing H-14-100459, Sheet 1-6, Westinghouse Hanford Company, Richland, Washington.

Attachment 2

Static Hoisting Analysis

ANSYS 5.2
APR 3 1996
10:16:09
ELEMENTS
ELEM NUM
U
HCEL
ZV =1
*DIST=229.831
*XF =208.937
*YF =-7.156
Z-BUFFER

WMC-SD-MM-SDD-070, REV 0
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ANSYS 5.2
APR 3 1996
10:15:20
ELEMENT SOLUTION
STEP=1
SUB =1
TIME=1
UY
(NDAVG)
DMX =3.261
SMN =-3.25
SMX =1.027
-3.125
-2.774
-2.299
-1.824
-1.349
-.873528
-.398309
.07691
.552129
1.027

ANSYS 5.2
APR 3 1996
10:14:46
ELEMENT SOLUTION
STEP=1
SUB =1
TIME=1
MMOM2
(NDRAVG)
DMX =3.261
SMN =-26698
-26698
-23732
-20765
-17799
-14832
-11866
-8899
-5933
-2966
0

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ANSYS 5.2
APR 3 1996
10:14:14
ELEMENT SOLUTION
STEP=1
SUB=1
TIME=1
SMAX (NDAVG)
DMX =3.261
SMX =16167
0
1796
3593
5389
7185
8982
10778
12574
14370
16167

ANSYS 5.2
APR 3 1996
10:26:39
ELEMENTS
ELEM NUM
U
ACEL
ZV =1
DIST=229.831
XF =208.937
Z-BUFFER

ANSYS 5.2
APR 3 1996
10:24:18
ELEMENT SOLUTION
STEP=1
SUB =1
TIME=1
UY
(NDAVG)
DMX =1.609
SMN =-1.603
SMX =.153215
-1.603
-1.408
-1.212
-1.017
-.822256
-.627162
-.432068
-.236973
-.041879
.153215

ANSYS 5.2
APR 3 1996
10:25:55
ELEMENT SOLUTION
STEP=1
SUB =1
TIME=1
MIDM2 (NDRVG)
DMX =1.609
SMN =-10916
SMX =12015
-10916
-8368
-5820
-3972
-724.066
1824
4372
6920
9468
12015

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ANSYS 5.2
APR 3 1996
10:55:29
ELEMENT SOLUTION
STEP=1
SUB =1
TIME=1
SMAX (NDRAG)
DMX =1.609
SMX =7276
0
808.423
1617
2425
3234
4042
4851
5659
6467
7276

Attachment 3

Arm Elevation System Analysis

Cable Break 4

ANSYS 5.2
APR 16 1996
09:19:49
ELEMENTS
ELEM NUM
U
F01
F
ZV =1
DIST=53.35
YF =48.5
Z-BUFFER

BCIN Table for Material 1

Cable Break 4

ANSYS 5.2
APR 16 1996
10:30:57
Table Data
T1=0.00
ZV =1
DIST=.75
XF =.5
YF =.5
ZF =.5
Z-BUFFER

SUM ALL THE ACTIVE ENTRIES IN THE ELEMENT TABLE

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TABLE LABEL	TOTAL
UX	-293.683
SF	5789.79
SE ✓	0.293953E+07

Cable Break 4

ANSYS 5.2
APR 16 1996
09:21:10
ELEMENT SOLUTION
SUB =1
TIME=.66
UX (NDAVG)
DMX =7.397
SMN =-7.346
SMX =-.001113
-7.346
-6.53
-5.714
-4.898
-4.082
-3.265
-2.449
-1.633
-1.817196
-.001113

Cable Break 4

ANSYS 5.2
APR 16 1996
09:23:18
ELEMENT SOLUTION
SUB = 1
TIME = .66
SENE (NDAYS)
DMX = 7.397
SMN = .063505
SMX = 365.97
063505
40.72
81.376
122.032
162.689
203.345
244.001
284.658
325.314
365.97

Cable Break 4

ANSYS 5.2
APR 16 1996
09:25:25
ELEMENT SOLUTION
SUB =1
TIME=.66
SEQV (NDRVG)
DMX =7.397
SMN =.128E-08
SMX =57337
.128E-08
6371
12742
19112
25483
31854
38225
44595
50966
57337

Design Verification of Project - APPENDIX F

The SMMS engineering work plan stated the drawings would be released as "SQ". As evidenced by the attached EDT's and ECN cover sheets, the following discipline's approvals are evidenced by their signatures.

Overview Personnel - Overview Role

J.S. Schofield	Cognizant Engineering Manager
C.A. Esvelt	Cognizant Engineer
L.S. Krosrud	Independent Safety
M.L. McElroy	Quality Assurance
B. Hugg	Quality Assurance (306E facility)
W. Farley	Safety Analysis Engineer
D. Neibuhr	Operations Person in Charge
J. Purcell	H-14 Drawing Guru of Labeling

Design Team Members - Project Role

G.F. Vargo Jr.	Design Engineering Project Lead
C.E. Hanson	Design Engineering Manager
T.I. Stokes	System Engineer
M. Gimera	Software and Data Acquisition System Engineer
J.H. Bussell	Neutron probe electronics Engineer
W.T. Watson	Nuclear Physicist
D.B. Graves	Mechanical Engineer
M.D. Clements	Packaging Engineer
S.C. Cantrell	Electrical Engineering Support

The SMMS design team conducted several reviews during the course of the project. A 30% design briefing was conducted in late 1995, which had been requested by the WHC Design Authority Organization, of the Characterization Project. The SMMS engineering team presented the project overview, and details of the mechanical, electrical, and procedural aspects of the effort. Attendance was minimal, including only P.R. Deichelbohrer, and intermittent support from Operation's staff member J.F. Sickels. P.R. Deichelbohrer was the designated design authority at this stage of the project. No formal comments resulted from the review, and verbal comments were adequately incorporated into the design.

Another design briefing was held at the 60% stage, which was held in the 306E facility in early 1996. Several RCRs were generated at this meeting, which included safety, quality, independent mechanical and electrical reviewers, as well as anyone else interested in attending the briefing. These RCRs were never formally dispositioned. The RCRs have been included in this appendix, and upon review of the RCRs, the reviewer can quickly see the comments are typically vague or have little impact on hardware.

Independent review, while a viable approach per the engineering practices, does not really lend itself to the SMMS as a way of determining functionality. The SMMS was thoroughly tested per acceptance test plans, and passed all the tests. The design drawings and all EDTs have independent review signatures which also serve as backup that the design verification was sufficient for the project needs.

We have included the EDT cover sheets, which show all released project drawings, and the signatories involved. We have also included our informal drawing tracking sheet, which showed all design drawings, drafter, checker, and engineer.

We have also included a package concerning the adequateness of the explosion proof housing. This subject has been thoroughly discussed in the NEC position paper, but this was interesting enough, that we opted to include it in this appendix.

Our final “go-ahead” from QA is evidenced by the green tagging memo to Mike McElroy.

REVIEW COMMENT RECORD (RCR)

1. Date 11/17/95		2. Review No.
3. Project No.		4. Page 1 of 2

5. Document Number(s)/Title(s) SMMS 60% DESIGN REVIEW	6. Program/Project/ Building Number TWRS	7. Reviewer C.P. Shaw	8. Organization/Group 74750	9. Location/Phone 2940GWW/376-0814
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17. Comment Submittal Approval: 10. Agreement with indicated comment disposition(s) 11. CLOSED

Organization Manager (Optional)	Reviewer/Point of Contact	Date	Reviewer/Point of Contact	Date
	Author/Originator		Author/Originator	

12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/ resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
1	Lacking any kind of definitive performance requirements and assemblies drawing, it is hard to make anything more than generalized comments.			
2	In general, the tolerances on the piece parts seem unnecessarily tight. From my experience, the 200 area shop would charge a fortune, they will inspect each and every 3 place dimension.			
3	Many items are made from pipe, however, I don't think the designer understands the loose tolerances on pipe. Best use mechanical tubing.			
4	Drawing D209-1B Arm Assembly: It appears when the little arm flips out, the cable going to the probe will ride up on the arm. Is this what you want?			
5	The cable going to the camera is not part of the package, however its concept was presented i.e. an instrument line and some nitrogen pressurization lines wrapped into a non-circular bundle. This is			

REVIEW COMMENT RECORD (RCR)			
	1. Date	2. Review N	
	11/17/95		
	3. Project No.	4. Page	
			2 of 2

[illegible]

REVIEW COMMENT RECORD (RCR)

1. Date 11/15/95		2. Review No.
3. Project No.		4. Page 1 of 1

5. Document Number(s)/Title(s) SMMS 60% DESIGN REVIEW	6. Program/Project/ Building Number TWRS	7. Reviewer L. L. Carter	8. Organization/Group 8W730	9. Location/Phone 3200GWW/376-3929
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17. Comment Submittal Approval: 10. Agreement with indicated comment disposition(s) 11. CLOSED

Organization Manager (Optional)	Date	Reviewer/Point of Contact	Date	Reviewer/Point of Contact
				Author/Originator

12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/ resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
1	The in-tank measurements will depend upon the absolute value of the detector readings. I understand that the plan is to make a calibration check of the instruments each time before putting them in the tank. After the instrumentation is in the tank, perhaps the neutron probe should be pulled up a few feet above the top of the waste and a calibration check made again. Also, might make another calibration check after removal from the tank.			
2	Detector #3 responds to thermal neutrons and there is a concern that there could sometimes be trace materials with high thermal cross sections in the tank that could influence this reading. I haven't come up with a suggestion on a detector/shield arrangement to avoid this potential (probably not very likely) problem, but it might warrant some additional thought.			

REVIEW COMMENT RECORD (RCR)

	1. Date 11/08/95	2. Review N
	3. Project No.	4. Page 1 of 1

5. Document Number(s)/Title(s) SMMS 60% DESIGN REVIEW	6. Program/Project/ Building Number TWRS	7. Reviewer M. L. McElroy	8. Organization/Group 3E200	9. Location/Phone 2704HV/373-5598
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17. Comment Submittal Approval: 10. Agreement with indicated comment disposition(s) 11. CLOSED

Organization Manager (Optional)	Date	Reviewer/Point of Contact	Date	Reviewer/Point of Contact
				Author/Originator

12. Item #	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/ resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
1	The design at the 60%, appears to be satisfactory and acceptable. Any comments that I may have had were resolved when I reviewed and commented on the individual documents in the design package, before they were put into the 60% package, i.e. work plan, DRD, etc.			
2	Note: With the design changing because of the scope change and schedule, the "Work Plan", the FDC, etc. may have to change, be ECN'd, to reflect the changes and direction.			

REVIEW COMMENT RECORD (RCR)

	1. Date	2. Review N
	11/08/95	
	3. Project No.	4. Page
		2 of 1

12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/ resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status

REVIEW COMMENT RECORD (RCR)

1. Date 11/08/95		2. Review N
3. Project No.		4. Page 3 of 1

5. Document Number(s)/Title(s) SMMS 60% DESIGN REVIEW	6. Program/Project/ Building Number TWRS	7. Reviewer P. L. Deichelbohrer	8. Organization/Group 75230	9. Location/Phone 2704HV/373-2037
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17. Comment Submittal Approval: 10. Agreement with indicated comment disposition(s) 11. CLOSED

Organization Manager (Optional)	Reviewer/Point of Contact	Reviewer/Point of Contact
Date	Date	Author/Originator

12. Item 13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/ resolve the discrepancy/problem indicated.) The Camera Work Plan should have been written, reviewed, and released before the 60% Design Review. The USQ should have been done before the 60% Design Review. To what Safety Basis are we working? Has Bussel's NEC Report been released? Will it be revised as a result of Dunk's comments on the safety barriers? The camera FDC should have been written, reviewed and released before the 60% Design Review. What is status of: Training plan Conceptual Design Operating Test Procedure Operating Procedures Theory of Operation Report	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status

REVIEW COMMENT RECORD (RCR)		1. Date	2. Review N
		10/6/95	
		3. Project No.	4. Page
			2 of 2

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[illegible]

REVIEW COMMENT RECORD (RCR)

1. Date 11/02/95		2. Review N 1273-95
3. Project No.		4. Page 1 of 1

5. Document Number(s)/Title(s) SMMS 60& DESIGN REVIEW	6. Program/Project/ Building Number TWRS	7. Reviewer L. S. Krogsrud	8. Organization/Group 31N30	9. Location/Phone 2751E/372-2302
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17. Comment Submittal Approval: 10. Agreement with indicated comment disposition(s) 11. CLOSED

Organization Manager (Optional)	Date	Reviewer/Point of Contact	Date	Reviewer/Point of Contact
		Author/Originator		Author/Originator

12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/ resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
1	Section 6.4.3 of the Design Requirements Document (WHC-SD-WM-DRD-002) says "Readings at the zero foot radial position may be taken with little or no visual support due to interference with the integral camera". There will probably be some minimum distance from the vertical axis below which the integral camera will be ineffective. Is this consistent with the safety requirements and the sampling plan?			
2	In view of item 1, is there any value in deleting the integral camera and using one of the mobile camera systems which are separately under development and could go through another riser? I believe this was Troy's original plan, but don't know why they went with the integral camera.			

REVIEW COMMENT RECORD (RCR)

	1. Date	2. Review N.
	11/02/95	1273-95
	3. Project No.	4. Page
		2 of 1

12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/ resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status

REVIEW COMMENT RECORD (RCR)

	1. Date	2. Review 1
	11/02/95	1273-95
	3. Project No.	4. Page
		1 of 1

5. Document Number(s)/Title(s)	6. Program/Project/ Building Number	7. Reviewer	8. Organization/Group	9. Location/Phone
SMMS 60% DESIGN REVIEW	TWRS	W. J. Kennedy	75150	2704HV/373-0259

17. Comment Submittal Approval:

10. Agreement with indicated comment disposition(s) 11. CLOSED

Organization Manager (Optional)	Date	Reviewer/Point of Contact	Date	Reviewer/Point of Contact
---------------------------------	------	---------------------------	------	---------------------------

Author/Originator	Author/Originator
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12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detail recommendation for the action required to correct/ resolve the discrepancy/problem indicated.)	14. Disposition (Provide justification if NOT accepted.)	15. Disposition (Provide justification if NOT accepted.)	16. Status
1	The Engineering Work Plan references decon capabilities, specifically CO ₂ . We have been trying to obtain a CO ₂ unit for the last two years. We seem to be running into permit problems. I would not design anything with the need for CO ₂ as a decon agent. A spraywash would probably suffice, but will this ruin the waste underneath the riser for further sampling? Efficient, safe decon of whatever comes out of the tank will be a high priority for CPO.			
2	Storage. The Plan calls for storage of the unit in the farm. Does this include the van with electronics? How will this system hold up to 100F to 0F conditions?			
3	I am assuming that a Neutron seek will be used in conjunction with the system. Who will be the custodian? Where will it be stored?			
4	On attachment 2, could you replace operations org. code 7c900, with 7c500.			

REVIEW COMMENT RECORD (RCR)

	1. Date 11/02/95	2. Review 1 1273-95
	3. Project No.	4. Page 2 of 1

12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/ resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status

Waste Tank Surface Neutron Moisture Probe
Proposed "Explosion Proof" Probe Housing
Design

Presented
to
Hanford Intercontractor Electrical Board

5/4/95

JH Bussell
TI Stokes

Operational Description

- o Mechanism is lowered into the a tank through a riser.
- o Arm is deployed and probe is lowered to surface.
- o Measurement is taken.
- o Probe is raised and mechanism is rotated. Measurement is repeated.
- o System must be operational in all waste tanks with respect to area classification by NEC.

Proposed Design

- o Concept was previously reviewed on 3/2/95 or 3/3/95. At that time, it was recommended that UL-1203 be used as a guideline to design the probe enclosure. See page 10.
- o Termination method for signal cable does not permit the use of seal above the cap.
- o We propose to use the seal as shown on pages 6 and 7.

Moisture Probe in Deployment Position

Moisture Probe Deployed in Tank with Arm Raised to 90°

Moisture Probe in Measurement Position.

JH Busse
6/3/95

JH Busell
5/3/95

See Project File SMMS96-138 for Cable Specification

See Project File SMMS96-139 for Resin Specification

Author: Charles M Monasmith at WHC160
Date: 3/3/95 4:12 PM
Priority: Normal
TO: James H Bussell at WHC35
TO: Michael (Mike) Gimera at WHC177
TO: Raymond B Jr Mailhot at WHC224
TO: Troy I Stokes at WHC207
CC: Charles M Monasmith
CC: Edwin A (Ed) Harding
Subject: NEUTRON SOURCE ENCLOSURE

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----- Message Contents -----

The Hanford Electrical Codes Board reviewed your conceptual design (off the record) for an enclosure for a Class I Division 1 Group B atmosphere.

The consensus of the Board was the design of threaded joints (5 threads engaged) with a seal off fitting (for cable entrance) was sound. It was recommended that UL Standard 1203 "Explosion-Proof and Dust-Proof Enclosures for Use in Hazardous Locations" be consulted for design details of the enclosure. This standard is available for loan from the ICF-KH library in TCPC. A further suggestion was to investigate the use of a purged enclosure rather than an explosion proof enclosure.

Sounds to me like you have a good concept design.

Chuck Monasmith

SURFACE MOISTURE MONITORING SYSTEM DRAWING STATUS

N. Fox

3/19/96

3/20/96

TITLE OF DRAWING	DRAWING NO.	#	ENGINEER/DESIGNER	SCHED TO CHECK	ACTUAL TO CHECK	SCHED FROM CHECK	ACTUAL FROM CHECK	SCHED TO BKCHK	ACTUAL TO BKCHK	SIGNED BY	CHECK	COMMENTS	EDT #	Total
SMMS DRAWING TREE	H-14-100457	1	Gimera	20-Feb	20-Feb	Rick	Says will check last							2
SMMS INSTALLATION ASSY	H-14-100458	1	Stokes	15-Mar	18-Mar	20-Mar	27-Mar	4 APR						2
SMMS INSTALLATION ASSY	H-14-100458	2	Stokes	15-Mar	18-Mar	20-Mar	27-Mar	4 APR						2
SMMS INSTALLATION ASSY	H-14-100458	3	Stokes	15-Mar	18-Mar	20-Mar	27-Mar	4 APR						3
SMMS INSTALLATION ASSY	H-14-100458	4	Stokes	15-Mar	18-Mar	20-Mar	27-Mar	4 APR						4
SMMS DEPLOYMENT DEVICE ASSY	H-14-100459	1	Graves	N/A	18-Jan	N/A	25-Jan	N/A	7-Feb					5
SMMS DEPLOYMENT DEVICE ASSY	H-14-100459	2	Gober	N/A	18-Jan	N/A	25-Jan	N/A	7-Feb	BJW				6
SMMS DEPLOYMENT DEVICE ASSY	H-14-100459	3	Gober	N/A	18-Jan	N/A	25-Jan	N/A	7-Feb	BJW				7
SMMS DEPLOYMENT DEVICE ASSY	H-14-100459	4	Gober	N/A	18-Jan	N/A	25-Jan	N/A	7-Feb	BJW				8
SMMS DEPLOYMENT DEVICE ASSY	H-14-100459	5	Gober	N/A	18-Jan	N/A	25-Jan	N/A	7-Feb	BJW				9
SMMS DEPLOYMENT DEVICE ASSY	H-14-100459	6	Gober	N/A	18-Jan	N/A	25-Jan	N/A	7-Feb	BJW				10
SMMS ARM & MAST ASSY	H-14-100460	1	Gober	N/A	22-Jan	N/A	29-Jan	N/A	7-Feb	BJW				11
SMMS ARM & MAST ASSY	H-14-100460	2	Gober	N/A	22-Jan	N/A	29-Jan	N/A	7-Feb	BJW				12
SMMS ARM & MAST ASSY	H-14-100460	3	Gober	N/A	22-Jan	N/A	29-Jan	N/A	7-Feb	BJW				13
SMMS ARM & MAST ASSY	H-14-100460	4	Gober	N/A	22-Jan	N/A	29-Jan	N/A	7-Feb	BJW				14
SMMS ARM & MAST ASSY	H-14-100460	5	Gober	N/A	22-Jan	N/A	29-Jan	N/A	7-Feb	BJW				15
SMMS ARM & MAST ASSY	H-14-100460	6	Gober	N/A	22-Jan	N/A	29-Jan	N/A	7-Feb	BJW				16
														17

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SURFACE MOISTURE MONITORING SYSTEM DRAWING STATUS

3/19/98

TITLE OF DRAWING	DRAWING NO.	# SHT'S	ENGINEER/ DESIGNER	SCHED TO CHECK	ACTUAL TO CHECK	SCHED FROM CHECK	ACTUAL FROM CHECK	SCHED TO CHECK	ACTUAL TO CHECK	SIGNED BY	COMMENTS EDT #
SMMS ARM & MAST ASSY	H-14-100460	7	Graves Gober	N/A	22-Jan BJW	N/A	2-Feb BJW	N/A	21-Feb BJW	22-Feb BJW	608745
SMMS ARM & MAST ASSY	H-14-100460	8	Graves Gober	N/A	22-Jan BJW	N/A	2-Feb BJW	N/A	21-Feb BJW	22-Feb BJW	608745
SMMS ARM & MAST ASSY	H-14-100460	9	Graves Gober	N/A	22-Jan BJW	N/A	2-Feb BJW	N/A	21-Feb BJW	22-Feb BJW	608745
SMMS ARM & MAST ASSY	H-14-100460	10	Graves Gober	N/A	22-Jan BJW	N/A	2-Feb BJW	N/A	21-Feb BJW	22-Feb BJW	608745
SMMS ARM & MAST ASSY	H-14-100460	11	Graves Gober	N/A	22-Jan BJW	N/A	2-Feb BJW	N/A	21-Feb BJW	22-Feb BJW	608745
SMMS ARM & MAST ASSY	H-14-100460	12	Graves Gober	N/A	22-Jan BJW	N/A	2-Feb BJW	N/A	21-Feb BJW	22-Feb BJW	608745
SMMS ARM & MAST ASSY	H-14-100460	13	Graves Gober	N/A	22-Jan BJW	N/A	2-Feb BJW	N/A	21-Feb BJW	22-Feb BJW	608745
SMMS ENCLOSURE ASSY	H-14-100461	1	Graves Gober	N/A	19-Jan AC	N/A	2-Feb AC	1st time 2nd time	18-Feb 27-Feb	28-Feb	608745
SMMS ENCLOSURE ASSY	H-14-100461	2	Graves Gober	N/A	19-Jan AC	N/A	2-Feb AC	1st time 2nd time	18-Feb 27-Feb	28-Feb	608745
SMMS ENCLOSURE ASSY	H-14-100461	3	Graves Gober	N/A	19-Jan AC	N/A	2-Feb AC	1st time 2nd time	18-Feb 27-Feb	28-Feb	608745
SMMS ENCLOSURE ASSY	H-14-100461	4	Graves Gober	N/A	19-Jan AC	N/A	2-Feb AC	1st time 2nd time	18-Feb 27-Feb	28-Feb	608745
SMMS ENCLOSURE ASSY	H-14-100461	5	Graves Gober	N/A	19-Jan AC	N/A	2-Feb AC	1st time 2nd time	18-Feb 27-Feb	28-Feb	608745
SMMS ENCLOSURE ASSY	H-14-100461	6	Graves Gober	N/A	19-Jan AC	N/A	2-Feb AC	1st time 2nd time	18-Feb 27-Feb	28-Feb	608745
SMMS ENCLOSURE ASSY	H-14-100461	7	Graves Gober	N/A	19-Jan AC	N/A	2-Feb AC	1st time 2nd time	18-Feb 27-Feb	28-Feb	608745
SMMS ENCLOSURE ASSY	H-14-100461	8	Graves Gober	N/A	19-Jan AC	N/A	2-Feb AC	1st time 2nd time	18-Feb 27-Feb	28-Feb	608745
SMMS ENCLOSURE ASSY	H-14-100461	9	Graves Gober	N/A	19-Jan AC	N/A	2-Feb AC	1st time 2nd time	18-Feb 27-Feb	28-Feb	608745
SMMS DECON SPRAY RING ASSY	H-14-100462	1	Graves Gober	N/A	1-Feb	N/A	8-Feb 28-Feb	1st time 2nd time	20-Feb 28-Feb		608742

SURFACE MOISTURE MONITORING SYSTEM DRAWING STATUS

3/19/96

TITLE OF DRAWING	DRAWING NO.	# SHTS	ENGINEER/DESIGNER	SCHED TO CHECK	ACTUAL TO CHECK	SCHED FROM CHECK	ACTUAL FROM CHECK	SCHED TO BKCHK	ACTUAL TO BKCHK	SIGNED BY CHECK	COMMENTS EDT #
SMMS DECON SPRAY RING ASSY	H-14-100462	2	Graves	N/A	1-Feb	N/A	8-Feb	20-Feb	20-Feb		606742
SMMS DECON SPRAY RING ASSY	H-14-100462	3	Gober	N/A	1-Feb	N/A	8-Feb	20-Feb	20-Feb		35
SMMS DECON SPRAY RING ASSY	H-14-100462	4	Gober	N/A	1-Feb	N/A	8-Feb	20-Feb	20-Feb		606742
SMMS IMPACT LIMITER ASSY	H-14-100463	1	Graves	N/A	18-Dec	N/A	19-Dec	20-Feb	20-Feb		37
SMMS IMPACT LIMITER ASSY	H-14-100463	2	Gober	N/A	18-Dec	N/A	19-Dec	20-Feb	20-Feb	14-Mar	606742
SMMS IMPACT LIMITER ASSY	H-14-100463	3	Graves	N/A	18-Dec	N/A	19-Dec	20-Feb	20-Feb	14-Mar	606742
SMMS VEHICLE MODIFICATIONS	H-14-100464	1	Ritter	N/A	20-Feb	23-Feb	28-Feb	7-Mar	7-Mar	2 APR	40
SMMS VEHICLE MODIFICATIONS	H-14-100464	2	Schulz	N/A	20-Feb	28-Feb	12-Mar	2nd time	2nd time	2 APR	41
SMMS VEHICLE MODIFICATIONS	H-14-100464	3	Ritter	N/A	20-Feb	28-Feb	12-Mar	2nd time	2nd time	2 APR	42
SMMS VEHICLE MODIFICATIONS	H-14-100464	4	Schulz	N/A	20-Feb	28-Feb	12-Mar	2nd time	2nd time	2 APR	43
SMMS VEHICLE MODIFICATIONS	H-14-100464	5	Ritter	N/A	20-Feb	28-Feb	12-Mar	2nd time	2nd time	2 APR	44
SMMS VEHICLE MODIFICATIONS	H-14-100464	6	Schulz	N/A	20-Feb	28-Feb	12-Mar	2nd time	2nd time	2 APR	45
SMMS VEHICLE MODIFICATIONS	H-14-100464	7	Ritter	N/A	20-Feb	28-Feb	12-Mar	2nd time	2nd time	2 APR	46
SMMS VEHICLE MODIFICATIONS	H-14-100464	8	Schulz	N/A	20-Feb	28-Feb	12-Mar	2nd time	2nd time	2 APR	47
LOW PROBE DELIVERY SYS. ASSY	H-14-100465	1	Fox	N/A	20-Feb	N/A	28-Feb	1st time	1st time	14-Mar	606743
LOW PROBE DELIVERY SYS. ASSY	H-14-100465	2	Ritter	N/A	20-Feb	N/A	28-Feb	1st time	1st time	14-Mar	606743
LOW PROBE DELIVERY SYS. ASSY	H-14-100465	3	Fox	N/A	20-Feb	N/A	28-Feb	1st time	1st time	14-Mar	606743
LOW PROBE DELIVERY SYS. ASSY	H-14-100465	4	Ritter	N/A	20-Feb	N/A	28-Feb	1st time	1st time	14-Mar	606743
LOW PROBE DELIVERY SYS. ASSY	H-14-100465	5	Fox	N/A	20-Feb	N/A	28-Feb	1st time	1st time	14-Mar	606743

SURFACE MOISTURE MONITORING SYSTEM DRAWING STATUS

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LOW PROBE DELIVERY SYS. ASSY	H-14-100465	5	Ritter	N/A	20-Feb	N/A	26-Feb	1st time	7-Mar	14-Mar	606743
LOW PROBE DELIVERY SYS. ASSY	H-14-100465	6	Fox	N/A	20-Feb	AC	12-Mar	2nd time	12-Mar	14-Mar	606743
SMMS ONE-LINE DIAGRAM	H-14-100466	1	Gimera	N/A	5-Feb	AC	12-Mar	1st time	7-Mar	14-Mar	606743
SMMS BLOCK DIAGRAM	H-14-100467	1	Croskrey	N/A	5-Feb	MF	21-Feb	2nd time	12-Mar	6-Mar	606746
SMMS BLOCK DIAGRAM	H-14-100467	2	Gimera	N/A	16-Feb	MF	21-Feb	27-Feb	1-Mar	29-Feb	606746
SMMS BLOCK DIAGRAM	H-14-100467	3	Croskrey	N/A	16-Feb	MF	21-Feb	28-Feb	29-Feb	29-Feb	606746
SMMS BLOCK DIAGRAM	H-14-100467	4	Gimera	N/A	16-Feb	MF	21-Feb	28-Feb	29-Feb	29-Feb	606746
SMMS ASSY OPERATOR CONTROL ENCLOSURE	H-14-100468	1	Croskrey	N/A	20-Feb	MF	21-Feb	28-Feb	29-Feb	29-Feb	606746
SMMS ASSY OPERATOR CONTROL ENCLOSURE	H-14-100468	2	Gimera	N/A	30-Jan	N/A	9-Feb	28-Feb	29-Feb	22-Feb	606744
SMMS Extension Cord Assemblies	H-14-100469	1	Schulz	N/A	30-Jan	N/A	9-Feb	20-Feb	20-Feb	AC	606744
SMMS Extension Cord Assemblies	H-14-100469	2	Gimera	29-Feb	27-Feb	4-Mar	8-Mar	20-Feb	22-Feb	AC	606744
SMMS Extension Cord Assemblies	H-14-100469	3	Schulz	29-Feb	27-Feb	4-Mar	8-Mar	11-Mar	13-Mar	10-Mar	606744
SMMS Extension Cord Assemblies	H-14-100469	4	Gimera	29-Feb	27-Feb	4-Mar	8-Mar	11-Mar	13-Mar	10-Mar	606744
DRIVER SIDE ELECTRONICS ENCLOSURE SMMS ASSEMBLY	H-14-100470	1	Schulz	N/A	18-Jan	1-Mar	8-Mar	11-Mar	13-Mar	10-Mar	606744
DRIVER SIDE ELECTRONICS ENCLOSURE SMMS ASSEMBLY	H-14-100470	2	Gimera	N/A	18-Jan	1-Mar	8-Mar	11-Mar	13-Mar	10-Mar	606744
DRIVER SIDE ELECTRONICS ENCLOSURE SMMS ASSEMBLY	H-14-100470	2	Schulz	N/A	18-Jan	1-Mar	8-Mar	11-Mar	13-Mar	10-Mar	606744
DRIVER SIDE ELECTRONICS ENCLOSURE SMMS ASSEMBLY	H-14-100470	2	Gimera	N/A	18-Jan	1-Mar	8-Mar	11-Mar	13-Mar	10-Mar	606744

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DRIVER SIDE ELECTRONICS ENCLOSURE SMMS ASSEMBLY	H-14-100470	3	Gimera Schulz	N/A	18-Jan BJW	21-Feb BJW	21-Feb	N/A	29-Feb 8-Mar		606744 42 67
DRIVER SIDE ELECTRONICS ENCLOSURE SMMS ASSEMBLY	H-14-100470	4	Gimera Schulz	N/A	18-Jan BJW	21-Feb BJW	21-Feb	N/A	29-Feb 8-Mar		606744 42 68
DRIVER SIDE ELECTRONICS ENCLOSURE SMMS ASSEMBLY	H-14-100470	5	Gimera Schulz	N/A	18-Jan BJW	21-Feb BJW	21-Feb	N/A	29-Feb 8-Mar		606744 42 69
DRIVER SIDE ELECTRONICS ENCLOSURE SMMS ASSEMBLY	H-14-100470	6	Gimera Schulz	N/A	18-Jan BJW	21-Feb BJW	21-Feb	N/A	29-Feb 8-Mar		606744 42 70
DRIVER SIDE ELECTRONICS ENCLOSURE SMMS ASSEMBLY	H-14-100470	7	Gimera Schulz	N/A	18-Jan BJW	21-Feb BJW	21-Feb	N/A	29-Feb 8-Mar		606744 42 71
DRIVER SIDE ELECTRONICS ENCLOSURE SMMS ASSEMBLY	H-14-100471	1	Gimera Schulz	N/A	18-Jan MF	21-Feb BJW	21-Feb	N/A	27-Feb 7-Mar	11-Mar	606744 72
DRIVER SIDE ELECTRONICS ENCLOSURE SMMS ASSEMBLY	H-14-100471	2	Gimera Schulz	N/A	18-Jan MF	21-Feb BJW	21-Feb	N/A	27-Feb 7-Mar	11-Mar	606744 73
DRIVER SIDE ELECTRONICS ENCLOSURE SMMS ASSEMBLY	H-14-100471	3	Gimera Schulz	N/A	18-Jan MF	21-Feb BJW	21-Feb	N/A	27-Feb 7-Mar	11-Mar	606744 74
PASSENGER SIDE ELECTRONICS ENCLOSURE SMMS ASSY	H-14-100472	1	Gimera Schulz	N/A	18-Jan BJW	1-Mar MF	21-Feb MF	11-Mar	12-Mar 19-Mar		606744 2 75
PASSENGER SIDE ELECTRONICS ENCLOSURE SMMS ASSY	H-14-100472	2	Gimera Schulz	N/A	18-Jan BJW	1-Mar MF	21-Feb MF	11-Mar	12-Mar 19-Mar		606744 2 76
PASSENGER SIDE ELECTRONICS ENCLOSURE SMMS ASSY	H-14-100472	3	Gimera Schulz	N/A	18-Jan BJW	1-Mar MF	21-Feb MF	11-Mar	12-Mar 19-Mar		606744 2 77
PASSENGER SIDE ELECTRONICS ENCLOSURE SMMS ASSY	H-14-100472	4	Gimera Schulz	N/A	18-Jan BJW	1-Mar MF	21-Feb MF	11-Mar	12-Mar 19-Mar		606744 2 78
PASSENGER SIDE ELECTRONICS ENCLOSURE SMMS ASSY	H-14-100472	5	Gimera Schulz	N/A	18-Jan BJW	1-Mar MF	21-Feb MF	11-Mar	12-Mar 19-Mar		606744 2 79
PASSENGER SIDE ELECTRONICS ENCLOSURE SMMS ASSY	H-14-100472	6	Gimera Schulz	N/A	18-Jan BJW	1-Mar MF	21-Feb MF	11-Mar	12-Mar 19-Mar		80

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PASSENGER SIDE ELECTRONICS ENCLOSURE SMMS WIRING	H-14-100473	1	Gimera Schulz	N/A	18-Jan BJW	1-Mar MF	28-Feb 8-Mar	5-Mar 11-Mar	5-Mar 11-Mar	12-Mar	606744	81
SMMS ELEMENTARY DIAGRAM	H-14-100474	1	Gimera Schulz	N/A	29-Jan BJW	8-Mar MF	5-Mar MF	11-Mar	11-Mar	14-Mar	606744	82
SMMS ELEMENTARY DIAGRAM	H-14-100474	2	Gimera Schulz	N/A	29-Jan BJW	8-Mar MF	5-Mar MF	11-Mar	11-Mar	14-Mar	606744	83
SMMS LOOP DIAGRAM	H-14-100475	1	Gimera Schulz	N/A	5-Feb BJW	8-Mar MF	28-Feb 14-Mar	13-Mar	13-Mar	21-Mar	606744	84
SMMS LOOP DIAGRAM	H-14-100475	2	Gimera Schulz	N/A	5-Feb BJW	8-Mar MF	28-Feb 14-Mar	13-Mar	13-Mar	21-Mar	606744	85
SMMS LOOP DIAGRAM	H-14-100475	3	Gimera Schulz	N/A	5-Feb BJW	8-Mar MF	28-Feb 14-Mar	13-Mar	13-Mar	21-Mar	606744	86
SMMS LOOP DIAGRAM	H-14-100475	4	Gimera Schulz	N/A	5-Feb BJW	8-Mar MF	28-Feb 14-Mar	13-Mar	13-Mar	21-Mar	606744	87
SMMS LOOP DIAGRAM	H-14-100475	5	Gimera Schulz	N/A	5-Feb BJW	8-Mar MF	28-Feb 14-Mar	13-Mar	13-Mar	21-Mar	606744	88
SMMS PROBE TESTING ELECTRONIC ENCLOSURE ASSY (suitcase)	H-14-100476	1	Bussell Fox	20-Feb	WS	WS	26-Feb WS	29-Feb	29-Feb	8-Mar	606746	89
SMMS PROBE TESTING ELECTRONIC ENCLOSURE ASSY (suitcase)	H-14-100476	2	Bussell Fox	20-Feb	WS	WS	26-Feb WS	29-Feb	29-Feb	6-Mar	606746	90
SMMS CABLE ASSEMBLIES	H-14-100477	1	Gimera Croskrey	N/A	18-Jan BJW	N/A	12-Feb 28-Feb	20-Feb 27-Feb	20-Feb 27-Feb	1-Mar	606746	91
SMMS CABLE ASSEMBLIES	H-14-100477	2	Gimera Croskrey	N/A	18-Jan BJW	N/A	12-Feb 28-Feb	20-Feb 27-Feb	20-Feb 27-Feb	1-Mar	606746	92
SMMS CABLE ASSEMBLIES	H-14-100477	3	Gimera Croskrey	N/A	18-Jan BJW	N/A	12-Feb 28-Feb	20-Feb 27-Feb	20-Feb 27-Feb	1-Mar	606746	93
SMMS CABLE ASSEMBLIES	H-14-100477	4	Gimera Croskrey	N/A	18-Jan BJW	N/A	12-Feb 28-Feb	20-Feb 27-Feb	20-Feb 27-Feb	1-Mar	606746	94
SMMS Probe Power Supply Board PCB Diagram	H-14-100478	1	Bussell Croskrey	4-Mar 8-Mar	19-Mar		27-Mar				606748	95
SMMS Probe Power Supply Board PCB Diagram MATERIALS LIST	H-14-100478	2	Bussell Croskrey	4-Mar 8-Mar	19-Mar		27-Mar				606748	96

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SMMS Probe Power Supply Board PCB Diagram <i>ART WORK CUT & TRIM</i>	H-14-100478	3	Bussell Croskrey	4-Mar 8-Mar 14-Mar	19-Mar						606748	97
SMMS Probe Power Supply Board PCB Diagram <i>CUT & TRIM</i>	H-14-100478	3	Bussell Croskrey	4-Mar 8-Mar 14-Mar	19-Mar						606748	98
SMMS Probe Interface Board PCB Diagram (Material's list)	H-14-100479	1	Bussell Croskrey	11-Mar 14-Mar	19-Mar						606748	99
SMMS Probe Interface Board PCB Diagram (Schematics)	H-14-100479	2	Bussell Croskrey	4-Mar 11-Mar 14-Mar	19-Mar						606748	100
SMMS Probe Interface Board PCB Diagram (artwork)	H-14-100479	3	Bussell Croskrey	4-Mar 11-Mar 14-Mar	19-Mar						606748	101
SMMS Probe Interface Board PCB Diagram (artwork)	H-14-100479	4	Bussell Croskrey	4-Mar 11-Mar 14-Mar	19-Mar						7	102
SMMS Probe Interface Board PCB Diagram (artwork)	H-14-100479	5	Bussell Croskrey	4-Mar 11-Mar 14-Mar	19-Mar						7	103
SMMS Probe Interface Board PCB Diagram (artwork)	H-14-100479	6	Bussell Croskrey	4-Mar 11-Mar 14-Mar	19-Mar						7	104
SMMS Probe Line Driver Board PCB Diagram (Material's list)	H-14-100480	1	Bussell Croskrey	4-Mar 13-Mar 15-Mar 22-Mar	first scheduled second scheduled third scheduled fourth scheduled	29-Mar 5 APR 20 APR					606748	105
SMMS Probe Line Driver Board PCB Diagram (Schematics)	H-14-100480	2	Bussell Croskrey	4-Mar 13-Mar 15-Mar 22-Mar	first scheduled second scheduled third scheduled fourth scheduled	29-Mar 5 APR 20 APR					606748	106

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SMMS Probe Line Driver Board	H-14-100480	3	Bussell Croskrey	4-Mar 13-Mar 15-Mar 22-Mar	first scheduled second scheduled third scheduled fourth scheduled	29-MAR	5-APR				606 748 107
PCB Diagram											
SMMS Probe Line Driver Board	H-14-100480	2	Bussell Croskrey	4-Mar 13-Mar 15-Mar 22-Mar	first scheduled second scheduled third scheduled fourth scheduled	29-MAR	5-APR				108
PCB Diagram											
SMMS Probe Preamp Board	H-14-100481	1	Bussell Croskrey	4-Mar 13-Mar 15-Mar 22-Mar	first scheduled second scheduled third scheduled fourth scheduled	29-MAR	5-APR				606 748 109
PCB Diagram											
SMMS Probe Preamp Board	H-14-100481	2	Bussell Croskrey	4-Mar 13-Mar 15-Mar 22-Mar	first scheduled second scheduled third scheduled fourth scheduled	29-MAR	5-APR				606 748 110
PCB Diagram											
SMMS Probe Preamp Board	H-14-100481	3	Bussell Croskrey	4-Mar 13-Mar 15-Mar 22-Mar	first scheduled second scheduled third scheduled fourth scheduled	29-MAR	5-APR				606 748 111
PCB Diagram											
SMMS Probe Preamp Board	H-14-100481	2	Bussell Croskrey	4-Mar 13-Mar 15-Mar 22-Mar	first scheduled second scheduled third scheduled fourth scheduled	29-MAR	5-APR				112
PCB Diagram											
SMMS Probe Isolation Board	H-14-100482	1	Bussell Croskrey	4-Mar 13-Mar 15-Mar 22-Mar	first scheduled second scheduled third scheduled fourth scheduled	29-MAR	5-APR				606 748 113
PCB Diagram											
SMMS Probe Isolation Board	H-14-100482	2	Bussell Croskrey	4-Mar 13-Mar 15-Mar 22-Mar	first scheduled second scheduled third scheduled fourth scheduled	29-MAR	5-APR				606 748 114
PCB Diagram											

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SMMS Probe Isolation Board	H-14-100482	2	Bussell Croskey	4-Mar 13-Mar 22-Mar	21-Mar 13-Mar 22-Mar	21-Mar 13-Mar 22-Mar	21-Mar 13-Mar 22-Mar	5 APR	13-Mar 26 MAR	27 MAR	606745 115
PCB Diagram (work)		2	Bussell Croskey	4-Mar 13-Mar 22-Mar	21-Mar 13-Mar 22-Mar	21-Mar 13-Mar 22-Mar	21-Mar 13-Mar 22-Mar	5 APR	13-Mar 26 MAR	27 MAR	606745 116
SMMS PROBE ASSEMBLY	H-14-100483	1	Gober Croskey	20-Feb	21-Feb	14-Mar AC	14-Mar AC	8-Mar	13-Mar 26 MAR	27 MAR	117
SMMS PROBE ASSEMBLY	H-14-100483	2	Gober Croskey	20-Feb	21-Feb	14-Mar AC	14-Mar AC	8-Mar	13-Mar 26 MAR	27 MAR	118
SMMS PROBE ASSEMBLY	H-14-100483	3	Gober Croskey	20-Feb	21-Feb	14-Mar AC	14-Mar AC	8-Mar	13-Mar 26 MAR	27 MAR	119
SMMS PROBE ASSEMBLY	H-14-100483	4	Gober Croskey	20-Feb	21-Feb	14-Mar AC	14-Mar AC	8-Mar	13-Mar 26 MAR	27 MAR	120
SMMS PROBE ASSEMBLY	H-14-100483	5	Gober Croskey	20-Feb	21-Feb	14-Mar AC	14-Mar AC	8-Mar	13-Mar 26 MAR	27 MAR	121
SMMS PROBE ASSEMBLY	H-14-100483	6	Gober Croskey	20-Feb	21-Feb	14-Mar AC	14-Mar AC	8-Mar	13-Mar 26 MAR	27 MAR	122
SMMS PROBE ASSEMBLY	H-14-100483	7	Gober Croskey	20-Feb	21-Feb	14-Mar AC	14-Mar AC	8-Mar	13-Mar 26 MAR	27 MAR	123
SMMS PROBE ASSEMBLY	H-14-100483	8	Gober Croskey	20-Feb	21-Feb	14-Mar AC	14-Mar AC	8-Mar	13-Mar 26 MAR	27 MAR	124
SMMS DEPLOYMENT ELECT ENCL	H-14-100484	1	Gimera Croskey	N/A	29-Jan AC	N/A	8-Feb AC	N/A	13-Feb 26 MAR	15-Feb	606745 125
SMMS DEPLOYMENT ELECT ENCL	H-14-100484	2	Gimera Croskey	N/A	29-Jan AC	N/A	8-Feb AC	N/A	13-Feb	15-Feb	606745 126
SMMS DEPLOYMENT ELECT ENCL	H-14-100484	3	Gimera Croskey	N/A	29-Jan AC	N/A	8-Feb AC	N/A	13-Feb	15-Feb	606745 127
SMMS DEPLOYMENT ELECT ENCL	H-14-100484	4	Gimera Croskey	N/A	29-Jan AC	N/A	8-Feb AC	N/A	13-Feb	15-Feb	606745 128
SMMS DEPLOYMENT ENCLOSURE WIRING	H-14-100485	1	Gimera Schulz	N/A	18-Jan BJW	N/A	12-Feb BJW	N/A	19-Feb	15-Feb	606745 129

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SMMS DEPLOYMENT ENCLOSURE WIRING	H-14-100485	2	Gimera Schulz	N/A	18-Jan BJW	N/A	12-Feb BJW	N/A	19-Feb	15-Feb	606745 130
LOW DEPLOYMENT DEVICE WIRING DIAGRAM	H-14-100486	1	Gimera Schulz	N/A	18-Jan BJW	1-Mar MF	26-Feb		28-Feb	8-Mar	606746 131
SMMS SOURCE HANDLING TOOL	H-14-100552	1	Ritter Guber	20-Feb	12-Mar					22-MAR	606743 132
SMMS Shipping Container	H-14-100553	1	Graves Schuler	8-Mar 15-Mar	first scheduled second scheduled					28-MAR	606742 133
SMMS Shipping Container	H-14-100553	2	Graves Schuler	8-Mar 15-Mar	first scheduled second scheduled					28-MAR	606742 134
SMMS Shipping Container	H-14-100553	3	Graves Schuler	8-Mar 15-Mar	first scheduled second scheduled					28-MAR	606742 135
SMMS SOURCE STORAGE CASK	H-14-100554	1	Ritter Schuler	8-Mar 11-Mar	first scheduled second scheduled third scheduled					29-MAR	606742 136
SMMS CALIBRATION FIXTURE #1	H-14-100557	1	Ritter Schuler	22-Mar 7-Mar	15-MAR					22-MAR	606743 137
SMMS CALIBRATION FIXTURE #2	H-14-100558	1	Ritter Schuler	28-Feb 7-Mar	19-MAR					22-MAR	606743 138
SMMS SOURCE STORAGE CASK	H-14-100554	2	11							29-MAR	606742

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**Westinghouse
Hanford Company**

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2 7 3

**Internal
Memo**

From: Characterization Equipment Development
Phone: 376-5387 H5-09
Date: June 18, 1996
Subject: GREEN TAGGING THE SURFACE MOISTURE MEASUREMENT SYSTEM

SMMS96-090

To: M. L. McElroy S7-07

cc: G. T. Dukelow S7-12
C. E. Hanson H5-09 *CW 6/18/96*
B. J. Hug L6-35
L. S. Krogsrud T4-07
Project Files H5-09
GFV LB

The SMMS testing and as-building has been concluded. The system was developed under the prototypic guidelines of EP 2.4, using redline drawings for fabrication and assembly purposes. This development process was agreed to as evidenced by WHC-WM-SD-WP-300 Rev. 0, "Engineering Work Plan for Surface Moisture Measurement System".

The design drawings were officially released into the configuration control system approximately March, 1996. Please find an attached copy of all EDTs that were used to release the design drawings. Furthermore, since March 1996, testing and minor design modifications have continued. However, the design modifications were performed prior to the running of the hardware and software acceptance test procedures. As of the date of this memo, all ECNs have been issued and all as-building modifications have been completed.

The acceptance test procedures were successfully performed. The resultant acceptance test reports provide evidence that the equipment is ready for field use. (See WHC-WM-SD-ATR-153 and WHC-WM-SD-ATR-158, Software and Hardware ATRs.)

With receipt of this memo, we request our Quality Assurance project lead to green tag the overall SMMS system as ready for field deployment. Should you have any questions, you may contact me at 376-5387.

G. F. Vargo Jr., Principal Engineer
Characterization Equipment Development

kld

Attachments

Smms96-086

ENG

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1. ECN No 624768

Proj.
ECN

2. ECN Category (mark one) Supplemental ☒ Direct Revision ☐ Change ECN ☐ Temporary ☐ Standby ☐ Supersedeure ☐ Cancel/Void ☐	3. Originator's Name, Organization, MSIN, and Telephone No. D. B. Graves, 8A200, L6-38, 376-5209	3a. USQ Required ☒ Yes ☒ No See Attached Attachment	4. Date 4/19/96	
	5. Project Title/No./Work Order No. Surface Moisture Measurement System / N2249	6. Bldg./Sys./Fac. No. 200-G	7. Approval Designator QS	
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) H-14-100460, Sheets 1-4, 7-9 and 11, Rev 0	9. Related ECN No(s). N/A	10. Related PO No. N/A	
11a. Modification Work ☐ Yes (fill out Blk. 11b) ☒ No (NA Blks. 11b, 11c, 11d)	11b. Work Package No. N/A	11c. Modification Work Complete N/A Cog. Engineer Signature & Date	11d. Restored to Original Condition (Temp. or Standby ECN only) N/A Cog. Engineer Signature & Date	

12. Description of Change

ETN- 95-0049

SHEET 1

- Revise Note 9 to read: "APPLY A THIN COAT OF (NEVER SEEZE PURE NICKEL SPECIAL) LUBRICANT TO JOINT SURFACES PRIOR TO ASSEMBLY."
- Add new Note 11 to read: "APPLY LOCTITE THREADLOCKER 242 COMPOUND TO THREADS OF ALL FASTENERS AT ASSEMBLY."
Delete Items 17, 18, 46 and 56 from drawing.
For Item 20, show quantity of "1" for Assembly -010.
- Add new Item 35, MAST ELBOW FITTING to Parts/Material List (See Page 5 of this ECN). Material is 304L SST per ASTM-A 276. Quantity is 1 ea. for Assembly -030.
- Add new Item 36, ARM ELBOW FITTING to Parts/Material List (See Page 6 of this ECN). Material is 304L SST per ASTM-A 276. Quantity is 1 ea. for Assembly -010.

US9 TF-95-00, Rev. 2

(Continued on Sheet 3)

13a. Justification (mark one)

Criteria Change ☐	Design Improvement ☒	Environmental ☐	Facility Deactivation ☐
As-Found ☐	Facilitate Const ☐	Const. Error/Omission ☐	Design Error/Omission ☐

13b. Justification Details

This ECN corrects drawing to as-built conditions and adds a redesigned elbow joint with much greater strength. Design verification method shall be by independent review.

14. Distribution (include name, MSIN, and no. of copies)

D. B. Graves	L6-38	1	Sta. 1	55-59	Sta. 15
L. S. Krogsrud	R3-08	1	Sta. 2	56-81	56-12
D. P. Niebuhr	S7-03	1	Sta. 3	52-05	Sta. 16
J. E. Purcell	S4-43	1	Sta. 4	41-29	55-00
T. I. Stokes	L6-37	1	Sta. 5	74-30	Sta. 20
*G. F. Vargo Jr.	H5-09	1	Sta. 6	T2-03	Sta. 30

(Advanced complete copy) T4-00 1
56-72 1

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3E NOTICE

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1 ECN No 624769

Prd.
ECN

2. ECN Category (mark one) Supplemental ☐ Direct Revision ☐ Change ECN ☐ Temporary ☐ Standby ☐ Supersede ☐ Cancel/Void ☐	3. Originator's Name, Organization, MSIN, and Telephone No. D. B. Graves, 8A200, L6-38, 376-5209	3a. USG Required? See Block 12 ☒ Yes ☒ No See Attachment	4. Date 5/6/96
	5. Project Title/No./Work Order No. Surface Moisture Measurement System / N2249	6. Bldg./Sys./Fac. No. 200-G 241-G	7. Approval Designer QS
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) H-14-100461, Sheets 1-9, Rev 0	9. Related ECN No(s). N/A	10. Related PO No. N/A
11a. Modification Work ☐ Yes (fill out Blk. 11b) ☒ No (NA Blks. 11b, 11c, 11d)	11b. Work Package No. N/A	11c. Modification Work Complete N/A Cog. Engineer Signature & Date	11d. Restored to Original Condition (Temp. or Standby ECN only) N/A Cog. Engineer Signature & Date

12. Description of Change

PROGRAM NO. ETN-95-0049

SHEET 1

- Revise Note 9 to delete the phrase "ITEM 29 AND".
- Add new Flag Note 10 to read: "BOND ITEM 110 TO ITEM 17 WITH CONTACT CEMENT".
- Add new Flag Note 11 to read: "INSTALL ITEM 74 SO THAT IT WILL ROTATE FREELY IN THE CLOCKWISE DIRECTION AS VIEWED FROM OUTSIDE OF THE ENCLOSURE ASSEMBLY."
- Add new Flag Note 12 to read "TIGHTEN ITEMS 119 TO COMPRESS ITEMS 113 UNTIL A COUNTER CLOCKWISE DRAG TORQUE OF 4.0 +/- 0.5 FT-LBS IS PRODUCED ON ITEM 21."

USG # TF-95-0089

(Continued on Sheet 3)

13a. Justification (mark one)

Criteria Change ☐ Design Improvement ☒ Environmental ☐ Facility Deactivation ☐
As-Found ☐ Facilitate Const ☐ Const. Error/Omission ☐ Design Error/Omission ☐

13b. Justification Details

This ECN corrects the drawing to as-built conditions. Primary modifications were to remove the Camera Winch and all its related items, replace the Arm Winch with a new winch similar to the Probe Winch, add a Clutch/Brake Assembly to the Arm Winch, add a round Crank Handle for the Probe Winch, add a Brace for the Enclosure Window, and add instrumentation panel meters. Design verification method shall be by independent review.

14. Distribution (include name, MSIN, and no. of copies) * Adv. Copy

D. B. Graves	L6-38	1	Sta. 2	56-81	1
L. S. Kroggsrud	R3-08	1	Sta. 3	52-05	1
D. P. Niebuhr	S7-03	1	Sta. 4	91-29	1
J. E. Purcell	S4-43	1	Sta. 5	74-30	1
T. I. Stokes	L6-37	1	Sta. 6	72-03	1
G. F. Vargo Jr.	H5-09	1	Sta. 15	56-12	1
B. J. Hug	L6-35	1	Sta. 16	55-00	1
Sta. 1	55-57	1	Sta. 20	74-00	1
			Sta. 30	56-72	1

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G CHANGE NOTICE

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1. ECN **Nº 624770**

Proj. ECN

2W Category (mark one) ☐ Supplemental ☐ Direct Revision ☐ Change ECN ☐ Temporary ☐ Standby ☐ Supersede ☐ Cancel/Void	3. Originator's Name, Organization, MSIN, and Telephone No. D. B. Graves, 8A200, L6-38, 376-5209	3a. USG Required? ☒ Yes <i>5/14/96 CEN</i> ☐ No See Attachment <i>Blk 12</i>	4. Date 5/13/96
	5. Project Title/No./Work Order No. Surface Moisture Measurement System / N2249	6. Bldg./Sys./Fac. No. 200-G	7. Approval Designator QS
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) H-14-100459, Sheets 1-4 and 6, Rev 0	9. Related ECN No(s). 624768 624769	10. Related PO No. N/A
11a. Modification Work ☐ Yes (fill out Blk. 11b) ☒ No (NA Blks. 11b, 11c, 11d)	11b. Work Package No. N/A	11c. Modification Work Complete N/A Cog. Engineer Signature & Date	11d. Restored to Original Condition (Temp. or Standby ECN only) N/A Cog. Engineer Signature & Date

12. Description of Change

PROGRAM NO. ETN-95-0049

SHEET 1

1. Delete Note 12.

2. Add new Note 14 to read: "EXCEPT AS NOTED, APPLY (LOCTITE THREADLOCKER 242 COMPOUND) TO THREADS OF ALL FASTENERS AT ASSEMBLY."

3. Add new Flag Note 15 to read: "APPLY (NEVER SEEZE PURE NICKEL SPECIAL) LUBRICANT TO THREADS OF FASTENERS AT ASSEMBLY".

4. Add new Flag Note 16 to read: "PAINT ARROW AS SHOWN, NEAR SIDE AND FAR SIDE. ARROWS TO BE 6 INCH LONG AND COLOR RED".

USG # TE-95-0089, Rev. 2 (CONTINUED ON SHEET 3)

13a. Justification (mark one)

Criteria Change ☐	Design Improvement ☒	Environmental ☐	Facility Deactivation ☐
As-Found ☐	Facilitate Const ☐	Const. Error/Omission ☐	Design Error/Omission ☐

13b. Justification Details

This ECN corrects drawing to as-built conditions and adds an Anti-Rotation Clamp, changes the Arm Lifting Cable, add holes to the Bearing Housing Flange for interfacing with the Shipping/Storage Container and adds a spring loaded clamp for the Inclinator Cable. Design verification method shall be by independent review.

14. Distribution (include name, MSIN, and no. of copies)

D. B. Graves	L6-38	1	Sta. 2	S6-81	1
B. J. Hug	L6-35	1	Sta. 3	S2-05	1
L. S. Krogsrud	R3-08	1	Sta. 4	R1-29	1
D. P. Niebuhr	S7-03	1	Sta. 5	T4-30	1
J. E. Purcell	S4-43	1	Sta. 6	T2-03	1
T. I. Stokes	L6-37	1	Sta. 15	E6-12	1
G. F. Vargo Jr.	H5-09	1	Sta. 16	S5-00	1
Sta. 1	S5-59	1	Sta. 20	T4-00	1

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CHANGE NOTICE

Page 1 of 8

1. ECN No 624771

Pro.
ECN

ECN Category (mark one) Supplemental ☒ [X] Direct Revision ☐ [] Change ECN ☐ [] Temporary ☐ [] Standby ☐ [] Supersede ☐ [] Cancel/Void ☐ []	3. Originator's Name, Organization, MSIN, and Telephone No. D. B. Graves, BA200, L6-38, 376-5209	3a. USQ Required? <i>SEE BLK #12</i> [X] Yes [] No <i>See Attachment 3-20-96</i>	4. Date 5/16/96
	5. Project Title/No./Work Order No. Surface Moisture Measurement System / N2249	6. Bldg./Sys./Fac. No. 200-G	7. Approval Designator QS
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) H-14-100458, Sheets 1-4, Rev 0	9. Related ECN No(s). N/A	10. Related PO No. N/A

11a. Modification Work [] Yes (fill out Blk. 11b) [X] No (NA Blks. 11b, 11c, 11d)	11b. Work Package No. N/A	11c. Modification Work Complete N/A _____ Cog. Engineer Signature & Date	11d. Restored to Original Condition (Temp. or Standby ECN only) N/A _____ Cog. Engineer Signature & Date
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12. Description of Change

PROGRAM NO. ETN-95-0049

SHEET 1

- For Item 16, revise Material/Reference from "ASTM A193 GR B8" to "ASTM A193 GR B8M". Revise bolt length in Description from "3 L" to "2 1/2 L".
- For Item 17, revise Material/Reference from "ASTM A194 GR 8" to "ASTM A194 GR 8M".
- For Item 21, BEAM, revise Description from "12 FT L" TO "12 FT - 4 IN L". Revise Quantity from 2 ea. for Assembly -030 to 1 ea. for Assembly -050.
- For Item 29, CABLE ASSEMBLY W3, add quantity of 1 ea. for Assembly -030.

USQ # TF-95-0089, Rev. 2

(CONTINUED ON SHEET 3)

13a. Justification (mark one)

Criteria Change ☐ []	Design Improvement ☒ [X]	Environmental ☐ []	Facility Deactivation ☐ []
As-Found ☐ []	Facilitate Const ☐ []	Const. Error/Omission ☐ []	Design Error/Omission ☐ []

13b. Justification Details

This ECN incorporates design improvements suggested by Operations which aid deployment of the SMMS in the field. Design verification method shall be by independent review.

14. Distribution (include name, MSIN, and no. of copies)

D. B. Graves	L6-38	1	STA. 1 — 55-59
B. J. Hug	L6-35	1	3 — 52-05
L. S. Krogsrud	R3-08	1	4 — R1-29
D. P. Niebuhr	S7-03	1	5 — T4-30
J. E. Purcell	S4-43	1	6 — T2-03
T. I. Stokes	L6-37	1	15 — E6-12
G. F. Vargo Jr.	H5-09	1	16 — 55-00
			20 — T4-00

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IG CHANGE NOTICE

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1. ECN No 624772

Proj.
ECN

2. ECN Category (mark one) Supplemental ☒ Direct Revision ☐ Change ECN ☐ Temporary ☐ Standby ☐ Supersede ☐ Cancel/Void ☐	3. Originator's Name, Organization, MSIN, and Telephone No. D. B. Graves, 8A200, L6-38, 376-5209	3a. USQ Required? [X] Yes [] No See Block 12	4. Date 5/28/96
	5. Project Title/No./Work Order No. Surface Moisture Measurement System / N2249	6. Bldg./Sys./Fac. No. 200-G 241-G 10	7. Approval Designator QS
	8. Document Numbers Changed by this ECN (Includes sheet no. and rev.) H-14-100553, Sheets 1-3, Rev 0	9. Related ECN No(s). N/A	10. Related PO No. N/A
11a. Modification Work [] Yes (fill out Blk. 11b) [X] No (NA Blks. 11b, 11c, 11d)	11b. Work Package No. N/A	11c. Modification Work Complete No. N/A Cog. Engineer Signature & Date	11d. Restored to Original Condition (Temp. or Standby ECN only) N/A Cog. Engineer Signature & Date

12. Description of Change

PROGRAM NO. ETN-95-0049

NOTE: PRIOR TO FIELD USE OF THIS EQUIPMENT, THE USQ SAFETY REVIEW (TF-95-0089, REVISION 1) WILL BE REVISED TO INCLUDE THIS ECN, AS A REVISION 2. ISSUANCE OF TF-95-0089, REVISION 2 WILL BE TRACKED VIA THE ORR.

SET 1

- For Item 6, SPACER RING, revise Quantity Required from 4 ea. to 6 ea.
- For Item 21, CAP SCREW, revise Quantity Required from 8 ea. to 12 ea.

(CONTINUED ON SHEET 3)

13a. Justification (mark one)

Criteria Change [] Design Improvement [X] Environmental [] Facility Deactivation []
As-Found [] Facilitate Const [] Const. Error/Omission [] Design Error/Omission []

13b. Justification Details

This ECN incorporates design improvements suggested by Operations, or discovered during acceptance testing, which aid deployment of the SMMS in the field. Design verification method shall be by independent review.

14. Distribution (include name, MSIN, and no. of copies)

D. B. Graves L6-38 1 Sta. 1 S5-59: Sta. 15
B. J. Hug L6-35 1 Sta. 3 S2-05: E5-12
L. S. Krogsrud R3-08 1 Sta. 4 R1-29: Sta. 16
D. P. Niebuhr S7-03 1 Sta. 5 T4-30: S5-00
J. E. Purcell S4-43 1 Sta. 6 T2-03: Sta. 20
T. I. Stokes L6-37 1
F. Vargo Jr. H5-09 1 *Advanced complete copy) T4-00

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1. ECN No 624773

Proj.
ECN

2. ECN Category (mark one) Supplemental ☒ Direct Revision ☐ Change ECN ☐ Temporary ☐ Standby ☐ Supersede ☐ Cancel/Void ☐	3. Originator's Name, Organization, MSIN, and Telephone No. D. B. Graves, 8A200, L6-38, 376-5209	3a. USQ Required? ☒ Yes ☐ No See Block 12	4. Date 5/31/96
	5. Project Title/No./Work Order No. Surface Moisture Measurement System / N2249	6. Bldg./Sys./Fac. No. 200-G 241-G JB	7. Approval Designator QS
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) H-14-100463, Sheets 1 & 3, Rev 0	9. Related ECN No(s). N/A	10. Related PO No. N/A

11a. Modification Work ☐ Yes (fill out Blk. 11b) ☒ No (NA Blks. 11b, 11c, 11d)	11b. Work Package No. N/A	11c. Modification Work Complete N/A Cog. Engineer Signature & Date	11d. Restored to Original Condition (Temp. or Standby ECN only) N/A Cog. Engineer Signature & Date
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12. Description of Change

PROGRAM NO. ETN-95-0049

NOTE: PRIOR TO FIELD USE OF THIS EQUIPMENT, THE USQ SAFETY REVIEW (TF-95-0089, REVISION 1) WILL BE REVISED TO INCLUDE THIS ECN, AS A REVISION 2. ISSUANCE OF TF-95-0089, REVISION 2 WILL BE TRACKED VIA THE ORR.

SHEET 1

1. For Item 3 in Parts/Material List, revise Description Title to "SUB-ASSEMBLY, LARGE IMPACT LIMITER".

(CONTINUED ON SHEET 3)

13a. Justification (mark one)

Criteria Change ☐	Design Improvement ☒	Environmental ☐	Facility Deactivation ☐
As-Found ☐	Facilitate Const ☐	Const. Error/Omission ☐	Design Error/Omission ☐

13b. Justification Details

This ECN incorporates corrects assembly call outs and incorporates loops and straps to secure the Impact Limiters during field installation. Design verification method shall be by independent review.

14. Distribution (include name, MSIN, and no. of copies) * Adv. Copy

D. B. Graves	L6-38	1	Sta. 1	55-59	1
B. J. Hug	L6-35	1	Sta. 3	52-05	1
L. S. Krogsrud	R3-08	1	Sta. 4	41-29	1
D. P. Niebuhr	S7-03	1	Sta. 5	T4-30	1
J. E. Purcell	S4-43	1	Sta. 6	T2-03	1
T. I. Stokes	L6-37	1	Sta. 15	E6-12	1
F. Vargo Jr.	H5-09	1	Sta. 16	55-00	1
			Sta. 20	T4-00	1

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1. ECN No 624774

Proj.
ECN

2. Category (mark one) Supplemental ☒ Direct Revision ☐ Change ECN ☐ Temporary ☐ Standby ☐ Supersedeure ☐ Cancel/Void ☐	3. Originator's Name, Organization, MSIN, and Telephone No. D. B. Graves, 8A200, L6-38, 376-5209	3a. USQ Required? ☐ Yes ☒ No	4. Date 6/5/96
	5. Project Title/No./Work Order No. Surface Moisture Measurement System / N2249	6. Bldg./Sys./Fac. No. 200-G	7. Approval Designator N/A
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) H-14-100557, Sheet 1, Rev 0 H-14-100558, Sheet 1, Rev 0	9. Related ECN No(s). N/A	10. Related PO No. N/A
11a. Modification Work ☐ Yes (fill out Blk. 11b) ☒ No (NA Blks. 11b, 11c, 11d)	11b. Work Package No. N/A	11c. Modification Work Complete N/A _____ Cog. Engineer Signature & Date	11d. Restored to Original Condition (Temp. or Standby ECN only) N/A _____ Cog. Engineer Signature & Date

12. Description of Change

PROGRAM NO. ETN-95-0049

H-14-100557 and H-14-100558. SHEET 1

- Add .125 dia. hole in Item 2 as shown on Page 3 of this ECN.
 - Add .125 dia. hole and .12 slot in Item 5 as shown on Page 3 of this ECN.
- Update Item 1 assembly drawing.

(CONTINUED ON SHEET 3)

13a. Justification (mark one)			
Criteria Change ☐	Design Improvement ☒	Environmental ☐	Facility Deactivation ☐
As-Found ☐	Facilitate Const ☐	Const. Error/Omission ☐	Design Error/Omission ☐
13b. Justification Details			
This ECN adds holes in the Calibration Fixtures in order to relieve vacuum in the fixtures when the Neutron Source is removed. Design verification method shall be by independent review.			

14. Distribution (include name, MSIN, and no. of copies)

D. B. Graves	L6-38	1	STA. 1 — 55-59
B. J. Hug	L6-35	1	3 — 56-81
L. S. Krogsrud	R3-08	1	4 — 52-05
D. P. Niebuhr	S7-03	1	5 — 74-30
J. E. Purcell	S4-43	1	6 — 72-03
T. I. Stokes	L6-37	1	15 — E6-12
G. F. Vargo Jr.	H5-09	1	16 — 55-00
			20 — 74-00

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1. ECN No 624775

Proj.
ECN

2. ECN Category (mark one) Supplemental ☒ Direct Revision ☐ Change ECN ☐ Temporary ☐ Standby ☐ Supersedeure ☐ Cancel/Void ☐	3. Originator's Name, Organization, MSIN, and Telephone No. D. B. Graves, 8A200, L6-38, 376-5209	3a. USQ Required? ☐ Yes ☒ No	4. Date 6/5/96	
	5. Project Title/No./Work Order No. Surface Moisture Measurement System / N2249	6. Bldg./Sys./Fac. No. 200-G	7. Approval Designator N/A	
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) H-14-100554, Sheet 2, Rev 0	9. Related ECN No(s). N/A	10. Related PO No. N/A	
11a. Modification Work ☐ Yes (fill out Blk. 11b) ☒ No (NA Blks. 11b, 11c, 11d)	11b. Work Package No. N/A	11c. Modification Work Complete N/A Cog. Engineer Signature & Date	11d. Restored to Original Condition (Temp. or Standby ECN only) N/A Cog. Engineer Signature & Date	

12. Description of Change

PROGRAM NO. ETN-95-0049

- For Item 8, BOTTOM PLUG, at Zone E-5, revise 4.000 dimension to 4.640.
- For Item 10, TOP INSERT, at Zone E-1, revise .876 dimension to .236.

13a. Justification (mark one)

Criteria Change ☐ Design Improvement ☒ Environmental ☐ Facility Deactivation ☐
 As-Found ☐ Facilitate Const ☐ Const. Error/Omission ☐ Design Error/Omission ☐

13b. Justification Details

This ECN adjusts Insert lengths to allow the Adaptor Seal Assembly to seat on the Insert when installed. Dimensions reflect as-built condition. Design verification method shall be by independent review.

14. Distribution (include name, MSIN, and no. of copies) STA 1 — 55-59
 D. B. Graves L6-38 1 3 — 56-81
 B. J. Hug L6-35 1 4 — 52-05
 L. S. Krogsrud R3-08 1 5 — 74-30
 D. P. Niebuhr S7-03 1 6 — 72-03
 J. E. Purcell S4-43 1 13 — E6-12
 T. I. Stokes L6-37 1 16 — 55-00
 F. Vargo Jr. H5-09 1 20 — 74-00
 (need complete advanced copy)

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RING CHANGE NOTICE

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1. ECN No 624776

Proj.
ECN

2. ECN Category (mark one) ☐ Supplemental ☒ Direct Revision ☐ Change ECN ☐ Temporary ☐ Standby ☐ Supersedeure ☐ Cancel/Void	3. Originator's Name, Organization, MSIN, and Telephone No. D. B. Graves, 8A200, L6-38, 376-5209	3a. USQ Required? ☒ Yes ☐ No See Block 12	4. Date 6/7/96	
	5. Project Title/No./Work Order No. Surface Moisture Measurement System / N2249	6. Bldg./Sys./Fac. No. 200-G	7. Approval Designator Q	
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) H-14-100461, Sheet 1, Rev 0	9. Related ECN No(s). N/A	10. Related PO No. N/A	
11a. Modification Work ☐ Yes (fill out Blk. 11b) ☒ No (NA Blks. 11b, 11c, 11d)	11b. Work Package No. N/A	11c. Modification Work Complete N/A Cog. Engineer Signature & Date	11d. Restored to Original Condition (Temp. or Standby ECN only) N/A Cog. Engineer Signature & Date	

12. Description of Change

PROGRAM NO. ETN-95-0049

NOTE: PRIOR TO FIELD USE OF THIS EQUIPMENT, THE USQ SAFETY REVIEW (TF-95-0089, REVISION 1) WILL BE REVISED TO INCLUDE THIS ECN, AS A REVISION 2. ISSUANCE OF TF-95-0089, REVISION 2 WILL BE TRACKED VIA THE ORR.

ET 1

1. For Item 26, ANGLE, 2 X 2 X 1/4, in Parts/Material List, revise Material from 304L SST to 316L SST.

13a. Justification (mark one)

Criteria Change ☐	Design Improvement ☐	Environmental ☐	Facility Deactivation ☐
As-Found ☒	Facilitate Const ☐	Const. Error/Omission ☐	Design Error/Omission ☐

13b. Justification Details

This ECN corrects a material call out in order to reflect as-built conditions. Design verification method shall be by independent review.

14. Distribution (include name, MSIN, and no. of copies)

*D. B. Graves	L6-38	1	Sta. 2	56-21
B. J. Hug	L6-35	1	Sta. 3	52-05
L. S. Krogsrud	R3-08	1	Sta. 4	R1-29
D. P. Niebuhr	S7-03	1	Sta. 5	T4-30
J. E. Purcell	S4-43	1	Sta. 6	T2-03
T. I. Stokes	L6-37	1	Sta. 15	56-12
*G. F. Vargo Jr.	H5-09	1	(advanced copy please)	
Sta. 1	56-59	1	Sta. 16	55-00
			Sta. 20	T4-00
			Sta. 30	56-72

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NG CHANGE NOTICE

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1. ECN **628805**

Proj.
ECN

2. ECN Category (mark one) Supplemental ☒ (X) Direct Revision ☐ Change ECN ☐ Temporary ☐ Standby ☐ Supersede ☐ Cancel/Void ☐	3. Originator's Name, Organization, MSIN, and Telephone No. JH Bussell, 74F40, H6-11, 376-9621 <i>W 75250</i>	3a. USQ Required? ☒ Yes ☐ No	4. Date June 05, 1996																																																								
	5. Project Title/No./Work Order No. Surface Mois. Meas. Syst./E46576	6. Bldg./Sys./Fac. No. 200G	7. Approval Designer SQ																																																								
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) See block 12.	9. Related ECN No(s). NA	10. Related PO No. NA																																																								
11a. Modification Work ☐ Yes (fill out Blk. 11b) ☒ No (NA Blks. 11b, 11c, 11d)	11b. Work Package No. NA	11c. Modification Work Complete NA Cog. Engineer Signature & Date	11d. Restored to Original Condition (Temp. or Standby ECN only) NA Cog. Engineer Signature & Date																																																								
12. Description of Change ETN-95-0049 USQ: TF-95-0089 Rev 2 Prior to field use of this equipment, the USQ Safety Review that was prepared (TF-95-0089 REV. 1) will be revised to include this ECN, as Rev. 2. Issuance of TF-95-0089 Rev. 2 will be tracked via the ORR. <u>Documents to be changed by this ECN:</u> H-14-100469, Sh 1, Rev 0 Surface Moisture Monitoring System Cable Assemblies H-14-100479, Sh 1, Rev 0 SMMS Probe Interface Board PCB Assembly H-14-100479, Sh 2, Rev 0 SMMS Probe Interface Board PB Diagram																																																											
13a. Justification (mark one) Criteria Change ☐ Design Improvement ☒ Environmental ☐ Facility Deactivation ☐ As-Found ☐ Facilitate Const ☐ Const. Error/Omission ☐ Design Error/Omission ☐																																																											
13b. Justification Details Changes required to improve operability of system.																																																											
14. Distribution (include name, MSIN, and no. of copies) <table border="0"> <tr> <td>JH Bussell</td> <td>H6-11</td> <td>ML McElroy</td> <td>S7-07</td> <td>STA. 1</td> <td>—</td> <td>S5-59</td> </tr> <tr> <td>SC Cantrell</td> <td>H6-11</td> <td>DP Niebuhr</td> <td>S7-03</td> <td>3</td> <td>—</td> <td>S6-81</td> </tr> <tr> <td>KL Drury</td> <td>H5-09</td> <td>GF Vargo, JR</td> <td>H5-09</td> <td>4</td> <td>—</td> <td>R1-29</td> </tr> <tr> <td>CA Esvelt</td> <td>S7-11</td> <td>Central Files</td> <td>A3-88</td> <td>5</td> <td>—</td> <td>T4-30</td> </tr> <tr> <td>DB Graves</td> <td>L6-38</td> <td>TI Stokes</td> <td>H5-09</td> <td>6</td> <td>—</td> <td>T2-03</td> </tr> <tr> <td>CE Hanson</td> <td>H5-09</td> <td>LS Krogsrud</td> <td>T4-07</td> <td>15</td> <td>—</td> <td>E6-12</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td>16</td> <td>—</td> <td>S5-00</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td>20</td> <td>—</td> <td>T4-00</td> </tr> </table>				JH Bussell	H6-11	ML McElroy	S7-07	STA. 1	—	S5-59	SC Cantrell	H6-11	DP Niebuhr	S7-03	3	—	S6-81	KL Drury	H5-09	GF Vargo, JR	H5-09	4	—	R1-29	CA Esvelt	S7-11	Central Files	A3-88	5	—	T4-30	DB Graves	L6-38	TI Stokes	H5-09	6	—	T2-03	CE Hanson	H5-09	LS Krogsrud	T4-07	15	—	E6-12					16	—	S5-00					20	—	T4-00
JH Bussell	H6-11	ML McElroy	S7-07	STA. 1	—	S5-59																																																					
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KL Drury	H5-09	GF Vargo, JR	H5-09	4	—	R1-29																																																					
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				16	—	S5-00																																																					
				20	—	T4-00																																																					
<table border="1"> <tr> <td colspan="2">RELEASE STAMP</td> </tr> <tr> <td colspan="2">JUN 05 1996</td> </tr> <tr> <td>DATE</td> <td>HANFORD</td> </tr> <tr> <td>STA. 21</td> <td>RELEASE</td> </tr> <tr> <td></td> <td>ID: 21</td> </tr> </table>				RELEASE STAMP		JUN 05 1996		DATE	HANFORD	STA. 21	RELEASE		ID: 21																																														
RELEASE STAMP																																																											
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DATE	HANFORD																																																										
STA. 21	RELEASE																																																										
	ID: 21																																																										

ING CHANGE NOTICE

Page 1 of 2

1. ECN 630666

Proj.
ECN

2. Category (mark one) ☐ Supplemental ☒ Direct Revision ☐ Change ECN ☐ Temporary ☐ Standby ☐ Supersedeure ☐ Cancel/VOID	3. Originator's Name, Organization, MSIN, and Telephone No. 376-5387 GF Vargo, Jr., W75250, H5-C9	3a. USQ Required? SET Block 12 5/21/96 ☒ Yes ☒ No C4	4. Date 05/07/96	
	5. Project Title/No./Work Order No. Surf. Mois. Meas. Syst./E46576	6. Bldg./Sys./Fac. No. BY-110	7. Approval Designator Q	
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-ATP-158, Rev 0	9. Related ECN No(s). N/A	10. Related PO No. N/A	
	11a. Modification Work ☐ Yes (fill out Blk. 11b) ☒ No (NA Blks. 11b, 11c, 11d)		11b. Work Package No. N/A	11c. Modification Work Complete N/A Cog. Engineer Signature & Date

12. Description of Change
 ETN-95-0049

UML VB

This ECN replaces document WHC-SD-ATP-158, Rev. 0 in it's entirety.

USQ JUSTIFICATION

~~No USQ is required because no change has been made that effects the USQ SAFETY REVIEW TF 95-0089, REV 1 SURFACE MOISTURE MONITORING OF HANFORD TANK WASTE BY NEUTRON ACTIVATION.~~

*Prior to field use of this equipment, the USQ Safety Review - 95-0089 Rev.1) will be revised to include this ECN, as Rev. 2. Issuance of TF-95-0089 Rev.2 will be tracked via the ORR. **5-2296***

13a. Justification (mark one)			
Criteria Change ☐	Design Improvement ☒	Environmental ☐	Facility Deactivation ☐
As-Found ☐	Facilitate Const ☐	Const. Error/Omission ☐	Design Error/Omission ☐

13b. Justification Details

This ECN is required to include design enhancements to the software that were added after the performance of the Acceptance Test Procedure (ATP). *Design verification by INDRPT OUT Review PER EP 4.1.*

14. Distribution (include name, MSIN, and no. of copies)		
SC Cantrell	S2-02	GF Vargo, Jr. H5-09
CA Esvelt	S7-12	Central Files H5-09
ML McElroy	S7-07	Project Files H5-09
M Gimera	L6-37	TI Stokes L6-37
CE Hanson	H5-09	
LS Krogsrud	R3-08	
DP Niebuhr	S7-03	

RELEASE STAMP

MAY 22 1996

DATE: **MAY 22 1996**

STA: **21** **RELEASE** **20**

ENGINE

Page 1 of 2

1. ECN 630672

Proj.
ECN

2. ECN Category (mark one) Supplemental ☒ [X] Direct Revision ☐ [] Change ECN ☐ [] Temporary ☐ [] Standby ☐ [] Supersedeure ☐ [] Cancel/Void ☐ []		3. Originator's Name, Organization, MSIN, and Telephone No. GF Vargo, Jr/75250/H5-09/376-5387		3a. USQ Required? ☒ [X] Yes ☐ [] No		4. Date 05/21/96	
		5. Project Title/No./Work Order No. Characterization		6. Bldg./Sys./Fac. No.		7. Approval Designator SQ	
		8. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-OMM-024, Rev 0		9. Related ECN No(s). NA		10. Related PO No. NA	
11a. Modification Work ☐ [] Yes (fill out Blk. 11b) ☒ [X] No (NA Blks. 11b, 11c, 11d)		11b. Work Package No. NA		11c. Modification Work Complete NA Cog. Engineer Signature & Date		11d. Restored to Original Condition (Temp. or Standby ECN only) NA Cog. Engineer Signature & Date	
12. Description of Change Complete rewrite. USQ EVALUATION Prior to field use of this equipment, the USQ safety review (TF-95-0089, Rev. 1) will be revised to include this ECN, as a Rev. 2. Issuance of TF-95-0089, Rev. 2 will be tracked via the ORR."							
13a. Justification (mark one) Criteria Change ☐ [] Design Improvement ☒ [X] Environmental ☐ [] Facility Deactivation ☐ [] As-Found ☐ [] Facilitate Const ☐ [] Const. Error/Omission ☐ [] Design Error/Omission ☐ []							
13b. Justification Details This document was completely rewritten to include additional requirements as recommended by field operations.							
14. Distribution (include name, MSIN, and no. of copies) See distribution sheet							

JUN 11 1996 DATE: 21 STA: 21		RELEASE STAMP HANFORD RELEASE ID: 21	
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2.2. 5mms96.088

1 TRANSMITTAL

Page 1 of 1

1. EDT 158645

2. To: (Receiving Organization) Distribution		3. From: (Originating Organization) GF Vargo, Jr/75250		4. Related EDT No.: NA	
5. Proj./Prog./Dept./Div.: Characterization Equipment Development		6. Cog. Engr.: CA Esvelt		7. Purchase Order No.: NA	
8. Originator Remarks: For Approval				9. Equip./Component No.: NA	
				10. System/Bldg./Facility: NA	
11. Receiver Remarks:				12. Major Asm. Dwg. No.: NA	
				13. Permit/Permit Application No.: NA	
				14. Required Response Date: 05/31/96	

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	WHC-SD-WM-ATR-158	ALL	0	SOFTWARE ACCEPTANCE TEST REPORT FOR SURFACE MOISTURE MEASUREMENT SYSTEM	Q	1		

16. Approval Designator (F)		KEY				Disposition (H) & (I)					
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)		Reason for Transmittal (G) 1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)				1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged					
17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)											
(G)	(H)	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	Reason	Disp.
1	1	Cog.Eng. CA Esvelt	[Signature]	6-4-96	S7-12	GF Vargo, Jr	[Signature]	6-4-96	H5-09	1	1
1	1	Proj. Mgr. CE Hanson	[Signature]	6/4/96	H5-09	Central Files			A3-88	4	
1	1	QA ML McElroy	[Signature]	6/14/96	S7-07	Project Files			H5-09	4	
1	1	Safety LS Krogsrud	[Signature]	6/14/96	R3-08						
1	1	DP Niebuhr	[Signature]	6/7/96	S7-03						
1	1	SC Cantrell	[Signature]	6-7-96	S2-02						
1	1	M Gimera	[Signature]	6/14/96	H5-09						

18. Signature of EDT Originator [Signature]		19. Authorized Representative Date for Receiving Organization [Signature]		20. Cognizant Manager Date [Signature]		21. DOE APPROVAL (if required) Ctrl. No. [Signature]	
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WHC-SD-WM-SDD-070, REV 0
Page F-49

Page 1 of 1

1. EDT 604984

ENGINEERING DATA TRAINING

20.

2. To: (Receiving Organization) The Distribution List		3. From: (Originating Organization) Nuclear Analysis and Characterization		4. Related EDT No.: NA							
5. Proj./Prog./Dept./Div.: Characterization		6. Cog. Engr.: CA Esvelt		7. Purchase Order No.: NA							
8. Originator Remarks: See attached acceptance test report for the Surface Moisture Measurement System for your approval.				9. Equip./Component No.: NA							
				10. System/Bldg./Facility: NA							
				12. Major Assem. Dwg. No.: NA							
				13. Permit/Permit Application No.: NA							
11. Receiver Remarks:				14. Required Response Date: ASAP							
15. DATA TRANSMITTED											
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition			
1.	WHC-SD-WM-ATR-153	A11	0	Surface Moisture Measurement System Hardware Acceptance Test Report	SQ	1					
16. KEY											
Approval Designator (F)		Reason for Transmittal (G)			Disposition (H) & (I)						
E, S, Q, D or N/A (see WHC-CM-3-5, Sec. 12.7)		1. Approval 2. Release 3. Information			4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)			1. Approved 2. Approved w/comment 3. Disapproved w/comment			
					4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged						
17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)											
(G)	(H)	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G)	(H)
Reason	Disp.									Reason	Disp.
1	1	Cog. Eng. CA Esvelt	<i>[Signature]</i>	5-1-96	ST-12	DB Graves	<i>[Signature]</i>	5/1/96	6-37	1	1
1	1	Cog. Mgr. JS Schofield	<i>[Signature]</i>	5/1/96	ST-12	M Gimera	<i>[Signature]</i>	5/15/96	L6-37	1	1
1	1	QA ML McElroy	<i>[Signature]</i>	5/1/96	ST-07	JH Bussell	<i>[Signature]</i>	5/15/96	L6-38	1	1
1	1	Safety LS Krogsrud	<i>[Signature]</i>	5/1/96	ST-09	WT Watson	<i>[Signature]</i>	5/15/96	H0-32	1	1
1	1	Ops. DP Niebuhr	<i>[Signature]</i>	5/1/96		TI Stokes	<i>[Signature]</i>	5/15/96	H5-09	1	1
1	1	Proj. Eng. GF Vargo Jr.	<i>[Signature]</i>	5-15-96							
1	1	Proj. Mgr. CE Hanson	<i>[Signature]</i>	5/15/96	H5-09						
18. Signature of EDT inator: <i>[Signature]</i> Date: 5/6/96											
19. Authorized Representative for Receiving Organization: <i>[Signature]</i> Date: 5/24/96											
20. Cognizant Manager: <i>[Signature]</i> Date: 5/19/96											
21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments											

JUN 12 1996
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ISMJTTAL

Page 1 of 1
1. EDT 158625

2. To: (Receiving Organization) Distribution		3. From: (Originating Organization) Instrument Systems, 74F40		4. Related EDT No.: NA	
5. Proj./Prog./Dept./Div.: Safety Programs		6. Cog. Engr.: CA ESVELT		7. Purchase Order No.: NA	
8. Originator Remarks: For approval and release				9. Equip./Component No.: NA	
				10. System/Bldg./Facility: 200G	
11. Receiver Remarks:				12. Major Assm. Dwg. No.: H-14-100457	
				13. Permit/Permit Application No.: NA	
				14. Required Response Date: 6/5/96	

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	WHC-SD-WM-DA-202	ALL	0	NEC Hazardous Classification and Compliance Regarding the Surface Moisture Monitor Measurement System	S	1	1	

16. KEY									
Approval Designator (F)		Reason for Transmittal (G)				Disposition (H) & (I)			
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)		1. Approval	4. Review			1. Approved	4. Reviewed no/comment		
		2. Release	5. Post-Review			2. Approved w/comment	5. Reviewed w/comment		
		3. Information	6. Dist. (Receipt Acknow. Required)			3. Disapproved w/comment	6. Receipt acknowledged		
17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)									
(G)	(H)	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN
Reason	Disp.								
1	1	Cog. Eng. CA Esvelt	<i>[Signature]</i>	6/11/96	47-12	CH Monasmit	<i>[Signature]</i>	6-11-96	E6-27
1	1	Proj. Mgr. CE Hanson	<i>[Signature]</i>	6/11/96	H5-09	GP McDonald	<i>[Signature]</i>	6-11-96	E6-27
		QA				RA Huckfeldt	<i>[Signature]</i>	6/11/96	H3-01
1	1	Safety LS Krogsrud	<i>[Signature]</i>	6/11/96	16-07				
1	1	GF Vargo	<i>[Signature]</i>	6/12/96	H5-09				
1	1	JH Bussell	<i>[Signature]</i>	6/11/96	H6-11				
1	1	TI Stokes	<i>[Signature]</i>	6/11/96	L6-37				
18. Signature of EDT Originator		19. Authorized Representative Date for Receiving Organization		20. Cognizant Manager Date		21. DOE APPROVAL (if required) Ctrl. No.			
<i>[Signature]</i> 6-11-96		<i>[Signature]</i> 6/11/96		<i>[Signature]</i> 6/11/96		(1) Approved (1) Approved w/comments (1) Disapproved w/comments			

2.2.2.
0mm096-093
H

EN				Page 1 of <u>4</u>		1. ECN 628800 Proj. ECN																																											
2. ECN Category (mark one) Supplemental ☐ Direct Revision ☒ Change ECN ☐ Temporary ☐ Standby ☐ Supersedure ☐ Cancel/Void ☐		3. Originator's Name, Organization, MSIN, and Telephone No. S.C. Cantrell, 74F40, H6-11, 376-6439		3a. USQ Required? ☒ Yes ☐ No		4. Date 06/03/86																																											
		5. Project Title/No./Work Order No. Surface Moisture Measurement System / E46576		6. Bldg./Sys./Fac. No. 200-G 241-G KN		7. Approval Designator Q																																											
		8. Document Numbers Changed by this ECN (includes sheet no. and rev.) See Page 3		9. Related ECN No(s). ECN-624769		10. Related PO No. N/A																																											
11a. Modification Work ☐ Yes (fill out Blk. 11b) ☒ No (NA Blks. 11b, 11c, 11d)		11b. Work Package No. N/A		11c. Modification Work Complete N/A Cog. Engineer Signature & Date		11d. Restored to Original Condition (Temp. or Standby ECN only) N/A Cog. Engineer Signature & Date																																											
12. Description of Change ETN-95-0049 Prior to field use of this equipment, the USQ Safety Review that was prepared (TF-95-0089 Rev. 1) will be revised to include this ECN, as Rev.2. Issuance of TF-95-0089 Rev. 2 will be tracked via the ORR. For description of change see page 3.																																																	
13a. Justification (mark one) Criteria Change ☐ Design Improvement ☐ Environmental ☐ Facility Deactivation ☐ As-Found ☒ Facilitate Const ☐ Const. Error/Omission ☐ Design Error/Omission ☐																																																	
13b. Justification Details This ECN corrects drawings to as-built conditions. Design verification method shall be by independent review.																																																	
14. Distribution (include name, MSIN, and no. of copies) <table style="width:100%; border: none;"> <tr> <td>SC Cantrell</td> <td>H6-11</td> <td>1</td> <td>DP Niebuhr</td> <td>S7-03</td> <td>1</td> </tr> <tr> <td>*CA Esvelt</td> <td>S7-12</td> <td>1</td> <td>JE Purcell</td> <td>S4-43</td> <td>1</td> </tr> <tr> <td>M Gimera</td> <td>L6-37</td> <td>1</td> <td>GA Ritter</td> <td>H0-32</td> <td>1</td> </tr> <tr> <td>DB Graves</td> <td>L6-38</td> <td>1</td> <td>TI Stokes</td> <td>L6-37</td> <td>1</td> </tr> <tr> <td>CE Hanson</td> <td>H5-09</td> <td>1</td> <td>*GF Vargo Jr.</td> <td>H5-09</td> <td>1</td> </tr> <tr> <td>LS Krogsrud</td> <td>T4-07</td> <td>1</td> <td>Central Files</td> <td>A3-88</td> <td>1</td> </tr> <tr> <td>ML McElroy</td> <td>S7-07</td> <td>1</td> <td>Project Files</td> <td>H5-09</td> <td>1</td> </tr> </table>						SC Cantrell	H6-11	1	DP Niebuhr	S7-03	1	*CA Esvelt	S7-12	1	JE Purcell	S4-43	1	M Gimera	L6-37	1	GA Ritter	H0-32	1	DB Graves	L6-38	1	TI Stokes	L6-37	1	CE Hanson	H5-09	1	*GF Vargo Jr.	H5-09	1	LS Krogsrud	T4-07	1	Central Files	A3-88	1	ML McElroy	S7-07	1	Project Files	H5-09	1	RELEASE-STAMP <div style="border: 1px solid black; padding: 5px; text-align: center;"> JUN 14 1986 DATE: _____ STA: 21 RELEASE ID: (21) </div>	
SC Cantrell	H6-11	1	DP Niebuhr	S7-03	1																																												
*CA Esvelt	S7-12	1	JE Purcell	S4-43	1																																												
M Gimera	L6-37	1	GA Ritter	H0-32	1																																												
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CE Hanson	H5-09	1	*GF Vargo Jr.	H5-09	1																																												
LS Krogsrud	T4-07	1	Central Files	A3-88	1																																												
ML McElroy	S7-07	1	Project Files	H5-09	1																																												

ENGINEERING

WHC-SD-WM-SDD-070, REV 0
Page F-52

2 of 4

1. ECN (use no. from pg. 1)

628800

15. Design Verification Required ☒ Yes ☐ No		16. Cost Impact Additional Savings ☐ \$ ☐ NA Additional Savings ☐ \$ ☐ NA		17. Schedule Impact (days) Improvement ☐ Delay ☐ NA	
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18. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 12. Enter the affected document number in Block 19.

SDD/DD	☐	Seismic/Stress Analysis	☐	Tank Calibration Manual	☐
Functional Design Criteria	☐	Stress/Design Report	☐	Health Physics Procedure	☐
Operating Specification	☐	Interface Control Drawing	☐	Spares Multiple Unit Listing	☐
Criticality Specification	☐	Calibration Procedure	☐	Test Procedures/Specification	☐
Conceptual Design Report	☐	Installation Procedure	☐	Component Index	☐
Equipment Spec.	☐	Maintenance Procedure	☐	ASME Coded Item	☐
Const. Spec.	☐	Engineering Procedure	☐	Human Factor Consideration	☐
Procurement Spec.	☐	Operating Instruction	☐	Computer Software	☐
Vendor Information	☐	Operating Procedure	☐	Electric Circuit Schedule	☐
OM Manual	☐	Operational Safety Requirement	☐	ICRS Procedure	☐
FSAR/SAR	☐	IEFD Drawing	☐	Process Control Manual/Plan	☐
Safety Equipment List	☐	Cell Arrangement Drawing	☐	Process Flow Chart	☐
Radiation Work Permit	☐	Essential Material Specification	☐	Purchase Requisition	☐
Environmental Impact Statement	☐	Fac. Proc. Samp. Schedule	☐	Tickler File	☐
Environmental Report	☐	Inspection Plan	☐		☐
Environmental Permit	☐	Inventory Adjustment Request	☐	None	☒

19. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision

Document Number/Revision

Document Number Revision

N/A

20. Approvals

Signature		Date	Signature		Date
OPERATIONS AND ENGINEERING			ARCHITECT-ENGINEER		
Cog. Eng.	CA Esvelt	6-10-96	PE		
Proj. Mgr.	CE Hanson	6/16/96	QA		
QA	ML McElroy	6/16/96	Safety		
Safety			Design		
Environ.			Environ.		
Other			Other		
Prog. Eng.	GF Vargo Jr.	6-7-96			
Originator	SC Cantrell	6-6-96			
Indep. Review	JA Bussell	6-6-96			
			DEPARTMENT OF ENERGY		
			Signature or a Control Number that tracks the Approval Signature		
			ADDITIONAL		

3mm596-09-
2.2.2

Page 1 of <u>27</u>	1. ECN 628801 Proj. ECN
---------------------	-----------------------------------

2. ECN Category (mark one) Supplemental ☒ (X) Direct Revision ☐ Change ECN ☐ Temporary ☐ Standby ☐ Supersedeure ☐ Cancel/Void ☐	3. Originator's Name, Organization, MSIN, and Telephone No. JH Busse11, 74F40, H6-11, 376-9621	3a. USQ Required? ☒ Yes ☐ No	4. Date June 11, 1996
	5. Project Title/No./Work Order No. Surf. Mois. Meas. Syst./ E46576	6. Bldg./Sys./Fac. No. 200G	7. Approval Designator SQ
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) See Block 12.	9. Related ECN No(s). N/A	10. Related PO No. N/A

11a. Modification Work ☐ Yes (fill out Blk. 11b) ☒ No (NA Blks. 11b, 11c, 11d)	11b. Work Package No. N/A	11c. Modification Work Complete N/A Cog. Engineer Signature & Date	11d. Restored to Original Condition (Temp. or Standby ECN only) N/A Cog. Engineer Signature & Date
---	-------------------------------------	---	---

12. Description of Change
ETN-95-0049

USQ: TF-95-0089 Rev 2

Prior to field use of this equipment, the USQ Safety Review that was prepared (TF-95-0089 REV. 1) will be revised to include this ECN, as Rev. 2. Issuance of TF-95-0089 Rev. 2. will be tracked via the ORR.

Documents to be changed by this ECN:

H-14-100469 SHEETS 1 & 2, each REV 0
 H-14-100483 SHEETS 1,2,3,4,5,6 & 7, each REV 0

13a. Justification (mark one)

Criteria Change ☐	Design Improvement ☒ (X)	Environmental ☐	Facility Deactivation ☐
As-Found ☐	Facilitate Const ☐	Const. Error/Omission ☐	Design Error/Omission ☐

13b. Justification Details

Changes were required and performed that improved the operability of system. This ECN incorporates those changes to the design drawings. Design verification method shall be by independent review.

14. Distribution (include name, MSIN, and no. of copies) <table style="width: 100%;"> <tr> <td>JH Busse11 H6-11</td> <td>ML McElroy</td> <td>S7-07</td> </tr> <tr> <td>SC Cantrell H6-11</td> <td>DP Niebuhr</td> <td>S7-03</td> </tr> <tr> <td>KL Drury H5-09</td> <td>*6F Vargo, Jr.</td> <td>H5-09</td> </tr> <tr> <td>CA Esvelt S7-12</td> <td>Central Files</td> <td>A3-88</td> </tr> <tr> <td>DB Graves L6-38</td> <td>Project Files</td> <td>H5-09</td> </tr> <tr> <td>CE Hanson H5-09</td> <td>TI Stokes</td> <td>L6-37</td> </tr> <tr> <td>LS Krogsrud T4-07</td> <td>JE Purcell</td> <td>S4-43</td> </tr> </table>	JH Busse11 H6-11	ML McElroy	S7-07	SC Cantrell H6-11	DP Niebuhr	S7-03	KL Drury H5-09	*6F Vargo, Jr.	H5-09	CA Esvelt S7-12	Central Files	A3-88	DB Graves L6-38	Project Files	H5-09	CE Hanson H5-09	TI Stokes	L6-37	LS Krogsrud T4-07	JE Purcell	S4-43	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> RELEASE STAMP JUN 14 1996 DATE: STA: <u>21</u> HANFORD RELEASE ID: (21) </div>
JH Busse11 H6-11	ML McElroy	S7-07																				
SC Cantrell H6-11	DP Niebuhr	S7-03																				
KL Drury H5-09	*6F Vargo, Jr.	H5-09																				
CA Esvelt S7-12	Central Files	A3-88																				
DB Graves L6-38	Project Files	H5-09																				
CE Hanson H5-09	TI Stokes	L6-37																				
LS Krogsrud T4-07	JE Purcell	S4-43																				

ENGINEERING

WMC-SD-WM-SDD-070, REV 0
Page F-5427 (M) ECN (use no. from pg. 1)
Page 2 of 256 628801

15. Design Verification Required [X] Yes [] No		16. Cost ENGINEERING Additional [] \$ Savings [] \$ 0/A		TION Additional [] \$ Savings [] \$		17. Schedule Impact (days) Improvement [] Delay [] N/A	
---	--	--	--	---	--	--	--

18. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 12. Enter the affected document number in Block 19.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spare Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]	NONE	[X]

19. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number/Revision
None.		

20. Approvals

Signature		Date		Signature		Date	
OPERATIONS AND ENGINEERING				ARCHITECT-ENGINEER			
Cog. Eng.	CA Esvelt	<i>[Signature]</i>	6-12-96	PE			
Proj. Mgr.	CE Hanson	<i>[Signature]</i>	6/12/96	QA			
QA ML	McElroy	<i>[Signature]</i>	6/12/96	Safety			
Safety	LS Krogsrud	<i>[Signature]</i>	6/12/96	Design			
Environ.				Environ.			
Other	GF Vargo	<i>[Signature]</i>	6/12/96	Other			
Preparer	JH Bussell	<i>[Signature]</i>	6/12/96				
Indep. Reviewers				DEPARTMENT OF ENERGY			
- Electrical:		SC Cantrell	<i>[Signature]</i>	Signature or a Control Number that tracks the Approval Signature			
- Mechanical:		TI Stokes	<i>[Signature]</i>				
				ADDITIONAL			

SMMS96-105
2.7.7
ECN

Page 1 of 6		1. ECN 628802
		Proj. ECN

2. ECN Category (mark one) Supplemental ☐ Direct Revision ☐ Change ECN ☒ Temporary ☐ Standby ☐ Supersede ☐ Cancel/Void ☐	3. Originator's Name, Organization, MSIN, and Telephone No. JH Busse11, 74F40, H6-11, 376-9621	3a. USQ Required? [] Yes [x] No	4. Date June 19, 1996
	5. Project Title/No./Work Order No. Surf. Mois. Meas. Syst./ E46576	6. Bldg./Sys./Fac. No. 200G	7. Approval Designator NA
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) See Block 12.	9. Related ECN No(s). 628801	10. Related PD No. N/A

11a. Modification Work [] Yes (fill out Blk. 11b) [X] No (NA Blks. 11b, 11c, 11d)	11b. Work Package No. N/A	11c. Modification Work Complete N/A Cog. Engineer Signature & Date	11d. Restored to Original Condition (Temp. or Standby ECN only) N/A Cog. Engineer Signature & Date
--	------------------------------	--	--

12. Description of Change
ETN-95-0049

The USQ for ECN 628801 is TF-95-0089 Rev 2.

Documents to be changed by this ECN:
H-14-100483 SHEETS 1 & 2 each REV 0

13a. Justification (mark one)

Criteria Change ☐	Design Improvement ☒	Environmental ☐	Facility Deactivation ☐
As-Found ☐	Facilitate Const ☐	Const. Error/Omission ☐	Design Error/Omission ☐

13b. Justification Details

This ECN corrects text errors in ECN 628801 and add an additional item to material list that was omitted. Design verification method shall be by independent review.

14. Distribution (include name, MSIN, and no. of copies) <i>*ADV. COPY</i>			<div style="border: 1px solid black; padding: 5px;"> <p>JUN 20 1996</p> <p>RELEASE STAMP</p> <p>DATE: 21</p> <p>STA: 21</p> <p>HANFORD RELEASE</p> <p>ID: 21</p> </div>
JH Busse11 H6-11	ML McElroy S7-07		
SC Cantrell H6-11	DP Niebuhr S7-03		
KL Drury H5-09	*GF Vargo, Jr. H5-09		
CA Esvelt S7-12	Central Files A3-88		
DB Graves L6-38	Project Files H5-09		
CE Hanson H5-09	TI Stokes L6-37		
LS Krogsrud T4-07	JE Purcell S4-43		

JO-013-2 (11/94) GEF095 STA. 1- S5-S9
3- S2-05
4- R1-29
5- T4-30
6- T2-03

STA. 15- E6-12
16- S5-00
20- T4-00

APR 08 1996
ENGINE

Page 1 of 2
1. EDT 606745

2. To: (Receiving Organization) See Distribution	3. From: (Originating Organization) Nuclear Analysis and Characterization	4. Related EDT No.:
5. Proj./Prog./Dept./Div.: Surface Moisture Measurement System / Characterization	6. Cog. Engr.: <i>W75250/111111</i> G. F. Vargo Jr. <i>N2249</i>	7. Purchase Order No.: N/A
8. Originator Remarks: The purpose of this EDT is to release the final design drawings for the Surface Moisture Measurement System (SMMS) Deployment Device. (Program No. ETN-95-0049)		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: N/A
11. Receiver Remarks:		12. Major Assm. Dwg. No.: H-14-100458
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: ASAP

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	H-14-100459	1-6	0	SMMS Deployment Device Assembly	SQ	2	1	
2	H-14-100460	1-13	0	SMMS Mast/Arm Assembly	SQ	2	1	
3	H-14-100461	1-9	0	SMMS Enclosure Assembly	SQ	2	1	
4	H-14-100484	1-4	0	SMMS Intrinsic Barrier Panel	SQ	2	1	

16. KEY	
Approval Designator (F) E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	Reason for Transmittal (G) 1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)
Disposition (H) & (I) 1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged	
17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)	
(G)	(H)
Reason	Disp.
(J) Name	(K) Signature
(L) Date	(M) MSIN
(J) Name	(K) Signature
(L) Date	(M) MSIN
Reason	Disp.
2	1
Prog.Eng. G. F. Vargo	<i>G.F. Vargo</i> 3/1/96
2	1
Prog. Mgr. C. E. Hanson	<i>C.E. Hanson</i> 3/1/96
2	1
QA B. J. Hug	<i>B.J. Hug</i> 3/1/96
2	1
Safety <i>W. E. Hansen</i>	<i>W.E. Hansen</i> 3/1/96
Env.	
2	1
D. B. Graves	<i>D.B. Graves</i> 2/28/96
2	1
F. P. Johansen	<i>F.P. Johansen</i> 3/1/96

18. Signature of EDT Originator <i>B. Graves</i> 2-28-96	19. Authorized Representative Date for Receiving Organization <i>C. E. Hanson</i> 3/4/96	20. Cognizant Manager Date <i>C. E. Hanson</i> 3/4/96	21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments
---	---	--	---

TTAL

5. Proj./Prog./Dept./Div.:

Surface Moisture Measurement
System / Characterization

G. F. Vargo Jr.

1. EDT

606745

Page 2 of 2

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Design- ator	Reason for Trans- mittal	Origin- ator Dispo- sition	Receiv- er Dispo- sition
5	H-14-100485	1-2	0	SMMS Deployment Enclosure Wiring Diagram	SQ	2	1	

APR 10 1996 **21** ENGINEERING DATA TR

Page 1 of 2
1. EDT 606746

2. To: (Receiving Organization) See Distribution <i>75250</i>		3. From: (Originating Organization) Nuclear Analysis and Characterization		4. Related EDT No.:	
5. Proj./Prog./Dept./Div.: Surface Moisture Measurement System / Characterization		6. Cog. Engr.: G. F. Vargo Jr. <i>N2249</i>		7. Purchase Order No.: N/A	
8. Originator Remarks: The purpose of this EDT is to release the final design drawings for the Surface Moisture Measurement System (SMMS) Electrical Schematics and Cables. (Program No. ETN-95-0049)				9. Equip./Component No.: N/A	
				10. System/Bldg./Facility: N/A	
11. Receiver Remarks:				12. Major Assm. Dwg. No.: H-14-100458	
				13. Permit/Permit Application No.: N/A	
				14. Required Response Date: ASAP	

15. DATA TRANSMITTED				(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition
1	H-14-100466	1	0	Surface Moisture Monitoring System One-Line Diagram	SQ	2	1
2	H-14-100467	1-4	0	Surface Moisture Monitoring System Block Diagram	SQ	2	1
3	H-14-100476	1-2	0	SMMS Probe Testing Electronic Enclosure Assembly	SQ	2	1

16. KEY									
Approval Designator (F)		Reason for Transmittal (G)				Disposition (H) & (I)			
E, S, Q, D or N/A (see WHC-CM-3-5, Sec. 12.7)		1. Approval 2. Release 3. Information		4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)		1. Approved 2. Approved w/comment 3. Disapproved w/comment		4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged	
17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)									
(G)	(H)	(J) Name	(K) Signature	(L) Date	(M) MSIN	(N) Name	(O) Signature	(P) Date	(Q) MSIN
2	1	Prog. Eng. G. F. Vargo	<i>G. F. Vargo</i>	3-13-95	09	T. I. Stokes	<i>T. I. Stokes</i>	3-12-96	16-37
2	1	Prog. Mgr. C. E. Hanson	<i>C. E. Hanson</i>	4/4/91	05-09				
2	1	QA B. J. Hug	<i>B. J. Hug</i>	3/12/96	16-37				
2	1	Safety L. S. Krogerud	<i>L. S. Krogerud</i>	3/18/95	08				
		Env.							
2	1	J. H. Russell	<i>J. H. Russell</i>	3/7/96	16-11	DESIGN AUTHORITY			
2	1	F. P. Johansen	<i>F. P. Johansen</i>	3-12-96	16-38				
18. Signature of EDT Originator <i>D. B. Graves</i> Date: <i>3/7/96</i>		19. Authorized Representative Date for Receiving Organization <i>C. E. Hanson</i> Date: <i>4/4/91</i>				20. Cognizant Manager Date <i>C. E. Hanson</i> Date: <i>4/4/91</i>		21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments	

BD-7400-172-2 (04/94) GEFO97 STA 1 - S5-59 STA 4 - R1-24 STA 16 - S5-00
2 - S6-81 5 - T4-3c 20 - T4-00
3 - S2-05 6 - T2-03 30 - S6-72

ENGINEERING DATA TRANSM

(CONTINUATION PAGE)

5. Proj./Prog./Dept./Div.:	6. Cog. Eng.	1. EDT	
Surface Moisture Measurement System / Characterization	G. F. Vargo Jr.	606746	Page 2 of 2

15.	DATA TRANSMITTED				(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Trans- mittal	Orig- inator Dispo- sition	Receiv- er Dispo- sition
4	H-14-100477	1-4	0	Surface Moisture Monitoring System Cable Assemblies	SQ	2	1	
5	H-14-100486	1	0	LOW Deployment Device Wiring Diagram	SQ	2	1	

ENGINEERING DATA TRA

Page 1 of 2

1. EDT 606744

2. To: (Receiving Organization) See Distribution	3. From: (Originating Organization) Nuclear Analysis and Characterization	4. Related EDT No.:
5. Proj./Prog./Dept./Div.: Surface Moisture Measurement System / Characterization	6. Cog. Engr.: W75250/A2249 G. F. Vargo Jr.	7. Purchase Order No.: N/A
8. Originator Remarks: The purpose of this EDT is to release the final design drawings for the Surface Moisture Measurement System (SMMS) Electrical Systems and Cables. (Program No. ETN-95-0049)		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: N/A
11. Receiver Remarks:		12. Major Assm. Dwg. No.: H-14-100458
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: ASAP

15. DATA TRANSMITTED				(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition
1	H-14-100468	1-2	0	SMMS Operator Control Enclosure Assembly	SQ	2	1
2	H-14-100469	1-4	0	Surface Moisture Monitoring System Cable Assemblies	SQ	2	1
3	H-14-100471	1-3	0	SMMS Driver Side Electronic Enclosure Wiring Diagram	SQ	2	1

16. KEY									
Approval Designator (F)		Reason for Transmittal (G)				Disposition (H) & (I)			
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)		1. Approval 2. Release 3. Information		4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)		1. Approved 2. Approved w/comment 3. Disapproved w/comment		4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged	
(G)	(H)	17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)							
Reason	Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN
2	1	Prog. Eng. G. F. Vargo	<i>[Signature]</i>	04-03-95	09	T. I. Stokes	<i>[Signature]</i>	04-03-96	L6-37
2	1	Prog. Mgr. C. E. Hanson	<i>[Signature]</i>	04/19/95	09				
2	1	QA B. J. Hug	<i>[Signature]</i>	03-25-96	L6-37				
2	1	Safety L. S. Krogerud	<i>[Signature]</i>	04-14-96	R3-08				
		Env.							
2	1	J. H. Bussell	<i>[Signature]</i>	03/16/96	H6-11	DESIGN AUTHORITY			
2	1	F. P. Johansen	<i>[Signature]</i>		L6-38				
18. B. Graves Signature of EDT Originator		19. C. E. Hanson Authorized Representative Date for Receiving Organization		20. C. E. Hanson Cognizant Manager Date		21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments			

ENGINEERING DATA TRANSMISSION
(CONTINUATION PAGE)

5. Proj./Prog./Dept./Div.: Surface Moisture Measurement System / Characterization	6. Cog. Eng.: G. F. Vargo Jr.	1. EDT 606744	Page 2 of 2
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15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
4	H-14-100473	1	0	SMMS Passenger Side Electronics Enclosure Wiring Diagram	SQ	2	1	
5	H-14-100474	1-2	0	Surface Moisture Monitoring System Elementary Diagram	SQ	2	1	
6	H-14-100475	1-5	0	SMMS Loop Diagram	SQ	2	1	

MAY 08 1996 **21** ENGINEERING DATA TRANSMITTAL

Page 1 of 2

1. EDT 606743

2. To: (Receiving Organization) See Distribution		3. From: (Originating Organization) Nuclear Analysis and Characterization		4. Related EDT No.:	
5. Proj./Prog./Dept./Div.: W 75250 Surface Moisture Measurement System / Characterization		6. Cog. Engr.: G. F. Vargo Jr. N 2249		7. Purchase Order No.: N/A	
8. Originator Remarks: The purpose of this EDT is to release the final design drawings for miscellaneous systems of the Surface Moisture Measurement System (SMMS). (Program No. ETN-95-0049)				9. Equip./Component No.: N/A	
				10. System/Bldg./Facility: N/A	
11. Receiver Remarks:				12. Major Assm. Dwg. No.: H-14-100458	
				13. Permit/Permit Application No.: N/A	
				14. Required Response Date: ASAP	

15. DATA TRANSMITTED								
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	H-14-100464	1-4	0	SMMS Vehicle Modification Assembly	SQ	2	1	
2	H-14-100465	1-7	0	L.O.W. Probe Delivery System Assembly	SQ	2	1	
3	H-14-100552	1	0	SMMS Source Handling Tool	SQ	2	1	

16. KEY									
Approval Designator (F)		Reason for Transmittal (G)				Disposition (H) & (I)			
E, S, O, D or N/A (see WHC-CM-3-6, Sec.12.7)		1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)				1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged			
17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)									
Reason	Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN
2	1	Prog. Eng. G. F. Vargo	<i>[Signature]</i>	4-9-96	4-9-96	T. I. Stokes	<i>[Signature]</i>	4-9-96	L6-37
2	1	Prog. Mgr. C. E. Hanson	<i>[Signature]</i>	4/1/96	4-1-96	G. A. RITTER	<i>[Signature]</i>	4/1/96	4-1-96
2	1	QA B. J. Hug	<i>[Signature]</i>	4/1/96	L6-37	R. J. CUMMINGS	<i>[Signature]</i>	4/3/96	4-10
2	1	Safety L. S. Krogsrud	<i>[Signature]</i>	4/1/96	R3-08				
		Env.							
2	1	D. B. Graves	<i>[Signature]</i>	4-5-96	L6-38	DES. RESP.			
2	1	F. P. Johansen	<i>[Signature]</i>	4-5-96	L6-38				
18. Signature of EDT Originator D. B. Graves 4-5-96		19. Authorized Representative for Receiving Organization C. E. Hanson 4/1/96		20. Cognizant Manager C. E. Hanson 4/5/96		21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments			

BD-7400-172-2 (04/94) GEF097

STA 1-S5-59 *STA 6-T2-03
2-S6-E1 16-S5-00
3-S2-05 20-T4-00
4-R1-29 30-S6-72
5-T4-30

* ADV received

ENGINEERING DATA TRANSMITTAL

(CONTINUATION PAGE)

5. Proj./Prog./Dept./Div.: Surface Moisture Measurement System / Characterization	6. Cog. Eng. G. F. Vargo Jr.	1. EDT 606743	Page 2 of 2
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15.		DATA TRANSMITTED			(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
4	H-14-100557	1	0	SMMS Calibration Fixture #1	SQ	2	1	
5	H-14-100558	1	0	SMMS Calibration Fixture #2	SQ	2	1	

MAY 16 1996

ENGINEERING DATA TRAN

Page 1 of 2
EDT 606748

2. To: (Receiving Organization) See Distribution	3. From: (Originating Organization) Nuclear Analysis and Characterization u75250	4. Related EDT No.:
5. Proj./Prog./Dept./Div.: Surface Moisture Measurement System / Characterization	6. Cog. Engr.: G. F. Vargo Jr. N2249	7. Purchase Order No.: N/A
8. Originator Remarks: The purpose of this EDT is to release the final design drawings for neutron probe assembly and its circuit boards as part of the Surface Moisture Measurement System (SMMS). (Program No. ETN-95-0049)		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: N/A
11. Receiver Remarks:		12. Major Assm. Dwg. No.: H-14-100458
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: ASAP

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	H-14-100478	1-3	0	SMMS Probe, LV HV Power Supply PCB Assembly	SQ	2	1	
2	H-14-100479	1-3	0	SMMS Probe, Interface Board PCB Assembly	SQ	2	1	
3	H-14-100480	1-3	0	SMMS Probe, Line Driver Board PCB Assembly	SQ	2	1	

16. KEY									
Approval Designator (F)		Reason for Transmittal (G)				Disposition (H) & (I)			
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)		1. Approval	4. Review			1. Approved	4. Reviewed no/comment		
		2. Release	5. Post-Review			2. Approved w/comment	5. Reviewed w/comment		
		3. Information	6. Dist. (Receipt Acknow. Required)			3. Disapproved w/comment	6. Receipt acknowledged		
(G)	(H)	17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)						(G)	(H)
Reason	Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN
2	1	Prog. Eng. G. F. Vargo	<i>G. F. Vargo</i>	4-17-96	H5-09	F. P. Johansen	<i>F. P. Johansen</i>	L6-38	2
2	1	Prog. Mgr. C. E. Hanson	<i>C. E. Hanson</i>	5/9/96	H5-09	T. I. Stokes	<i>T. I. Stokes</i>	L6-37	2
2	1	QA B. J. Hug	<i>B. J. Hug</i>	4/17/96	L6-37				
2	1	Safety L. S. Krogsrud	<i>L. S. Krogsrud</i>	4/21/96	R3-08				
		Env.							
2	1	D. B. Graves	<i>D. B. Graves</i>	4-16-96	L6-38				
2	1	J. H. Bussell	<i>J. H. Bussell</i>	4-17-96	H5-11				
DESIGN AGENCY									
18. D. B. Graves Signature of EDT Originator 4-16-96		19. C. E. Hanson Authorized Representative Date for Receiving Organization 5/9/96		20. C. E. Hanson Cognizant Manager Date 5/9/96		21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments			

BD-7400-172-2 (04/96) GEF09

STA 1 - 55-57 *STA 4 - 71-24 *STA 16 - 55-60
2 - 56-81 5 - 74-30 20 - 74-00
3 - 52-05 6 - 72-63 30 - 56-72

BD-7400-172-1 (07/91)

ENGINEERING DATA TRANSMIT

(CONTINUATION PAGE)

5. Proj./Prog./Dept./Div.:	6. Cog. Eng.	7. Ed:	Page 2 of 2
Surface Moisture Measurement System / Characterization	G. F. Vargo Jr.	606748	

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
4	H-14-100481	1-3	0	SMMS Probe, Preamp Board PCB Assembly	SQ	2	1	
5	H-14-100482	1-3	0	SMMS Probe, Isolation Board PCB Assembly	SQ	2	1	
6	H-14-100483	1-8	0	SMMS Neutron Probe Assembly	SQ	2	1	

JUN 03 1996 21 ENGINEERING DATA TR

Page 1 of 2
1. EDT 606742

2. To: (Receiving Organization) ee Distribution	3. From: (Originating Organization) Nuclear Analysis and Characterization	4. Related EDT No.:
5. Proj./Prog./Dept./Div.: <i>BA200</i> Surface Moisture Measurement System / Characterization	6. Cog. Engr.: G. F. Vargo Jr. <i>N2249</i>	7. Purchase Order No.: N/A
8. Originator Remarks: The purpose of this EDT is to release the final design drawings for installation of the Surface Moisture Measurement System (SMMS), related installation support equipment and van electronics. (Program No. ETN-95-0049)		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: N/A
11. Receiver Remarks:		12. Major Assm. Dwg. No.: H-14-100458
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: ASAP

15. DATA TRANSMITTED									
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition	
1	H-14-100457	1	0	SMMS Drawing Tree	SQ	2	1		
2	H-14-100458	1-4	0	SMMS Installation Diagram	SQ	2	1		
3	H-14-100462	1-4	0	Surface Moisture Monitoring System Spray Washer	SQ	2	1		
4	H-14-100463	1-3	0	SMMS Impact Limiter	SQ	2	1		

16. KEY									
Approval Designator (F)		Reason for Transmittal (G)				Disposition (H) & (I)			
F, S, Q, D or N/A (see WHC-CM-3-5, Sec. 12.7)		1. Approval	4. Review			1. Approved	4. Reviewed no/comment		
		2. Release	5. Post-Review			2. Approved w/comment	5. Reviewed w/comment		
		3. Information	6. Dist. (Receipt Acknow. Required)			3. Disapproved w/comment	6. Receipt acknowledged		
(G)	(H)	17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)							
Reason	Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN
2	1	Prog. Eng. G. F. Vargo	<i>G. F. Vargo</i>	4/24/96	H5-09	F. P. Johansen	<i>F. P. Johansen</i>	4/24/96	L6-38
2	1	Prog. Mgr. C. E. Hanson	<i>C. E. Hanson</i>	4/24/96	H5-09	T. I. Stokes	<i>T. I. Stokes</i>	4-24-96	L6-37
2	1	QA B. J. Hug	<i>B. J. Hug</i>	4/25/96	L6-37				
2	1	Safety L. S. Krogstad	<i>L. S. Krogstad</i>	5/1/96	R3-08				
		Env.							
2	1	D. B. Graves	<i>D. B. Graves</i>	4/27/96	L6-38	RESP. ENG.			
2	1	J. H. Russell	<i>J. H. Russell</i>	4/27/96	H6-11				

18. <i>D. B. Graves</i> Signature of EDT Originator 4-17-96 Date	19. <i>C. E. Hanson</i> Authorized Representative Date for Receiving Organization 4/27/96	20. <i>C. E. Hanson</i> Cognizant Manager Date 4/29/96	21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments
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BD-7400-172-2 (04/94) GEF09/ADY * STA 1-53-57 * STA. 5-T4-30 * STA. 30-S6-72
2-56-81 6-T2-03
3-52-05 16-S5-00
4-R1-29 20-T4-00

ENGINEERING DATA TRANSMITTAL

(CONTINUATION PAGE)

5. Proj./Prog./Dept./Div.:

6. Cog. Eng.

1

Surface Moisture Measurement
System / Characterization

G. F. Vargo Jr.

606742

Page 2 of 2

15.	DATA TRANSMITTED				(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
5	H-14-100470	1-7	0	SMMS Driver Side Electronics Enclosure Assembly	SQ	2	1	
6	H-14-100472	1-6	0	SMMS Passenger Side Electronics Enclosure Assembly	SQ	2	1	
7	H-14-100553	1-3	0	SMMS Instrument Shipping/Storage Container	SQ	2	1	
8	H-14-100554	1-2	0	SMMS Source Storage Cask				

60% Design Briefing – Surface Moisture Measurement (S)

The SMMS 60% design will be presented during this meeting. The audience will be requested to review the project from their area of expertise, and provide constructive design comments. The detailed design briefing package will be distributed at the start of the presentation.

Unless substantial design changes are made between 60% and 100% design stages, the independent reviewers will not be requested for further review support. The final equipment will be qualified for field service via acceptance testing.

Location: 306E, Upstairs Conference Room
Date: 10/4/95
Time: 8:00 am start (concluded no later than noon)

Agenda:

Time:	Presenter:	Subject:
8:00 am	T.I. Stokes	Brief Introduction/Overview of Project - Basis of Data Need
8:10 am	W.T. Watson	Moisture Data (Surface Probe development) - Probe configuration - Results of modeling - Results of testing - Expected dose rates
8:30 am	J.M. Bates	Field Test Plan (Placement of Probe) - Statistical Basis - Ability to Interpret Data
8:40 am	G.A. Ritter	Field Data - Tanks of Interest - Riser/Waste Pre-Inspection
8:50 am	D.B. Graves	Mechanical Design - (Deployment of Probe) - In Tank Arm - Decontamination System - Impact Limiting System - Transport/Storage equipment
9:00 am	D.B. Smet	Camera Design - In tank camera without purge system - In tank camera with purge system
9:20 am	J.H. Bussell	Electrical Design - In Tank Arm - Surface Neutron Probe - Code Compliance
9:40 am	M. Gimera	Data Acquisition Van & Misc. Equipment

- Electrical/Mechanical Equipment & Considerations
 - Van heat load, generator, UPS, drawworks, bar coding, spider assembly, bumper, boom, passengers
- software
 - Data taken?, Processed?, Data records?
- operator interface discussion
- Real time data reduction software

10:00 am T.I. Stokes

Question & Answer Period
- Comments due by 10/6/95

List of Reviewers:

Independent Mechanical Review:	Craig Shaw
Independent Electrical/I&C Review:	Jim Dunks (all except camera system)
Independent Electrical/I&C Review:	Jim Bussell (only camera system)
Independent Physicyst Review:	Lee Carter
Health Physics Review:	Jackson Ellis
Operations Review:	Gus Myers
Nuclear Safety:	Steve Krogsrud
Quality Assurance:	Mike McElroy
Electrical Code Compliance:	Chuck Monasmith ← (can not attend meeting)

~~REVIEW~~ COMMENT RECORD (RCR)

<p align="center">REVIEW COMMENT RECORD (RCR)</p>				<p>1. Date Nov. 9, 1995</p>	<p>2. Review No. 1</p>
				<p>3. Project No. N4A2Y</p>	<p>4. Page 1 of 13</p>
<p>Document Number(s)/Title(s) WC-SD-WM-DTR-044</p>	<p>6. Program/Project/ Building Number UC-606</p>	<p>7. Reviewer PR Deichelbohrer</p>	<p>8. Organization/Group Char. Eng. Imp.</p>	<p>9. Location/Phone S7-12, 373-2037</p>	
<p>10. Agreement with indicated comment disposition(s) Recent Submittal Approval:</p>			<p>11. CLOSED</p>		
<p>Organization Manager (Optional)</p>			<p>Reviewer/Point of Contact</p>	<p>Date</p>	<p>Author/Originator</p>

Author/Originator	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
1	<p>13. Comment(s)/Discrepancy(ies) (Provide technical justification for the action and detailed recommendation of the action required to correct/resolve the discrepancy/problem indicated.)</p> <p>page 1 Include a Table of Contents and a List of Figures.</p>	<p>These will be added by our secretary after the technical review is complete.</p>	
2	<p>page 1 First sentence. Include the words "Under Ground" to distinguish from waste lying on the surface.</p> <p>Middle of first para. Missing word in the sentence "the design requirements for this probe may be found in ". Second para., last sentence. Here you imply that you are redesigning the SMSMS probe. You are actually designing it from the LOW</p>	<p>Word "underground" has been added to description.</p> <p>This sentence is deleted. Its meaning is covered in the following sentence.</p> <p>Reworded to read: "Differences in the waste geometry, relative to the probe, between the surface and the LOW or cone penetrometer for applications require a unique design for the surface probe to function as desired."</p>	

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REVIEW COMMENT RECORD (RCR)

1. Date			2. Review No.	16. statu s
Nov. 9, 1995			1	
3. Project No. N4A2Y			4. Page 2 of 13	
13. Comment(s)/Discrepancy(s): (Provide technical justification for the comment and detailed recommendation of the action required to correct/ resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)		
<p>page 2</p> <p>"Comparisons of the computer modeling predictions and the experimental prototype measurements confirm that the design should be able to meet the requirements for the SMMS." I am reading that you have some confidence that the SMMS probe will work. Logically, then, I have some confidence that it will not work. And, when it doesn't work, you'll just say, "I told you so."</p> <p>Section 2.0</p> <p>rad/hr is not metric</p> <p>Is Parra and Watson also the source of the tank-bottom dose rate?</p>		<p>We are stating that, based upon currently available testing and modeling information, the baseline surface neutron probe design should be able to meet design requirements. It is certainly true that there could be circumstances, as of yet uninvestigated, that could raise the uncertainty of some measurements beyond design requirement limits. We simply do not want to make unsubstantiated claims concerning probe performance. A developmental probe to be used in an uncontrolled environment will not, in general, come with absolute performance guarantees.</p> <p>Changed to grey/hr.</p> <p>Yes.</p>		
<p>page 3</p> <p>The verification of the MCNP code certification has to be cited.</p> <p>last para</p> <p>two metric violations</p>		<p>Reference cited. Carter, L. L., 1995, Certification of MCNP Version 4A for WHC Computer Platforms, WHC-SD-MP-SWD-30001, Rev.7, Westinghouse Hanford Company, Richland, Washington.</p> <p>Metric equivalent added, except for "4-inch riser" which is considered an item name rather than a dimensional reference.</p>		

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REVIEW COMMENT RECORD (RCR)

1. Date			2. Review No.	
Nov. 9, 1995			1	
3. Project No.			4. Page	
N4A2Y			3 of 13	
12. Comment (s):	13. Disposition (Provide justification if NOT accepted.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
<p>12. Comment (s): Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct, resolve the discrepancy/problem indicated.)</p> <p>5 The following sentence is too hard to understand: "While modelers did not allow this mechanical preference to constrain the mechanical geometries that would allow the probe to be easily and repeatably placed on the waste surface so that all detectors would be in the same position relative to the plane of the waste surface were preferred."</p> <p>next-to-the-last para.</p> <p>"Figure 3-2 shows the model predicted responses to changing moisture of a 4 cm long detector placed at the 10 source to detector spacings shown in Figure 3-1." "...placed at the 10 source..." could be better written: "...placed at the location of source number ten..." Also the nonlinearity of the #1 curve (Fig 3-2) has to be explained, or at least, discussed.</p> <p>The word "dampen" in: "...been contributing enough to the far-field response to dampen the moisture sensitivity." seems to be associated with moisture. Replace it with "reduce".</p>	<p>Replace with: "Modelers did not allow this mechanical preference to constrain the models considered. However, model geometries that would allow the probe to be easily and repeatably placed on the waste surface so that all detectors would be in the same position relative to the plane of the waste surface were preferred. For instance, each time the probe is placed upon the surface a given detector should automatically be at the same height above the surface."</p> <p>Replace with: "Figure 3-2 shows the model predicted responses to changing moisture of a 4 cm long detector placed at each of the 10 positions corresponding to the source-to-detector spacings shown in Figure 3-1."</p> <p>Sentence added: "The detector responses, while related to moisture content of the waste, are not expected to have linear relationships with moisture concentration."</p> <p>Substitution made.</p>		<p>Results are not illustrated, but are simply discussed. Because the results did not help to meet the design requirements we determined the results were not of sufficient interest to present graphically. I maintain that these results are not of interest to the design.</p>	
<p>5 page 5 second para.</p> <p>Where are the results illustrated that are talked about in: "The sensitivity to moisture was improved for these arrangements over that predicted for the horizontal source-to-detector spacing, but the depth of investigation did not increase as the detector was further spaced from the source and waste surface."</p>				

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REVIEW COMMENT RECORD (RCR)

REVIEW COMMENT RECORD (RCR)

		1. Date	2. Review No.	
		Nov. 9, 1995	1	
		3. Project No.	4. Page	
		N4A2Y	4 of 13	
13. Comment(s)/Discrepancy(s) for the comment and detailed recommendation of the action required to correct/ resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)		16. Status
<p>7 page 6 second para.</p> <p>Provide reference to support the sentence: "This choice was made primarily because of the results of tests performed for the design of the penetrometer neutron probe."</p> <p>last para.</p>		Reference cited.		
<p>"Figure 3-5" should be "Figure 3-6"</p> <p>page 7 second para.</p> <p>Specify dimension of "thin cadmium" in: "The model was refined by placing an ultra thin cadmium shield around detector 2 in order to reduce the average depth of investigation for that detector."</p> <p>next-to-the-last para.</p> <p>Reword the sentence "The range of moisture concentrations of most interest are from 0 to about 30 wt% water." to "The range of moisture concentrations of greatest interest are from 0 to 30 wt% water."</p> <p>Change "investigation" to "interrogation" in: "Figure 3-7 shows computer model estimated depths of investigation for each of the three detectors as a function of waste moisture."</p> <p>In reference to Figure 3-8 explain why the closest detector has the weakest signal.</p>		<p>Cadmium dimension of 0.005 cm included.</p> <p>"greatest" is substituted for "most".</p> <p>I disagree with this change of word choice. Investigation is the standard term in neutron probe well logging literature to describe this parameter (see Ref. Hearst and Carlson)</p> <p>Explanation added: "Detector 3 is predicted to experience the highest count rates, both because it is not wrapped with thermal neutron absorbing material and because it has a larger active region than the other two detectors. Detector 1 is expected to exhibit the lowest counting rates because of the thick thermal neutron absorber, cadmium, completely surrounding the detector."</p>		

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Page F-74

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REVIEW COMMENT RECORD (RCR)

			1. Date	2. Review No.
			Nov. 9, 1995	1
			3. Project No.	4. Page
			N4A2Y	5 of 13
13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/ resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status	
<p>9 Page 8</p> <p>The sentence: "For this estimate of signal contribution, all scattering events are not weighted equally. " should start a new paragraph.</p> <p>last para.</p> <p>Figure 4-22 should be Figure 4-2.</p> <p>Explain why BF3 was use when earlier the preferred detector was B10.</p> <p>Metric error. torr is not metric. In Hanford Info, I believe it is Pascal.</p>		<p>New paragraph begins with: "For the calculated estimates of signal contributions. in figures 3-9, 3-10, and 3-11, all scattering events are not weighted equally."</p> <p>Typographical error corrected.</p> <p>Previous para. (Sec 4.0): "This prototype probe, utilizing available size and type detectors and a similar neutron source, enabled us to produce a configuration very similar to the detector arrangement modeled in the baseline design." Boron-lined detectors, close to the desired size, were not available in desired time frame. This detector substitution will not affect substance of test results.</p>		
<p>10 page 9</p> <p>first para</p> <p>5 metric errors</p> <p>What is the significance of CH2 following polyethylene?</p> <p>second para.</p> <p>mCi in not metric.</p> <p>last sentence.</p> <p>The word "tub" shows up with no previous reference or explanation. Furthermore, in the Figure it looks like a barrel.</p> <p>next-to-the-last para.</p> <p>one metric error.</p>		<p>Conversion in Pascal has been cited.</p> <p>Curies are converted to becquerel. Inches converted to centimeters. cc are renamed as cm³.</p> <p>CH₂ is listed, as an appositive, to inform the reader of the chemical formula of the compound referred to as polyethylene.</p>		

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REVIEW COMMENT RECORD (RCR)

REVIEW COMMENT RECORD (RCR)

				1. Date	2. Review No.
				Nov. 9, 1995	1
				3. Project No.	4. Page
				NAA2Y	6 of 13
13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status		
<p>page 10</p> <p>Was the sand etc. autoclaved or heat-dried before? Does pea gravel have any hydrated moisture? Was it removed before the samples were prepared?</p> <p>item 7.</p> <p>cc in not metric.</p> <p>last para.</p> <p>Change the wording of "Approximately 30 tanks on a critical ..." to "Approximately 30 Hanford Waste tanks on a critical ...".</p>		<p>Neither the sand nor the pea gravel were not heat dried before mixing and may have contained a small concentration of adsorbed moisture. It is unknown whether or not the pea gravel contains any hydrated moisture. Small unknowns in the makeup of these standards will not change the conclusions of this DPR. Text will be included to clarify that some error in the moisture concentration of these standards is possible because of possible adsorbed or hydrated water in the matrix. Final calibrations of the SMSMS will be performed with standards whose composition and moisture content are well controlled and understood.</p> <p>cc changed to cm'</p>			
<p>page 11</p> <p>"The amount of neutron absorbing material in the pea gravel is negligible and, therefore, would not affect the results of these tests." This conclusion does not seem to be logical. I'd suspect that the 4.2% was from hydrated water. Also, we are targeting for 3% accuracy. 4.2% is not negligible compared to 3%.</p> <p>third para.</p> <p>"The average systematic error in the count rates determined from measurements over the 4 different locations was 1.2% (rms), and the average statistical error in the count rates is about 0.6% (rms)." Explain how this was done. What do you mean by rms? How did you distinguish between systematic and statistical errors?</p>		<p>This was a simple test to determine if there were significant amounts of neutron absorbing materials in the pea gravel. Results show that either neutrons were attenuated less by the gravel than by the sand or the gravel contained a small amount of water in some form or that the larger void space in the gravel lead to some neutron streaming. Since the neutrons passing through the mixture were already thermalized by polyethylene surrounding the source.</p>			

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Page F-76

REVIEW COMMENT RECORD (RCR)

1. Date Nov. 9, 1995			2. Review No. 1	
3. Project No. N4A2Y			4. Page 7 of 13	
13	<p>Comment(s)/Discrepancy(s) (Provide technical justification for the comment(s) recommendation or justification required to correct/resolve the discrepancy/problem indicated.)</p> <p>page 12 second para. one metric error third para. one metric error</p>	14. Mid Point	15. Disposition (Provide justification if NOT accepted.) Metric equivalents provided.	
14	<p>page 13 first para. one metric error second para one metric error third para. What is you justification for stating that the critical moisture concentration range is 20%?</p>		<p>Metric equivalents provided.</p> <p>Reference cited for 20wt% moisture safety criteria (Meacham et al 1995). The approach for safety characterization states that tanks may be declared "conditionally safe" if their moisture concentration is greater than 20 wt%.</p>	

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REVIEW COMMENT RECORD (RCR)

1. Date Nov. 9, 1995			2. Review No. 1	
3. Project No. N4A2Y			4. Page 8 of 13	
13. Comments/Discrepancy(s) (Provide technical justification for the comment, and detailed recommendation of the action required to correct/ resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status	
<p>page 14</p> <p>second para.</p> <p>one metric error</p> <p>third para.</p> <p>3 metric errors.</p> <p>"To study how well the probe can determine the amount of neutron absorbing material within the waste, further testing with more tubs and/or additional calculations would need to be performed." Current funding and scheduling does not include "further testing".</p> <p>In this section you should indicate how the probe will be calibrated and how the count rates will be interpreted. you should have formulas similar to:</p> <p>[% moisture] = A + B*r1 + C*r2 + D*r3 moisture conc.</p> <p>[B conc.] = E + F*r1 + G*r2 + H*r3 neutron abs. conc.</p> <p>[% mois/cm] = J + K*r1 + L*r2 + M*r3 moisture grad.</p> <p>where: r1, r2, and r3 are the count rates from each of the detectors. A, B, ...M are constants that will be established during calibration.</p> <p>You should describe, a little, how A, B, ...M will be determined by the calibration procedure.</p>		<p>Metric provided.</p> <p>Current schedule refers to two activities: Calibrate Probe Assembly and Surface Irregularity Testing. The suggested tests/calibrations may be performed within the scope of these activities.</p> <p>A future activity, currently on the schedule, is the preparation of calibration procedures. They do not belong in a development test report.</p> <p>Interpretation of results will be achieved using an automated interpretation routine, TWAD, that has been developed. This routine will compare measured data from each of the detectors with benchmark responses produced using a calibrated computer model. These benchmark responses will not only be available for different moisture concentrations, but also for different moisture gradients as a function depth in the waste. The routine uses second order curve fits to the modeled data to produce solution curves, but, because two variables are assumed (moisture concentration and gradient), a simple equation, like you suggest, is not possible. Measurements are then compared with these curves to locate the best (lowest error) solution. Documentation for this routine will be referenced rather than elaborating upon this approach in this test report.</p>	16. Status	

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13. Comments/Discrepancy(e) (Provide technical justification for the comment and detailed recommendation of the action required to correct/ resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
<p>page 15</p> <p>first para.</p> <p>second sentence</p> <p>"level agreement" should be "level of agreement"</p> <p>last para.</p> <p>The sentence: "Using these same constants, nearly all of the model-predicted results are in excellent agreement with measured results. " seems optimistic. Most of the points are off by 10 to 20%.</p> <p>"Since these absorption properties, were changed in a known way,..." should be: "Since these absorption properties, were changed in a known way,..."</p> <p>The sentences: "More tests will be needed to determine how these differences may be reconciled. These tests could include multiple boron concentration standards and should utilize standards where the uniformity of the boron distribution is better controlled better." are requesting additional funding and time which do not show up in the schedule.</p>		<p>Missing word added.</p> <p>Given the lack of detail included in the computer model and the amount of systematic uncertainty present in the experimental measurements, the agreement is quite good. Substitute "good" for "excellent".</p> <p>Typographical error corrected.</p> <p>These tests/calibrations will be performed under currently scheduled activities. See response to Item 15.</p>	15.
<p>page 16</p> <p>first para.</p> <p>The "should" in the sentence: "Both the test results and the modeling predictions confirm that the baseline surface moisture probe design should be capable of meeting the data needs." was discussed in item 3. Also, the last sentence.</p>		<p>Sentence revised: "Both the test results and the modeling predictions, performed to date, confirm that the baseline surface moisture probe design is capable of meeting the sensor design criteria."</p> <p>Sentence revised: "Results suggest that data obtained from all three detectors will provide information that could lead to an interpretation of the surface waste moisture concentration and an estimate of the moisture concentration gradient as a function of depth within the top 10-15 cm of waste."</p> <p>We do not intend to misrepresent probe capabilities, by stating that more may be achieved than what has been demonstrated to date.</p>	16.

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<p>We plan to ignore effects of thermal neutron absorbers for initial interpretations for two reasons. 1) Elements that have large thermal neutron absorption cross sections and are expected to be present in some tank wastes, such as Cadmium, are not likely to be found in the saltcake. Most of these elements would form oxide compounds that are not very water soluble and would likely have precipitated out into the sludge rather than crystallized in the salt cake. The surface moisture probe will be deployed primarily upon salt cakes. 2) Two of the three detectors in the baseline probe design have thermal neutron shields that will nearly eliminate these effects.</p> <p>As in reply to Item 15, the interpretation program will choose the interpretation that provides the best fit to the data. In cases where multiple or no clear interpretation is made, a scientist will interpret the data using additional modeling, hand calculations, and any extra available data (such as tank specific sampling or waste history data). Interpretations will be provided with estimated uncertainty or confidence levels. We will not rely upon the Safety Program to select from among a number of results.</p>	<p>14. Hold Point</p> <p>13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct. Resolve the discrepancy/problem indicated.)</p> <p>page 16 last Para. second sentence and the last two sentences.</p> <p>At each point on the waste you will get three count rates--one from each detector. And, at each point on the waste you will be looking for three numbers i.e.: surface moisture content, moisture gradient and neutron absorber concentration.</p> <p>Suppose you have more than one model. When you input the three count rates into the first model, it will produce the desired three numbers. If another model were used, and it produced a different result, how would you know which one is correct? In other words, all models would have to give the same results, if they were accurate. That result could be obtained from formulas similar to those I suggested in item 15.</p> <p>I do not see the need for a big, model-handling computer in the van. A PLC could handle the formulas.</p> <p>I can imagine you could have several models based on different stratification schemes, or different neutron absorber distributions, etc. Each may yield different sets of the three desired numbers, but how would a person choose between them? You may be planning to submit your results to the Safety Program and let them choose. Are we supposing they would have means to choose between the models/results?</p>

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This 5% accuracy refers to the accuracy of individual modeling predictions of count rates. The 3% accuracy, actually 3 weight percent accuracy in the PDC, refers to the target accuracy of the interpretations of the waste moisture. For the detector response predicted in Figure 3-8, a 5% error in count rate would translate to an average 1 wt% error in moisture prediction if the interpretation were based upon a single model calculation. A 5% error in all modeled count rates, if not systematically high or low compared with measurements, would result in a family of "calibration curves" fit more accurately than 5% to the measurements. The use of these curves would result in less than a 1 wt% contribution to the error in the interpretation from errors in the modeling.	The requirement for this modeling has been known to the WHC physicist since the beginning of this project and has been communicated to project management.	19 Page 16 Last para. Also, funding and scheduling will be needed for all this modeling which is not in the current budget. Near the beginning of the last para. target accuracy of 5% is stated. I believe this deviates from the PDC which claims 3%.		
The target accuracy is 43 weight percent not 3 percent absolute. Detector 2, for instance, detects about 14100 neutrons in 50 seconds at 15 wt% moisture and will detect about 16100 neutrons at 18 wt% moisture for a difference of about 2000 counts. As you point out, poisson counting statistics would give an error of about #120 counts (14000 ^{1/2}) using a counting period of 50 seconds. This corresponds to an associated weight percent uncertainty of about 0.2 wt%. Anticipated counting periods of about 4-5 minutes will give an uncertainty, due to counting statistics alone, of less than 0.1 weight percent.		20 Figure 4-15 These graphs show the expected sensitivity of the SMS probes. Typically, I'd say you are getting about 500 counts per %. For a target accuracy of 3%, you'd need your count result to be accurate to 15%. In the Figure you are indicating on the order of 20 000 counts during the counting period which would be repeatable within 141 counts (based on one standard deviation being the square root of 20000). Repeating the counting time, to increase accuracy, to 100 periods would (perhaps) provide sufficient accuracy (i.e., 14%). One hundred counting periods would be 83 hours. Are we planning to count each probe location for 83 hours?		

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16. Status	15. Disposition (Provide justification if NOT accepted.)	14. Hold Point		
21	Figure 3-1 Add a title. Add an eleventh segment so this figure will be consistent with Figure 2.			
22	Figure 3-2 Change title from: "Predicted Responses of Horizontal Placed Surface Neutron Detectors to Changes in Moisture. Incremental Source-to-Detector Spacing Interval: 4 cm." to "Predicted Responses of the Horizontal-Placed Surface Neutron Detectors Shown in Figure 1 to Changes in Moisture"			
23	Figure 3-3 Indicate horiz and vertical locations of source.			
24	Figure 3-5 Include a Title			
25	Figure 3-6 Include a title. Include dimensions of detector/source or else reference a drawing with dimensions. I would really prefer it if this figure were reproducible in black and white.			
26	Figure 3-7 Add a title			
27	Figures 3-9, -10 Add titles. Explain the fine printing under the figures. What are the abscissas and their units? I would really prefer it if these figures were reproducible in black and white.			
28	Figure 4-1 one metric error in title			
29	Figure 4-13 Metric error in title. Metric error on graph.			

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12.	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/ resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)
30	Figure 4-14 Metric error in title. Metric error on graph.		Metric conversion made.
31	Figure 4-17 How can I tell what moisture/B-conc. the labels on the abscissa represent?		Extra explanations added to title and to axis label.
			16. Status

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To: Todd Watson WHC

November 13, 1995

from: Dan Holsen

619/458-3715

Todd,

Re: FAX : 509/372-3777

Here are suggestions for answering Item's 11 and 12 of Paul's RCR.

11. (regarding moisture content of the sand/gravel) We don't know if the sand/gravel were autoclaved or heat-dried prior to packaging. We would have to look into this if it is necessary. We believe that the amount of moisture or hydrated material in the sand/gravel is small, mainly because of the excellent agreement between the calculations and experimental results. We are now making a measurement of the moisture content by heating the sand and gravel to high temperatures (500 deg F) and noting the change in weight before and after. In the final test beds, this will have to be addressed more carefully.

12. (regarding neutron attenuation of the gravel) This was a simple test to determine if there were significant amounts of neutron absorbing materials in the pea gravel. Neutrons were attenuated less by the gravel when compared to the sand. The 4.2% less attenuation could be explained by neutrons streaming through the large voids in the gravel. This is a known affect. Since the neutrons passing through the sand or gravel were already thermalized by the polyethylene surrounding the neutron source, it is unlikely that the reduction in attenuation was caused by a lower amount of hydrated water in the gravel. Furthermore, a 4.2% change in the neutron attenuation corresponds to a small change in the percentage of moisture content. Using Figure 4-10, a change of 1%wt requires a change of about 500 counts in the total detector counts measured in 50 seconds. 4.2% of 18,000 counts is 750 counts which would correspond to a maximum error of 1.5%wt in moisture content. This is the greatest error a 4.2% change in count rate could cause, and it is most likely less because the waste has smaller voids and, if the void space is filled with water, there is no streaming affect.

(regarding errors) The total error in the measurements is a combination of both systematic and statistical effects. The relative statistical error is a function of the number of counts measured (N) in the measurement time and is given by $1/\sqrt{N}$. The average statistical error in the count rates is about 0.6% (one standard deviation). The systematic error is caused by changes with time in the electronics or spatial variations in the test beds. Since the electronics are very stable with time, the most significant systematic effect was believed to be due to variations in the test bed construction. To determine the systematic error, four measurements on each tub in various positions were made. The total error (systematic plus statistical) was calculated by determining the standard deviation in the counts of the four measurements. To derive the systematic error, we assumed the total error was the sum of the systematic and statistical errors added in quadrature. The systematic error was found to be about 1.2% (one standard deviation).

STATICS OF RAISING
THE SMMS ARM/PROBE
Paul Deichelbohrer
Jan. 12, 1996
BELCRK.DWG

CABLE TENSION TO RAISE THE SMMS ARM/PROBE
Paul Deichelbohrer
January 12, 1996
crank.mcd

B := 48 Hinge-to-cable break out distance

L := 77.5 Length of Arm

d := 30 Cable Pick-up point

c := $4 + \frac{7}{8}$ Bell crank off-set

P := 27 Probe weight - pounds

W := 88 Arm Weight - pounds

T = ■ Cable tension - pounds

s = ■ angle raised - rad.

p = ■ angle of cable off-vertical

i := 0 ..25 angle raised (degrees) to be plotted

s := $\frac{\pi}{180} \cdot i$ convert to radians

counterclockwise moment:

T · sin(p) · (d · sin(s) + c · cos(s)) ■

clockwise moment:

W · $\begin{bmatrix} L \\ - \\ 2 \end{bmatrix}$ · sin(s) + P · sin(s) ■

tan(p) := $\left[\frac{d \cdot \sin(s) + c \cdot \cos(s)}{(B + d \cdot \cos(s) - c \cdot \sin(s))} \right]$ ■

the sin(p) will be a function of s, i.e., sin(p)=f(s)

f(s) := $\left[\frac{d \cdot \sin(s) + c \cdot \cos(s)}{\sqrt{((B + d \cdot \cos(s) - c \cdot \sin(s)))^2 + (d \cdot \sin(s) + c \cdot \cos(s))^2}} \right]$

T · f(s) · (d · sin(s) + c · cos(s)) := W · $\begin{bmatrix} L \\ - \\ 2 \end{bmatrix}$ · sin(s) + P · sin(s) ■

$$T(s) := \frac{W \cdot \begin{bmatrix} L \\ - \\ 2 \end{bmatrix} \cdot \sin(s) + P \cdot \sin(s)}{f(s) \cdot (d \cdot \sin(s) + c \cdot \cos(s))}$$

$\alpha := 0$ guess of angle of max tension

given

$$\frac{d}{d\alpha} T(\alpha) \approx 0$$

$\alpha := \text{find}(\alpha)$ $\alpha = 0.166$

$$\alpha \cdot \frac{180}{\pi} = 9.497 \quad \text{angle [degrees] of maximum tension}$$

$T(\alpha) = 460.976$ maximum tension -- pounds

Checking, at max tension

$f(0.166) = 0.126$ should be about the ratio of $30 \sin \alpha$ and B

$$\frac{30 \cdot \sin(0.166)}{48} = 0.103$$

$$T \cdot f(s) \cdot (d \cdot \sin(s) + c \cdot \cos(s)) := W \cdot \begin{bmatrix} L \\ - \\ 2 \end{bmatrix} \cdot \sin(s) + P \cdot \sin(s) \quad \square$$

$$460.976 \cdot f(0.166) \cdot (30 \cdot \sin(0.166) + 4.875 \cdot \cos(0.166)) = 567.926$$

$$88 \cdot 38.75 \cdot \sin(0.166) + 27 \cdot \sin(0.166) = 567.925$$

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5. Document Number(s)/Title(s) 75200-96-004-ENGINEERING REVIEW TEAM TASK WALK-DOWN OF THE SURFACE MOISTURE MEASUREMENT SYSTEM (SMMS)	6. Program/Project/ Building Number SMMS/306E	7. Reviewer Weekly Task Walkdown Team	8. Organization/Group Characterization Equipment Development	9. Location/Phone 306E/300
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17. Comment Submittal Approval: 10. Agreement with indicated comment disposition(s)
C. E. Hanson 11. CLOSED

Organization Manager (Optional)	Reviewer/Point of Contact G. F. Vargo, Jr	Reviewer/Point of Contact G. F. Vargo, Jr
Date	Date	Author/Originator Author/Originator

12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
1	Review the material that the foam inside the impact limiters (ILs) is made of. Determine if it is a hazardous material, and if this poses problems w/disposal.		The foam in the SMMS impact limiters is non-regulated waste (ie, not hazardous). I had our HAZMAT Coordinator review the SMMS (WHC-50012), and there are no waste restrictions. It can be placed in any ordinary landfill. The material is polyether polyurethane foam, and is chemically inert.	

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12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
2	The design of the cable connector at the probe top was questioned as to why a standard wiring connector wasn't used instead of a custom design. The reviewers opinion was since the probe design was in review at the Underwriters Laboratories (UL) for use in a Class I, Division 1, Group B atmosphere, the review of the connector was more likely to pass the analysis than a custom design.		Normally an approved or listed conduit seal such as a trade ETS seal would be used to seal a conduit within 18 inches of an explosion proof housing. In this particular case the seal serves two purposes. The first purpose is to terminate the strength member of the cable, the Kevlar (cm) fibers. The Kevlar (cm) fibers are played over a stainless steel cone while the conductors pass through the interior of the cone. The individual conductors are then separated at the point where the conductors leave the cone. This cone is pulled up into another cone structure called a socket in the wire cable industry (a surface of rotating a line on the end of a rod axis) the explosion proof housing lid. After the lid and one of the sockets are separated, the two 80-7% coaxial cables are separated as they enter a straight bore section in the lid. This whole volume is then filled with an epoxy resin. The epoxy resin bonds the Kevlar (cm) fibers to the stainless steel cone, the interior surface of the socket, and to itself. After the epoxy resin has cured an epoxy wedge is formed in the socket. As the tension force increases the epoxy wedges more tightly in the socket. The second purpose of the seal is to prevent combustion gases from leaving the explosion proof housing or to restrict the releases so that flammable gases outside the housing will not be ignited. The seal must be able to stand the 4 to 5 times the peak explosion pressure. In this cases hydrogen has peak explosion pressure of about 110 psi for an explosion in a spherical chamber. The safety factor accounts for a phenomenon known as pressure piling. Pressure piling is the dynamic pressure increase as combustion wave travels down a conduit. Pressure piling is very similar to "waterhammer" in fluid piping systems. This cable seal has been tested by an independent test laboratory (Tension Member Technology) to a tensile strength of 2530 lbs-force. At that point one of the conductors was pulled through potting compound.	
3	Add clips to the ILS to keep them in place, around the deployment arm, during installation.		Concurrence for using this sealing design has been obtained from the Hanford Intercontractor Electrical Board (reference May, 4, 1995 Meeting Minutes).	
4	Smooth the surface of the ILS so they can be more easily decontaminated. This may be accomplished by plastic wrap over the ILS before installation. The plastic wrap can then be removed and easily disposed.		Agree. At Operations suggestion, the Impact Limiters will be held in place with nylon straps fastened with Velcro. These can be placed outside any potential bagging. Agree. Operations is considering placing the Impact Limiters inside bagging during use, and will bag them after use. Also, all excess RTV was removed from the Impact Limiters.	

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5	What is the radiation life span of the probe electronics?		<p>Radiation effects will be first noticed at about 40,000 Rads or after 30 days of continuous operation in tanks with a dose rate of 200 Rads/hour. Based on best information available at the present time, radiation effects will be first noticed at about 40,000 Rads or after 8 days of continuous operation in tanks with a dose rate of 200 Rads/hour. The effect will be a change in the pulse height of detector tube output pulses as a result of the detector bias supply output voltage changing. This effect can be dealt with by simply adjusting gain on the "grooming" amplifier modules for each of the three detectors. The "grooming" amplifiers are used to set the pulse height of the detector tube output voltage pulses that correspond to full energy capture of neutron-boron reaction fragments by the proportional counting gas to about 6 volts. Other effects are result of increasing offset voltages in the operational amplifiers used in the line driver circuits. This effect will mainly affect the accuracy of temperature measurements as the nuclear counting pulses are AC coupled and are insensitive to changes in DC levels. If the offset voltage of the temperature amplifiers changed by a factor of 10, the temperature offset would be about 10 degrees Celsius. The gain of the line driver amplifiers is insensitive to amplifier gain changes due to radiation exposure since the other amplifiers are operated at a low gain, less than 5. The temperature sensors are based on pn junction voltage change with temperature and as a result the output should be within specification up to about 10⁵ Rads total, integrated dose. This hypothesis is based on the review of other voltage reference radiation test data. The effects may "go away" by annealing the electronics package; operating the probe outside a waste tank where there is no radiation field at ambient temperature and or slight above ambient temperature. Neutron radiation effects are negligible since the neutron flux is small; requiring more than 10⁶ hours of exposure before any effects are noticed.</p> <p>From the literature active electronic components such as transistors begin to change significantly in the range of 10² to 10⁶ Rads total, integrated dose and also begin to change significantly with fast neutron fluxes in the range of 5 x 10¹¹ to 5 x 10¹² neutrons/cm². Passive electronic components such as resistors, and capacitors with inorganic dielectrics should not change until about 10⁶ Rads total, integrated dose and 10¹² neutrons/cm².</p>	

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			<p>Radiation test data has been located on a voltage regulator used in the high voltage power supply and the +12 V power supply for the probe. The voltage regulator functioned within specifications until the total integrated dose was between 20,000 Rads and 100,000 Rads. The current used internally in the regulated output dropped 5% at about 50,000 Rads. On review of other integrated circuits similar to those used in the probe electronic package it seems reasonable to expect performance within manufacturer's specification to about 50,000 Rads. At that point the integrated circuit will continue to perform at a degraded level. The charge sensitive preamplifiers are specified to operate within specification upto 10⁵ Rads. However radiation test data from manufacturer indicated that the amplifiers will operate up to 10⁷ Rads with increased noise.</p> <p>PVC, polypropylene, polyolefin shrink tubing, polyethylene, and diallyl phthalate (high voltage standoff terminals) are the organic insulating materials that are used in the probe. Of these insulating materials, polypropylene has the lowest tolerance to radiation, 10⁶ Rads total integrated dose.</p> <p><u>Assumptions</u></p> <ol style="list-style-type: none"> 1. Electronic package is sufficiently shielded by the stainless steel housing preclude damage by beta particles. 2. It is assumed that the gamma radiation from the ²⁵²Cf neutron source is negligible when compared to the radiation from the tank waste. 3. It is assumed that 2.3 x 10¹² neutron/sec-gram are produced from the 15.7-microgram ²⁵²Cf neutron source. <p>Source produces 3.6 x 10⁷ neutron/sec</p> <ol style="list-style-type: none"> 4. For the purpose of this order of magnitude calculation it will be assumed that all neutrons emitted from the ²⁵²Cf neutron source have energies greater than 1 MeV. 	

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			<p>5. The fraction of neutron emitted that are available to interact with the electronic packages is given by the ratio of spherical surface subtended by electronic boards to the total spherical surface from center of neutron source to an edge of the electronic board. The neutron source is treated a point source. The fraction of neutron reaching the circuit boards is 0.9%.</p> <p>The neutrons emitted in the direction of the circuit board are: 3.2×10^5 neutrons/sec</p> <p>6. The area of a painted circuit board is (7.62 cm in diameter): 45.6 cm^2</p> <p>The neutron flux is then 7.1×10^3 neutrons/cm²-sec</p> <p>7. The maximum dose rate is 200 Rad/hour from tank waste</p> <p>Agree. Special washers were added to the pivot arm and the end was rounded to provide a smooth surface to prevent abrasion of the probe cable.</p> <p>Agree. Will be done using RTV where possible with Operations approval. However, most screws will need to be removed in the field and should not be filled. Experience with the void filling instructions indicate that the 5000 psi. water decon spray will adequately clean these devices.</p> <p>Agree. Cables are well guided and can not be tangled. If the arm will not return to vertical for any reason, the arm which can generate enough force to break the arm cable or the enclosure can be opened on mask and the arm cable cut. The probe cable can then be used to lower the arm. Procedures are being groomed to provide even more assurance that field problems will not occur.</p> <p>Agree. Arrows were added to the enclosure to show the orientation of the arm. The flange beneath the enclosure will be marked every 5° for setting of the rotation stops.</p>	
6	Fix pivot arm interference at the probe joint area to prevent interference with the probe electronic cable when the pivot arm is deployed.			
7	Fill all screw holes and crannies, where possible, to reduce the harboring of radioactive contaminants.			
8	The procedures and the design are to guarantee that the probe and deployment arm will not get stuck in a riser.			
9	Need to clearly identify the procedure for setting of the hard stops. Furthermore, orientation marks should be added to the upper support arm rise flange to identify the actual orientation of the down hole deployment arm.			
10	Revisit the design of the cables and make sure that the cables are of sufficient strength and durability.		<p>Tensile testing was done on actual samples of the cables and cable fittings. The arm cable broke at 1,050 lbs. or higher (the fitting did not fail). Service loads on the arm cable are expected to be 150 lbs. or less, for a safety factor of 7. The probe cable broke at 4,600 lbs. The special connection of the probe cable to the probe was tested and failed at 2,600 lbs. Service loads on the probe cable are no greater than 35 lbs., for a safety factor of 74. There is sufficient strength in the cables compared to expected loads.</p>	

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11	Who will perform the safety analysis for the in-tank video cameras?		Dave Smet will be responsible for making sure video cameras meet current NEC regulations.	
12	Does the NEMA 4X winch enclosure still meet the NEC code after modifications have been done to the enclosure?		NEMA 4X requires the enclosure to be withstand a direct spray of water (i.e., water tight). The winch enclosure was pressure tested and found to be air tight.	
13	A communication system must be provided between the Data Acquisition Van, Winch operators, and camera operators. This should be audio and visual, i.e., operators need to see the probe position, at all times, in the tank.		A hardwired intercom system is being added. The winch operators already have a video signal from the camera. We are investigating a video overlay with the probe position displayed digitally.	
14	Check into the proposed data delivery/retrieval scheme, i.e., data would be stored on transportable hard drive and then hand carried off the farm. Look into the possibility of using a radio link, from the van to outside the farm, for the sending of the SMS data.		The current plan is to use 135 MB floppies for data transfer. If this proves unsatisfactory, a radio link can easily be added.	
15	The boom on the LDM drawworks need to be anchored, when the van is in motion, i.e., removed and stored when the van is being driven on the road.		The boom drawworks will be removed when the van is moved and stored.	
16	John Purcell needs to be kept in the loop regarding numbers assigned to risers and equipment. If barcodes will be used to identify the risers then this methodology needs to be accepted by the drywell van community. Contact David Barnes to coordinate the implementing of the new riser identification scheme.		Agreed. We are working with John Purcell and will contact Dave Barnes.	

5mm398-007
F.F.

REVIEW COMMENT RECORD (RCR)

1. Date 04/18/96		2. Review No.
3. Project No.		4. Page 1 of 1

5. Document Number(s)/Title(s) SMMS Operations Walkdown (4/3/96 - 4/5/96)	6. Program/Project/ Building Number SMMS	7. Reviewer Dan Niebuhr	8. Organization/Group Characterization Ops	9. Location/Phone
--	--	----------------------------	---	-------------------

17. Comment Submittal Approval:

10. Agreement with indicated comment disposition(s) 11. CLOSED

11/23/96 Date
 Reviewer/Point of Contact
 Author/Originator

12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
1	Clearly identify on the box and the mounting flange the correct orientation for installation/removal.		Done--red arrows were painted on top and bottom of the mounting flange to match up with the arrow on the box.	✓
2	Mark a line on the source handling tool (minimum 18" away) to remind operators to keep hands away from the source end of the tool.		Done--a bright red-orange line with warning to "keep away from end" of tool was painted on the tool	✓
3	Clearly identify spreader bar orientation with the lifting arms on the device (color coded).		Done.	✓
4	Paint line on probe to identify which side faces up for source installation/removal.		Done--a vertical stripe was painted on the bottom section of the probe by the source insert to indicate which side faces up.	✓
5	Attach flags to the corners of the bumper so the driver can clearly see how far the bumper sticks out.		Done.	✓
6	Identify which side goes out for the anti-rotation clamps.		Done.	✓
7	Remove first thread for source handling tool to make it easier to attach to source.		Done.	✓
8	Build v-block to hold probe horizontal in glove bag (add rubber to the v-block to prevent probe rotation.)		Accept--nylon vblocks will be attached to a lab jack stand to provide adjustability.	✓
9	Arm brace--reduce weight and replace existing velcro straps with velcro straps that have a D-ring for cinching, 3" grab-tab, and attached to one of the braces.		Accept--this will be modified.	✓
10	Break edges around source on probe bottom, end of arm, and mast extension.		Done.	✓
11	Radius corners (approx 1 inch) on lower impact plate.		Done.	✓
12	Replace velcro straps for impact limiters with straps with D-rings and attach to outside of the impact limiters (with loops) to prevent the straps from sliding down.		Accept--this will be modified.	✓

REVIEW COMMENT RECORD (RCR)

REVIEW COMMENT RECORD (RCR)

				1. Date	2. Review No.
				04/18/96	
				3. Project No.	4. Page
					2 of 1
12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status	
C 13	Lifting clamp-tack weld washers to nuts and bolts.		Accept--this will be done after bolts are procured.	✓	
C 14	Consider a funnel for the bottom impact limiter to guide the probe into the hold.		Accept--a 2-piece teflon funnel with a 45 degree lead-in is being made to fit within the studs on top of the spray ring.	✓	
C 15	Apply never seize to bolts on stop clamps and anti-rotation clamps.		Done.	✓	
C 16	Destaco clamp-replace existing rubber stopper with harder plastic/rubber.		Done--a 1" x 2" brake pad replaced the rubber stopper which allows it to be used a good drag brake as well.	✓	
C 17	Relieve suction on probe from calibration fixtures-probe gets hung up at times.		Done.	✓	
C 18	Increase bagout sleeve length to 70 feet.		Accept--new sleeving will be procured.	✓	
C 19	Need fire extinguisher and CO monitor in the van.		Done.	✓	
C 20	Need to be able to remove TV monitor panel in the van so that the operator sitting in the driver seat can see the monitor (currently cannot open monitor panel door in this position).		Accept--this will be modified.	✓	
C 21	Consider exhaust hose for van to keep exhaust from building in the van.		Accept--an exhaust hose will be procured and stored in the back of the van.	✓	
C 22	Need to tie off cables on bumper.		Accept, this will be added.	✓	
C 23	Need more space (1/2" minimum) between bottom of impact plate and plumbing on spray ring to allow room for J-beams and sleeving.		Accept, a larger spacer will be installed to give an additional 1/2".	✓	
C 24	Need leveling jacks for I-beams with 9" adjustability minimum.		Accept, these will be procured.	✓	
25	Consider using wireless headsets at the box and linking these into the other headset system.		Can't help you on this one. The money well has run dry, so the wired headset system will have to stay as-is. Ops is welcome to buy/use an existing wireless system instead of this system.	✓	
26					
27					
28					
29					
30					
31					
32					
33					
34					

WHC-SD-LM-SDD-070,
Page F-96

Inchcape Testing services

ETL Testing Laboratories

ETL Testing Laboratories, Inc.
5003 S.W. 155th Drive, #212
Beaverton, OR 97006
Telephone (503) 626-0694
Fax (503) 626-7328

March 1, 1996

Mr. Danny LaPlante
ICF Kaiser Hanford Co.
PO Box 888
Richland, WA 99352

Post-It™ brand fax transmittal memo 7671 # of pages = one	
To <i>Jim Russell</i>	From <i>Danny LaPlante</i>
Co. <i>ICF KH</i>	Co.
Dept.	Phone #
Fax # <i>372-1147</i>	Fax #

Subj: Limited Evaluation of SMMS Probe Assembly
Ref: ETL Order No. 110351-331

Dear Mr. LaPlante:

This letter represents the results of the limited evaluation of the subject equipment to the requirements contained in the Standard for Explosion-Proof and Dust-Ignition Proof Electrical Equipment for Use in Hazardous (Classified) Locations, UL 1203. The equipment covered by this Report was evaluated from February 20, 1996 to March 1, 1996 at the ETL facility in Beaverton using the provided documentation. There are several items that require attention before full compliance to the above Standard can be determined.

- Cords (sec. 10.2): The supply cord is to be type S, SO, SOO, ST, STO, STOO, or equivalent. The supply cord has been custom manufactured for the SMMS Probe and no documentation has been provided which indicates the rating and classification of the wiring insulation from a Nationally Recognized Testing Laboratory (NRTL). Please provide this information or Inchcape Testing Services may test the material for an additional fee.
- *Performance Testing (sec. 13 - 25, 34 - 39, 47 - 48): As per contract, no testing on the SMMS Probe Assembly by a NRTL or other acceptable laboratory has been performed, or witnessed by a NRTL. Therefore, full compliance to UL 1203 could not be determined. Please provide this information or Inchcape Testing Services may test the Probe Assembly for an additional fee.
- Markings (sec. 49): The following (if missing) is to be legibly, permanently and clearly labeled on the SMMS Probe Assembly Control Enclosure (not on the Probe):
 - manufacturer's name
 - equipment identification
 - electrical rating (V, A, ph. freq.)
 - Designation of hazardous location for intended use: "Class __, Group __"
 - Ambient temperature rating
 - maximum operating temperature
 - Cautionary statement: "CAUTION - To Reduce The Risk of Ignition of Hazardous Atmospheres, Disconnect the Equipment From the Supply Circuit Before Opening. Keep Probe Assembly Tightly Closed in Operation."

Note: All documentation and design criteria provided by the client, and those organizations authorized by the client, used to evaluate possible Performance Test(s) results and those results obtained by other organizations of the SMMS Probe Assembly, if acceptable to the Authority Having Jurisdiction, may be sufficient for compliance with the Intent of UL 1203. See Items 1 & 2 above.

An Independent Organization testing for safety and performance

SCHEDULE FOR SMMS DEPLOYMENT

TANKS TO BE TESTED IN FY96 IN ORDER

(selected based on immediate riser availability, interim stabilized, and whether or not the tank has a LOW)

BY-110	JAN 96	(test this tank instead of S-102, a liquid tank)
BY-108	FEB 96	
BY-104	MAR 96	
BY-105	APR 96	
BY-103	MAY 96	
BY-106	JUNE 96	
B-103	JULY 96	
TX-118	AUG 96	
TX-105	SEP 96	

*John Lipnicki
Glenn R. Aker
Paul D.
me
Mike Wheat
Dave Smet
Ruben?*

DETAILED SCHEDULE

START	FINISH	DUR	
<i>CSSO Dana Langlois op's contact</i>			<u>BY-110</u>
9/11/95	9/29/95	15	Prepare riser inspection package for risers 7 and 12B, ES-95-###.
10/2/95	10/16/95	10	Inspect/prep risers 7 and 12B under package ES-95-###.
10/24/95	12/6/95	30	Prepare SMMS installation work package for operation in risers 7 and 12B, ES-95-###.
12/13/95	12/19/95	5	Stage equipment in field.
12/20/95	12/28/95	5	Schedule field work.
12/29/95	1/12/96	10	Install and operate SMMS in riser 12B under package ES-95-###.
1/15/96	1/19/96	5	Remove SMMS and move to next riser.
1/22/96	2/2/96	10	Install and operate SMMS in riser 7 under package ES-95-###.
			<u>BY-108</u>
X/X/96	X/X/96	15	Prepare riser inspection package for risers 7 and 12A, ES-95-###.
X/X/96	X/X/96	10	Inspect/prep risers 7 and 12A under package ES-

*bucket camera
foot tool
zip cord
camera inspection*

with 12

RISERAVL.XLS

Selected Entry Risers for SMMS based on document and drawing reviews and field walkdowns											
A Riser 8/29/95											
REFERENCES:		WHC-SD-TI-RE-053 WHC-SD-WM-TI-710									
		Equipment within 3' radius of center of riser									
Tank	Riser#	Size/Contents	Length	Headspace	(inches) Distance ab grade	(feet-inch) Distance near equip	Equip 1 Distance R to edge	Height above gr	Equip 2 Distance R to edge	Height above gr	
BY-104	4	4", breather filter (dog leg)	12.2	23	1"	6"	① 11' 2" - 13' 2", 5' 2", 13' 9"				
	5	4", liquid level reel	12	23.5	4"	2' - 6"					
Notes:		1) riser 4 is a dog leg per SD-TI-RE-053, and may not be able to insert smms. 2) riser 5 is located about 11 feet away from riser 4 and liquid level reel will need to be temporarily removed 3) riser 11 is weather covered but drawings H-2-35235 and section H-H on H-2-35236 show a 4" riser at this location that extends 7' - 8" from the 42" riser at the bottom of the pit, the riser flange is shown at the same elevation as the pit cover. 4) in tank photos, 4/27/83, show no obstructions on the waste surface below riser 4 5) in tank photos of riser 5, 4/27/83, show a level tape at waste surface, view partially blocked by air lift circulator in riser 13									
Action:		1) uncover riser 11 and check for availability, if riser 11 available, use risers 5 and 11. work package in final sign-off									
BY-103	12A	4", breather filter & liquid level reel	14.4	21.1	9"						
	10B	12", observation port	13.8	20.9	2"	4"					
Notes:		1) will need to move breather filter and liquid level reel on riser 12A to 10B for smms operation 2) may need to remove liquid level reel from riser 10B if it is too tall and interferes with smms 3) in tank photos of riser 10B, 7/28/87, show metal tape below riser 4) in tank photos, 7/28/87, show no obstructions on the waste surface below riser 12A									
Action:		1) field check for interference of smms with reel on riser 10B. 2) uncover riser 9 and check for availability, work package approved, sch for work 9/1/95									
BY-105	12A	4", spare	12.8	18	2"	6"					
	5	4", liquid level reel	12	20.7	6.5"	2' - 2"	①				
Notes:		1) riser 5 contains liquid level reel that is right next to high rad zone. photo shows pit hand railing that may interfere with smms equipment 2) core truck sampled in riser 12A on 2/9/95 under work package #ES-94-809 3) in tank photos, 11/9/82, show a level tape at riser 5 location, no other obstructions seen, view partially blocked by 13B saltwell screen 4) in tank photos, 11/9/82, show a few strands of metal tape, no other obstructions on the surface of waste below this riser									
Action:		1) field check hand railing for interference with smms 2) take photo of LOW in riser 10C 3) uncover riser 11 and check for availability, work package currently being performed									
BY-106	5	4", liquid level reel--move to 12B	12	16.4	7"	2' - 6"	①				
	10B	4", spare TWP for smms	13.8	13.5	4.5"	2"					
Notes:		1) riser 10B currently has vapor assembly installed--will have to be temporarily removed. 2) core truck sampled in riser 10B on 1/17/95 under work package #ES-94-808 3) move liquid level reel to riser 12B, which has an abandoned thermocouple tree inside riser									
Action:		1) uncover riser 117 and check for availability, work package needs to be prepared									
BY-108*	12A	12", obs. port	13.4	26.4	3"	8' - 0"					
	7	12", spare	13.4	26.4	1"	1' - 6"	①				
Notes:		1) core truck sampled in riser 12A on 7/30/95 under work package #ES-95-045 2) core truck sampled in riser 7 on 8/15/95 under work package #ES-95-045 3) in tank photos show old gasket on surface of waste below riser 7 4) there is berm running north from center of tank that is just to the west of riser 12A									
Action:		1) field check riser 7 to verify no interference with smms equipment, zoomed out photo needed									

B-103*	2	12", flange/obs port	17.2	20.1	18"	1'-9.5"		
	8	4", flange, spare	16.9	19.9	12.5"	2"		UNIDENTIFIED EXTENDING TO WASTE
		Action:	1) field check for interference with smms equipment above tank--need zoomed out views of both risers					
S-102	1	4", breather filter, G-1 housing	10.4	17.9	7" (1)	1'-5"		
	7	12", flange/obs port	10.5	18	1"	1'-0"		COPIES W/34-110
		Action:	1) field check for interference with smms equipment above tank--need zoomed out views of both risers					
TX-105*	8	4", liquid level reel	12	17.2	33" (2)	1'-7"	(2)	H-2-308, 812, ?
	11A	4", breather filter, G-1 housing	15.6	14.6	1'-0" (3)	open		
		Notes:	1) in tank photos, 10/24/89, show liquid level reel and no debris on waste surface below riser 8					
			2) in tank photos, 10/24/89, show no obstructions on the waste surface below riser 11A					
			3) top of riser 8 is weather covered, foam will have to be removed along with liquid level reel					
		Action:	1) field check for interference with smms equipment for riser 8, need zoomed out view of this riser					
TX-118	9A	4", flange, spare	14.7	22.4	13.5"	11.5"		
	11B	12", observation port	14.3	22.4				
		Action:	1) field check for interference with smms equipment above tank--need zoomed out views of both risers					
			2) take photo of LOW in riser 5					
NOTES:								
(1) S-102 risers 1 and 8 inside ammonium nitrate storage area								
(2) TX-105 riser 8 flange possibly under foam cover (if so, grade measurement is incorrect)								
(3) TX-105 riser 11A may have riser extension, flange possibly below grade								
* Tank does not have a LOW								

**Westinghouse
Hanford Company**

**Internal
Memo**

From: Characterization Equipment Engineering 75200-96-004
Phone: 373-3647 S7-12
Date: January 30, 1996
Subject: ENGINEERING REVIEW TEAM TASK WALK-DOWN OF THE SURFACE MOISTURE
MEASUREMENT SYSTEM (SMMS)

To: L. F. Ermold S7-84

cc: R. E. Bauer L6-37 C. E. Hanson H5-09
P. Deichelbohrer S7-12 J. S. Schofield S7-12
G. T. Dukelow S7-15 T. I. Stokes L6-37
R. V. Elwell S7-12 G. F. Vargo, Jr. H5-09
D. W. Hamilton S7-12 RER File/LB S7-12

Reference: Internal Letter, R. E. Raymond to D. W. Hamilton, et al.,
"Periodic Review Meetings," 75200-002-95, dated July 10,
1995.

Background

In accordance with the action plan for improvement of the Conduct of Engineering in Characterization Equipment Engineering (CEE), the CEE Engineering Review Team conducted a detailed review of the Surface Moisture Measurement System (SMMS) on January 5, 1996.

Task walk-downs have been performed about weekly since July 1995 in accordance with section C of the referenced letter. A recent review of the action plan for improvement in the Conduct of Engineering for CEE identified a commitment to report on this process on a monthly basis to the Director of Characterization Project. This letter is intended to meet that commitment.

Current Status [Attachment 1]

The SMMS is currently being assembled in the 306E building in the 300 Area. The device consists of a Deployment Arm, a Neutron Probe that senses the near surface moisture content of the tank waste, a Data Acquisition Van, and a Water Decontamination system. The fabrication of the system is 95% complete and is scheduled for start of hardware testing the week of January 22, 1996, in the 306E, and acceptance testing at the FMEF the week of February 1, 1996. Only minor fabrication/assembly details remain to be completed.

Tank Farm Operations is on-board. The field procedures and work plans are in progress and scheduled for draft(s) completion by mid-February. The majority of all other documentation has been written and issued, or is in the final stages of release.

Task Walk-Down Summary

A detailed review of the hardware was performed. A punchlist of items noted by the team is attached [Attachment 2].

(NOTE: This punchlist was put in the form of a Review Comment Record {RCR}, so the disposition and closure of them can be tracked)

Conclusion

The detailed task walk-down identified no significant process, programmatic, or conduct of engineering issues related to this task.

A handwritten signature in black ink that reads "R. E. Raymond". The signature is stylized with large, flowing letters.

R. E. Raymond, Manager
Characterization Equipment Engineering

kld:lrn

Attachments (2)

Appendix G

Safety Class and Equipment List

Subj: USQ Screening for SMMS
Date: 96-05-17 09:52:23 EDT
From: George_F_Jr_Vargo@rl.gov
To: HiLineEngr@aol.com

WHC-SD-WM-SDD-070, REV 0
Page G-2

Gary,

The PRC voted today to recommend a USQ for organic tanks based on WHC-SD-WM-SARR-033 [Webb 1996] and USQE TF-95-0096 [Farley 1996], and conditions in tank C-201 and C-202.

Allen Webb is writing the JCO for organic tanks, which will become the authorization basis for activities in organic tanks. The JCO will have specific safety controls for the organic tanks, which will be implemented immediately.

The SMMS USQ will need to be updated to agree with the new JCO authorization basis and new JCO controls. SARR-033 is being recommended as the safety basis for putting tanks on or taking them off an organic watch lists.

The organic watch lists in Hanlon and OSD-30 never had an authorization basis, so it should go away.

Wayne

----- Headers -----

From: George_F_Jr_Vargo@rl.gov Fri May 17 09:52:03 1996
Return-Path: George_F_Jr_Vargo@rl.gov
Received: from mailhost.lanl.gov (mailhost.lanl.gov [128.165.3.12]) by emain09.mail.aol.com (8.6.12/8.6.12) with ESMTP id JAA04976 for <HiLineEngr@aol.com>; Fri, 17 May 1996 09:52:03 -0400
From: George_F_Jr_Vargo@rl.gov
Received: from fep1.rl.gov by mailhost.lanl.gov (8.7.5/1.2) id HAA21128; Fri, 17 May 1996 07:52:01 -0600 (MDT)
Received: by fep1.rl.gov (5.51/5.17.rl-1) id AA14509; Fri, 17 May 96 06:51:52 PDT
Received: from ccMail by ccmail.rl.gov (IMA Internet Exchange 1.04b) id 19c84700; Fri, 17 May 96 06:51:44 -0700
Mime-Version: 1.0
Date: Fri, 17 May 1996 06:46:54 -0700
Message-Id: <19c84700@ccmail.rl.gov>
Subject: USQ Screening for SMMS
To: HiLineEngr@aol.com
Content-Type: text/plain; charset=US-ASCII
Content-Transfer-Encoding: 7bit
Content-Description: cc:Mail note part

Appendix H

Radiation Sources and Dose Rate Related Information

Westinghouse
Hanford Company

Internal
Memo

From: Nuclear Analysis and Characterization
Phone: 376-2737 H0-38
Date: November 15, 1995
Subject: SURFACE NEUTRON MOISTURE PROBE DOSE RATE ESTIMATES

To: G. F. Vargo H5-09
cc: K. L. Drury H5-09
A. E. Waltar H0-32
WTW-File/LB 9601

- References:
1. LANL, 1993, *MCNP - A General Monte Carlo N Particle Transport Code*, Version 4A, LA-12625, (J. F. Briesmeister, Ed.), Los Alamos National Laboratory, Los Alamos, New Mexico.
 2. M. A. Beck, 1992, *Analysis Report for 241-BY-104 Auger Samples*, WHC-SD-WM-TI-540, Westinghouse Hanford Company, Richland, Washington.
 3. ANSI/ANS-6.1.1-1991, *Neutron and Gamma-ray Fluence-to-Dose Factors*.
 4. Internal Memo, B. D. Keele to D. W. Jeppson, "Radiological Characterization of Ferrocyanide Waste Tanks," 28200-91-074, dated November 15, 1991.
 5. ORNL, 1980, *ORIGEN2 - A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code*, (A. G. Croff), Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Calculations have been performed to estimate the dose rate field expected from the surface neutron moisture sensor after it has been deployed in a tank before undergoing any decontamination. These calculations are based on assumptions about waste characteristics, such as radionuclide content, and on the amount of waste expected to contaminate the probe. The results of these calculations are intended to provide operators and health physics personnel with preliminary estimates of expected dose rates so that the probe may be handled in a safe manner consistent with radiation work ALARA principles.

The surface neutron moisture probe will contain a neutron emitting source. The neutron dose rate estimates for the probe were calculated based upon ²⁵²Cf present in the probe itself. The surface neutron probe will contain

G. F. Vargo
Page 2
November 15, 1995

a 17- μ gram ^{252}Cf source that produces both neutrons and photons. This ^{252}Cf source was assumed to be the only neutron producing item for the dose rate calculations. A 17- μ gram ^{252}Cf source will emit approximately 3.91×10^7 neutrons per second. The calculations assumed that these neutrons were emitted with an energy spectrum given by the Watt fission spectrum, which for spontaneous fissions of ^{252}Cf may be expressed as

$$f(E) = \exp(-E/1.025) * \sinh(2.926 * E)^{1/2}$$

where E is the emitted neutron energy in MeV.

The photon dose rate estimates are based upon photon contributions expected from both the ^{252}Cf present in the probe source and from radionuclides, such as ^{137}Cs and ^{90}Sr , expected to be present in any waste that accumulates as contamination upon the outer surface of the probe. Cesium-137, ^{90}Sr , natural uranium, ^{239}Pu , ^{240}Pu , and ^{241}Am were considered to be the only sources of photon radiation in the waste contaminating the probe in these calculations. The amount of these radionuclides present will depend upon their concentrations in the waste that comes in contact with the probe and upon the amount of waste that remains fixed to the probe surface during removal from the tank.

Photon contributions from the ^{252}Cf were based upon ORIGEN2 calculations of a ^{252}Cf photon spectrum (Reference 5). This photon spectrum includes contributions from photons resulting from the spontaneous fission of ^{252}Cf . The ORIGEN2 calculation predicted that 17 μ grams of ^{252}Cf will emit about 1.9×10^6 photons per second.

Waste radionuclide contributions to the photon source were based upon two assumptions. Table 1 shows the assumed concentrations, per gram of waste material, of the considered radionuclides. It was also assumed in the calculation that the amount of waste material on the probe surface was 13.2 cm^3 or 21.2 grams. This amount of waste is equivalent to the volume occupied by a 0.5-cm-thick cylindrical layer coating the bottom, 8.4 cm (3.3 in.) diameter, of the neutron probe housing. This radionuclide amount will produce about 1.0×10^6 photons/second.

The assumed ^{137}Cs concentration was based upon measurements made from the salt cake or surface regions of tanks in the BY Tank Farm. Two auger samples were taken from the salt cake of tank 241-BY-104 (Reference 2). Gamma analyses of these samples determined that the ^{137}Cs concentration was 115.6 ± 0.8 $\mu\text{curies/gram}$ in the sample from riser 5 and 76 ± 3 $\mu\text{curies/gram}$ in the sample from beneath riser 10B. Gamma energy analyses of these samples showed that more than 90% of all gamma rays emitted from the sample

G. F. Vargo
Page 3
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originated from ^{137}Cs . Other potential waste radiation sources, while included in the current calculations, are expected to be relatively insignificant in this dose rate assessment. Photons from radionuclides, other than ^{137}Cs , may be produced from spontaneous fission, bremsstrahlung, and gamma decay. Measurements of the ^{137}Cs concentration vertical tank profile were made in 8 tanks in the BY farm using a CdTe gamma detector lowered into the tank liquid observation well (LOW) (Reference 4). Measurements with this detector estimated a ^{137}Cs concentration range of about 40 to 75 $\mu\text{curies/gram}$ in the salt cake surrounding the LOW installed in riser 10C. The Keele measurement of the ^{137}Cs concentration near the surface of tank BY-110 is about 40 $\mu\text{curies/gram}$. The Keele measurements of the near surface concentration of ^{137}Cs in the 8 BY tanks ranges from about 5 to 70 $\mu\text{curies/gram}$. Based upon available measurement information, the average ^{137}Cs concentration near the waste surface is probably about 50 $\mu\text{curies/gram}$. Using an assumed ^{137}Cs concentration of 115 $\mu\text{curies/gram}$ in the calculations is intended to provide a reasonable, yet somewhat conservative estimate of the photon radiation source in BY Tank Farm near surface or salt cake waste.

Table 1. Waste Radionuclide Concentrations Assumed for the Photon Source in the Dose Rate Calculations.

<u>Radionuclide</u>	<u>Concentration ($\mu\text{curies/gram}$)</u>
Cesium-137	115
Strontium-90	143
Americium-241	0.1
Plutonium-239	0.07
Plutonium-240	0.07
Uranium (natural)	3725 $\mu\text{g/g}$

For the dose rate calculations a Monte Carlo N-Particle (MCNP) geometry was constructed that contained the bottom portion of the neutron probe, consisting of the neutron source, detectors, and steel housing, and that contained a cylindrical layer of salt cake waste in contact with the bottom of the housing (Reference 1). In the model the contaminated probe is surrounded by void, to simulate air, and is position about 1 meter above a soil layer containing 10 wt% moisture. Figure 1 shows a sketch of the geometry used in the calculations. In reality, other materials, such as nearby equipment, could potentially either provide shielding or provide a reflector that could decrease or increase the dose rate in air near the probe.

To calculate the dose rate in the void space surrounding the contaminated probe, point detectors were arranged in a grid in a single vertical plane

G. F. Vargo
Page 4
November 15, 1995

intersecting the center of the geometry. The dose rate field surrounding the probe is expected to be somewhat cylindrically symmetric about the probe, so that the results from this single plane intersecting the geometry should be representative of any orientation about the probe. The radiation flux expected at each point detector is calculated and has been multiplied by the ANSI (Reference 3) fluence-to-dose conversion factors for the appropriate radiation type, neutron or photon (Reference 3). Dose rates were calculated separately for the photons and the neutrons and were simply added to produce total dose rate estimates.

Figure 2 shows the calculated dose rate field from photons only surrounding the contaminated probe. The plotted contour lines show the locations of specified photon dose rates in rem per hour. The black rectangle near the center of the plot is an outline of the position of the bottom half of the probe in the geometry. The scale, shown in centimeters, surrounds the plot frame. The predicted maximum on contact dose rate from photons alone is shown to be about 3 rem/h. The estimated dose rate from photons alone at a distance about 30 cm (1.2 ft) from the side surface of the probe housing at a height level with the bottom of the probe is about 30 mrem/h. These dose rates are expected to scale proportionately, until self-shielding becomes important, with the amount of waste material contaminating the probe and with the ^{137}Cs concentration in the waste. Therefore, if one wanted to know what the expected dose rate (from photons only) would be if one assumed a ^{137}Cs concentration of 230 $\mu\text{curies/gram}$ rather than 115 $\mu\text{curies/gram}$, then the predictions given in Figure 2 could simply be doubled to give the correct order of magnitude estimate.

Figure 3 shows the calculated dose rate field from neutrons only surrounding the contaminated probe. The plotted contour lines show the locations of specified neutron dose rates in rem per hour. As in Figure 2, the black rectangle near the center of the plot is an outline of the position of the bottom half of the probe in the geometry. The scale, shown in centimeters, surrounds the plot frame. The predicted maximum on contact dose rate from neutrons alone is shown to be about 30 rem/h. The estimated dose rate from neutrons alone at a distance about 30 cm (1.2 ft) from the side surface of the probe housing at a height level with the bottom of the probe is about 200 mrem/h. Reflection of neutrons from the ground, containing 10 wt% moisture, is included in these calculations. These dose rates are expected to scale proportionately with the amount of ^{252}Cf remaining in the source after given decay time period. Californium-252 has a half life of about 2.64 years and is therefore expected to be reduced in quantity at a rate of about 1.58 percent per month.

Figure 4 shows the combined photon and neutron dose rate field predicted around the neutron moisture probe. The estimated total on contact dose rate is estimated to be as high as 30 rem/h at the location just below the

G. F. Vargo
Page 4
November 15, 1995

base of the probe where the ^{252}Cf source is located. The dose rate 30 cm from the probe is about 300 mrem/h and the dose rate 1 m from the probe is less than 30 mrem/h. Since the majority (about 90 percent) of the dose is attributed to neutron radiation from the ^{252}Cf source, these combined neutron and photon dose rate predictions will not change significantly with relatively small changes in the assumptions used to calculate the photon dose rates.

Please contact me at 376-2737 if you have any questions or need additional information.

W. T. Watson, Advanced Scientist
Nuclear Analysis and Characterization

Reviewed by:

H. J. Goldberg, Principal Engineer
Nuclear Physics and Shielding

kls

Attachments

CHECKLIST FOR INDEPENDENT TECHNICAL REVIEW

DOCUMENT REVIEWED

NUMBER: _____

TITLE: SURFACE NEUTRON MOISTURE PROBE DOSE RATE ESTIMATES

AUTHOR(s): W. T. Watson

I. Method(s) of Review

- (X) Input data checked for accuracy
- (NA) Independent calculation performed
 - () Hand calculation
 - () Alternate computer code: _____
- (NA) Comparison to experiment or previous results
- (NA) Alternate method (define) _____

II. Checklist (either check or enter NA if not applied)

- (X) Task completely defined
- (X) Activity consistent with task specification
- (X) Necessary assumptions explicitly stated and supported
- (X) Resources properly identified and referenced
- (X) Resource documentation appropriate for this application
- (X) Input data explicitly stated
- (X) Input data verified to be consistent with original source
- (X) Geometric model adequate representation of actual geometry
- (X) Material properties appropriate and reasonable
- (NA) Mathematical derivations checked including dimensional consistency
- (NA) Hand calculations checked for errors
- (X) Assumptions explicitly stated and justified
- (X) Computer software appropriate for task and used within range of validity
- (NA) Use of resource outside range of established validity is justified
- (X) Software runstreams correct and consistent with results
- (X) Software output consistent with input
- (NA) Results consistent with applicable previous experimental or analytical findings
- (X) Results and conclusions address all points and are consistent with task requirements and/or established limits or criteria
- (NA) Conclusions consistent with analytical results and established limits
- (NA) Uncertainty assesment appropriate and reasonable
- () Other (define) _____

III. Comments: _____

IV. REVIEWER: DATE: 13 November 1995

Figure 1. Cross Sectional Sketch of the Geometry Modeled in the Dose Rate Calculations.

Figure 2. Calculated Photon Dose Rate Map Surrounding Contaminated Surface Neutron Moisture Probe.

Figure 3. Calculated Neutron Dose Rate Map Surrounding Surface Neutron Moisture Probe.

Figure 4. Calculated Dose Rates (Photon and Neutron) Surrounding Contaminated Surface Neutron Moisture Probe.

**Westinghouse
Hanford Company**

**Internal
Memo**

From: TWRS SAR Engineering
Phone: 373-5191 A3-37
Date: November 28, 1995
Subject: STORAGE AND CALIBRATION OF NEUTRON PROBE ASSEMBLY IN 306E BUILDING

8M100-BDB-95086

To: D. G. Panther L6-39
T. I. Stokes L6-37
G. F. Vargo H5-09
W. T. Watson H0-38

cc: W. G. Farley S7-71
L. S. Krogsrud R3-08
M. L. McElroy S7-07
G. W. Ryan A3-37
R. L. Schlosser S7-71 *RLS*
BDB File/LB

- References:
1. Stokes, T. I., 1995, *Surface Moisture Measurement of Tank Waste Engineering Work Plan*, WHC-SD-WM-WP-300, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
 2. Pearce, K. L., 1989, *Safety Assessment Document for the 306E Building*, WHC-SD-GN-SAD-301, Westinghouse Hanford Company, Richland, Washington.
 3. WHC, 1994, *Safety Analysis Manual*, WHC-CM-4-46, Westinghouse Hanford Company, Richland, Washington.
 4. 40 CFR 302, "Protection of the Environment", *Code of Federal Regulations*, as amended.
 5. 49 CFR 173, "Research and Special Programs Administration, DOT", *Code of Federal Regulations*, as amended.
 6. DOE Order 5400.9, "Sealed Radioactive Source Accountability", U.S. Department of Energy, Washington, D.C.
 7. DOE, 1992, *U.S. Department of Energy Radiological Control Manual*, DOE-EH-0256T, U.S. Department of Energy, Washington, D.C.

A current FY 1996 project to measure surface moisture in the waste tanks is using a neutron probe to gather the moisture data (Reference 1). Because the probe uses neutrons, a neutron source is required for operation. The source contained in the probe includes 1.7 Ci of ²⁴¹Am and 10 mCi of ²⁵²Cf.

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November 28, 1995

8M100-BDB-95086

Calibration of the probe assembly is required in accordance with engineering practices and functional design criteria. Calibration will consist of testing the probe with simulated waste in the 306E Building. In addition, the probe may be stored in the 306E Building when not in use.

The authorization basis for the 306E Building (Reference 2) is valid as long as the facility retains the designation of a radiological facility. Facilities are designated as radiological as long as the radionuclide inventory at risk in the facility remains below category 3 threshold quantities (Reference 3) or reportable quantities (Reference 4). To determine the inventory at risk, the maximum inventory permitted to be present in a specific location in the facility must be assumed. However, the material may be excluded from the total in computing the inventory at risk if adequate documentation shows that the material meets any of the following criteria:

- Sealed radioactive sources engineered to pass the special form testing specified in 49 CFR 173.469 (Reference 5) and controlled according to DOE 5400.9 (Reference 6) and Article 431 of the DOE Radiological Control Manual (Reference 7).
- Hazardous materials used in exempted commercial products.
- Materials contained in DOT Type B shipping containers (with or without overpack); to exclude this material from the inventory, the container's containment function must survive through all credible accident sequences.

The neutron probe source fits the definition of a sealed radioactive source and can be excluded from the total building inventory. The exclusion is valid only if all of the requirements for a sealed source delineated above are maintained. If the requirements are not maintained then the facility will be outside of its authorization basis. Proof that the neutron probe fits the definition of the sealed radioactive source must be included in the project file. This exclusion is shown in the hazard category calculation found in Table 1 (Attachment 1).

In addition, during the process of calculating the hazard category for the 306E Building, discrepancies were discovered in the radiological limits (Attachment 2) called out in the authorization basis (Reference 2). These include an anomalous limit on the allowable mass of ⁸⁹Sr and the assumption that several additional sources other than the ²⁴¹Am are also sealed. Proof that these additional sources are also sealed and must be included in their respective project files. Because these discrepancies were corrected in Table 1, the authorization basis (Reference 2) should be revised to reflect these changes.

D. G. Panther, et al.
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November 28, 1995

8M100-BDB-95086

Assuming that the requirements of a sealed radioactive source are maintained for those radionuclides taken credit for in Table 1, each radionuclide is below category 3 threshold limits. In addition, the requirement that the sum of the ratios be less than one is also maintained. Any radionuclides not listed in Table 1 that are brought into the facility must be exempted from the building inventory by meeting one of the above criteria or this conclusion will be invalid.

Storage and calibration of the neutron probe in the 306E Building does not alter the radiological designation of the 306E Building and is acceptable.

If you have any questions, please feel free to contact me on 373-5191 or via cc:Mail.

B. D. Board, Engineer
TWRS SAR Engineering

cab

Attachments

Table 1. 306E Facility Inventory Worksheet

Radionuclide	Total Facility or Segment Quantity			Excluded Quantity			Net Quantity		Category 3 Threshold Quantities		Ratio of Facility Inventory to Category 3 TQs	
	Ci	g	Sealed Source (Ci)	Sealed Source (g)	Type B (Ci)	Exempt (Ci)	Ci	g	Ci	g	Ci	g
⁹⁵ Tc	25	1.5E+03					2.5E+01	1.5E+03	1.7E+03	1.0E+05	1.5E-02	1.5E-02
¹²³ I	2	1.1E+04	2	1.10E+04			0.0E+00	0.0E+00	1.0E-03		0.0E+00	
¹⁴⁷ Nd	20	9.0E-02	20	9.00E-02			0.0E+00	0.0E+00	1.0E-01		0.0E+00	
²³⁷ Np	0.005	7.1E+00					5.0E-03	7.1E+00	4.2E-01	6.0E+02	1.2E-02	1.2E-02
²³⁸ Pu	1	1.9E-03	1	1.90E-03			0.0E+00	0.0E+00	1.0E-01		0.0E+00	
²³⁹ Pu	0.02	3.2E-01					2.0E-02	3.2E-01	5.2E-01	8.4E+00	3.8E-02	3.8E-02
²⁴⁰ Pu	0.02	8.8E-02	0.02	8.80E-02			0.0E+00	0.0E+00	1.0E-02		0.0E+00	
²⁴¹ Pu	1	9.7E-03					1.0E+00	9.7E-03	3.2E+01	3.1E-01	3.1E-02	3.1E-02
²⁴¹ Am	1.78	4.9E-01	1.7	0.49			8.0E-02	2.3E-03	5.2E-01	1.5E-01	1.5E-01	1.5E-02
²⁴³ Am	0.008	4.0E-02					8.0E-03	4.0E-02	5.2E-01	2.6E+00	1.5E-02	1.5E-02
²⁴⁴ Cm	0.01	1.2E-04	0.01	1.20E-04			0.0E+00	0.0E+00	1.0E-02		0.0E+00	
²⁴⁶ Cm	0.006	2.0E-02	0.006	2.00E-02			0.0E+00	0.0E+00	1.0E-02		0.0E+00	
²⁴⁸ Cm	0.001	2.3E-01	0.001	2.30E-01			0.0E+00	0.0E+00	1.0E-03		0.0E+00	
²⁵² Cf	0.019	3.4E-05					1.9E-02	3.4E-05	3.2E+00	2.2E-04	5.9E-03	1.5E-01
⁶⁰ Co	7	6.2E-03					7.0E+00	6.2E-03	2.8E+02	2.5E-01	2.5E-02	2.5E-02
⁸⁹ Sr	10	5.0E-04					1.0E+01	5.0E-04	3.4E+02	1.2E-02	2.9E-02	4.2E-02
⁹⁰ Sr	10	7.2E-02	10	7.20E-02			0.0E+00	0.0E+00	1.6E+01	1.2E-01	0.0E+00	0.0E+00
⁹⁰ Y	10	1.8E-05	10	1.80E-05			0.0E+00	0.0E+00	1.0E+01	0.0E+00	0.0E+00	0.0E+00
¹³⁴ Cs	10	7.8E-03					1.0E+01	7.8E-03	4.2E+01	3.3E-02	2.4E-01	2.4E-01
¹³⁷ Cs	10	1.2E-01					1.0E+01	1.2E-01	6.0E+01	6.9E-01	1.7E-01	1.7E-01
¹⁵² Eu	10	5.7E-02					1.0E+01	5.7E-02	2.0E+02	1.2E+00	5.0E-02	4.8E-02
¹⁵⁴ Eu	5	1.9E-02					5.0E+00	1.9E-02	2.0E+02	7.6E-01	2.5E-02	2.5E-02
¹⁵⁵ Eu	60	1.3E-01					6.0E+01	1.3E-01	9.4E+02	2.0E+00	6.4E-02	6.5E-02
¹⁴⁷ Sm	0.54	2.0E-04					5.4E-01	2.0E-04	1.0E+02		5.4E-03	
⁵⁴ Mn	20	2.5E-03	20	2.50E-03			0.0E+00	0.0E+00	1.0E+01		0.0E+00	
⁴⁶ Sc	8	2.4E-04					8.0E+00	2.4E-04	3.6E+02	1.1E-02	2.2E-02	2.2E-02
									Sum of the Ratios		9.0E-01	9.2E-01

- The radionuclides listed in Table 7.1 may be in the 306E Building in either singly or doubly encapsulated forms:

Table 7.1. Maximum Allowable 306E Building Radionuclide Inventory

Nuclide	Maximum Inventory (Ci)	Maximum Inventory (gms)	Physical Form
⁹⁹ Tc	25	1.50E+03	Sin. Ceramic
¹²⁹ I	2	1.10E+04	Pressed NaI Salt
¹⁴⁷ Nd	20	9.0E-02	Sin. Ceramic
Uranium	N/A****	****	Ceramic Oxide, Metal, Oxide, Ceramic Carbide, Ceramic Nitride
²³⁷ Np	.005	7.1E+00	Sin. Ceramic Oxide
²³⁶ Pu	1	1.9E-03	Sin. Ceramic Oxide, Metal
²³⁹ Pu	.02	3.2E-01	Sin. Ceramic Oxide
²⁴⁰ Pu	.02	8.8E-02	Sin. Ceramic Oxide
²⁴¹ Pu	1	9.7E-03	Sin. Ceramic Oxide, Metal
²⁴¹ Am	.08	2.3E-03	Oxide, Oxide with Aluminum Matrix
²⁴³ Am	.008	4.0E-02	Sin. Ceramic
²⁴⁴ Cm	.01	1.2E-04	Sin. Ceramic
²⁴⁶ Cm	.006	2.0E-02	Sin. Ceramic
²⁴⁸ Cm	.001	2.3E-01	Sin. Ceramic
²⁵² Cf	.009	1.7E-05	Sin. Ceramic
⁶⁰ Co	7	6.2E-03	Metal
⁸⁷ Sr	10	3.4E+00	Sin. Ceramic
⁹⁰ Sr	10	7.2E-02	Sin. Ceramic
⁹⁰ Y	10	1.8E-05	Sin. Ceramic
¹³⁴ Cs	10	7.8E-03	Pressed Salt
¹³⁷ Cs	10	1.2E-01	Pressed Salt, Ceramic
¹⁵² Eu*	10	5.7E-02	Powder
¹⁵⁴ Eu*	5	1.9E-02	Powder
¹⁵⁵ Eu*	60	1.3E-01	Powder
¹⁴⁵ Sm**	.54	2.0E-04	Powder
⁵⁴ Mn***	20	2.5E-03	Metal
⁴⁶ Sc***	8	2.4E-04	Metal

*Contained in Sm₂O₃ powder samples.

**Not included in GENII RMDLIB radionuclide library.

***Activated impurities in titanium metal capsule; no release assumed..

****Uranium is limited by toxicological criteria which is mass dependent.

The method for tracking the uranium inventory shall be determined by the following relationship:

$$NVS \times 5.00E-6 + VS \times 1.00E-2 \leq 411.0 \text{ grams}$$

- where: NVS = Mass of uranium in nonvolatile form--grams (metal, oxide, sintered oxide)
- VS = Mass of uranium in volatile or pyrophoric form--grams (carbide, nitride, etc.).

GENERAL PEER REVIEW CHECKLIST

Document Reviewed: INTERNAL MEMO SM100-95-BDB-005A⁻⁹⁵⁰⁸⁶
Author: BRETT D. BOARD
Date: 11/27/95
Scope of Review: ENTIRE DOCUMENT

Yes No* NA

☒ ☐ ☒	Accident scenarios explicitly stated and supported.
☒ ☐ ☐	Conclusions consistent with analytical results.
☒ ☐ ☐	Safety issues adequately defined.
☒ ☐ ☐	Hazardous material inventories defined and/or stated.
☒ ☐ ☐	Document format and content per approved preparation plan.
☒ ☐ ☐	Hazardous areas, complex areas, or processes within a facility or activity identified.
☒ ☐ ☐	Facility or activity type and hazard classification identified.
☒ ☐ ☐	Adequate engineering features or controls defined to reduce or control hazards.
☒ ☐ ☐	Safety boundaries of the facility or activity defined for this analysis.
☒ ☐ ☐	The level of detail corresponds to the hazards and risks.
☒ ☐ ☐	Risk of activity or process adequately defined.
☒ ☐ ☐	Risk acceptable per risk acceptance guidelines.
☐ ☐ ☒	Radiological dose consequences stated.
☐ ☐ ☒	Radiological dose consequences HEDOP approved.
☐ ☐ ☒	Frequency of accidents stated.

* All "NO" responses must be explained on this page or additional page.

GENERAL PEER REVIEW CHECKLIST

Yes No ^{*} NA

- ☒ [] [] Hazardous systems, components, or materials consistently emphasized and stated throughout the document.
- ☒ [] [] Appendices adequately support the document.
- ☒ [] [] References adequately support the document.
- ☒ [] [] All qualitative and quantitative analyses peer reviewed and approved.
- ☒ [] [] DOCUMENT APPROVED FOR FUNCTIONAL REVIEW

* All "NO" responses must be explained on this page or additional page.

Comments: *NONE*

GRANT W. RYAN *Grant W. Ryan*

Reviewer (Printed Name and Signature)

11/27/95

Date

CORRESPONDENCE DISTRIBUTION COVER:

Author

Addressee

Correspondence No.

G. A. Ritter

T. J. Froelich

9650538

Subject: LETTER OF INSTRUCTION #1 FOR WORK ORDER CD6015

INTERNAL DISTRIBUTION

Approval	Date	Name	Location	w/att
		Correspondence Control	A3-01	
		J. H. Bussell	L6-38	
		G. T. Dukelow	S7-14	
		C. E. Hanson	H5-09	
		G. A. Ritter	H0-38	
		T. I. Stokes	L6-37	
		G. F. Vargo	H5-09	
		W. T. Watson	H0-38

Westinghouse
Hanford Company

WHC-SD-WM-SDD-070, REV 0
Page H-20

P.O. Box 1970 Richland, WA 99352

February 2, 1996

9650538
SMMS96-044

T. J. Froelich, Activity Manager
Health Physics Division
Pacific Northwest Laboratory
Post Office Box 999
Richland, Washington 99352

Dear Mr. Froelich:

LETTER OF INSTRUCTION #1 FOR WORK ORDER CD6015

This Letter of Instruction (LOI) describes services provided to Westinghouse Hanford Company (WHC) by Pacific Northwest Laboratories (PNL) under work order CD6015.

PROJECT SCOPE

The purpose of this task is to test a neutron probe in a high gamma radiation environment in the PNL Calibration Facility to verify that the probe still functions satisfactorily under these conditions. Using funds provided by CD6015, PNL shall provide technical support (Greg Carter) to perform this testing. This neutron probe is part of the Surface Moisture Measurement System being developed by WHC in support of Tank Waste Remediation System (TWRS) Safety Programs.

SCHEDULE

This task is currently scheduled to be performed in the first part of February 1996. A minimum of 3 days notice will be given so that the appropriate arrangements can be made.

COST

The cost estimate for use of the facility and technical support is \$2000.00.

T. J. Froelich
Page 2
February 2, 1996

9650538
SMMS96-044

If you have any questions, please feel free to call me at 376-4669.

Very truly yours,

A handwritten signature in dark ink, appearing to read "G. A. Ritter". The signature is fluid and cursive, with the first name "G." and last name "Ritter" clearly distinguishable.

G. A. Ritter, Advanced Engineer
Nuclear Analysis and Characterization

kdp

RL - J. M. Gray
A. H. Wirkkala

PNL- Mr. Greg Carter

Author: George F Jr Vargo at ~WHC53
Date: 5/3/96 9:27 AM
Priority: Normal
Subject: preliminary accumulated gamma exposure results

----- Message Contents -----

Things do not look quite as good as we had originally thought - no major problem, but we will need to limit the dose accumulated by the probe (with the current electrical components) if the calibration is to last. By about 50,000 Rad the probe is out of calibration in a way that changing the 444 gain will not fix. In BY-110, I would expect the probe to remain in calibration for about 33 days. Based upon what I'm seeing, Tank Farm Operations MUST remove the probe before then to confirm calibration. And if they wait that long, we may need to dismantle the probe and replace some components (maybe just the voltage regulator). I would also suggest that a couple of small TLD's be thrown in the probe housing before each tank to help track the accumulated dose. If we know the dose accumulated it looks like we could correct for the error in calibration from about 50 to 150 Rad using the measurements in the field operational check standards. Jim and I will have complete letter report done tomorrow.

Todd

**Westinghouse
Hanford Company**

**Internal
Memo**

From: Nuclear Analysis & Characterization 96002
Phone: 376-2737 H0-32
Date: May 8, 1996
Subject: TEST RESULTS OF ACCUMULATED GAMMA-RAY EXPOSURE OF THE SURFACE
NEUTRON MOISTURE PROBE

To: G. F. Vargo, Jr. H5-09

cc: J. H. Bussell H6-11
K. L. Drury H5-09
G. T. Dukelow S7-14
A. E. Waltar H0-32
WTW File/LB

Attached you will find a report summarizing the results of the long term irradiation of the integrated surface moisture measurement neutron probe. The probe will function with more than 100,000 rad total accumulated gamma exposure. However, the probe will require corrections to the data to be able to perform moisture interpretations, for accumulated exposures as low as about 30,000 rad. Please contact me if you have any questions about this report. The information contained in this report will be incorporated into the SMMS neutron probe calibration report and released as a Westinghouse document.

W. T. Watson
Advanced Scientist

11p

Attachment

Test Results of Accumulated Gamma-Ray Exposure of 1 Surface Neutron Moisture Probe

1.0 EXECUTIVE SUMMARY

The complete surface moisture measurement system (SMMS) neutron probe was irradiated at the 3730 ^{60}Co Facility for a total of 2.8×10^5 rad. While the probe continued to function throughout the irradiation, the signal gain from the neutron detectors gradually changed in a way that interfered with the probe calibration to moisture content. Analyses of the data show that it is possible to correct for this effect up to at least 1.5×10^5 rad total accumulated exposure. Inspection of the probe electrical components revealed that the shift in the signal gain was primarily caused by the gradual degradation of the voltage regulator for the probe high voltage supply. The preferred solution to this problem is to simply limit the amount of exposure the probe receives, especially in any one tank deployment, by minimizing the time the probe is deployed in the tank.

2.0 IRRADIATION CONDITIONS

The SMMS neutron probe was irradiated at the 3730 ^{60}Co Facility from April 22 to 29, 1996. This facility contains multiple encapsulated ^{60}Co source arrays that are submerged near the bottom of a tank filled with water. More than 30 access tubes are installed in the tank to provide irradiation locations that receive different gamma-ray exposure rates depending upon their distance from the sources. These access tubes are 4-inch or larger diameter pipes that are sealed on the bottom end. The exposure rate as a function of height in each access tube was calibrated in 1984 (see attachment A). Current values of the exposure rates are accurately obtained by applying the decay constant for ^{60}Co to the original calibrated rates.

Expected in-tank exposure rates range from about 10 to 200 rad/hr at the waste surface and in the tank headspace. The design goal for the total accumulated exposure that the probe should be able to receive before failure is about 1×10^5 rad. We wanted to accelerate the rate at which the probe exposure accumulated during the test compared with that expected for in the in-tank environment. We did not want to subject the probe to an exposure rate that would cause significant heating or processes other than gamma irradiation to degrade or otherwise change the test results from expected in-tank results. We were confident that an exposure rate up to at least 3×10^3 rad/hr would meet this criteria. The region of the probe housing that contains components to be irradiated is about 13 inches long. We desired an access tube that would provide a relatively uniform exposure rate along the full 13 inches of probe requiring irradiation. Access tube number 27A was chosen for our irradiation based upon these criteria.

In order to place the probe in the most uniform irradiation field, a stand 5.5 inches tall was taped beneath the probe bottom. This stand provides an appropriate offset from the tube bottom, so that the probe and stand could be lowered completely to rest on the bottom of the tube. Figure 1 shows a sketch of the approximate placement of key probe components superimposed upon a graph of the gamma exposure rate in tube 27A. The average exposure rate

Figure 1. Graph of the Exposure Rate Profile in Tube 27A with a Sketch Showing the Placement of the Neutron Probe and Internal Electronics.

incident upon the probe region of interest is about 1.96×10^3 rad/hr and the rates ranged from about 1.75×10^3 to 2.05×10^3 rad/hr. Cobalt-60 has a half life of 5.271 years, leading to negligible decay of the source intensity over the one week irradiation time period.

3.0 TEST ARRANGEMENT AND PROCEDURE

The probe was energized (supplied with 24 volts) during the irradiation and several output signals were monitored. The gamma pile-up signal from each detector and the current supplied to the probe were monitored continuously. The detector outputs were routed through the masthead electronics prototype board to individual Nuclear Instrument Module (NIM) bin amplifiers and then on to analog logarithmic count rate meters. An output from each count rate meter (0-10 volts corresponding to zero to full scale) was connected to a strip chart recorder that continuously recorded each relative count rate. The current required by the probe was monitored by measuring the voltage drop across a 1 Ohm resistor placed in series with the input supply voltages to the probe. The measured voltage drops were recorded by a strip chart recorder.

Immediately before the probe was first placed in the irradiation facility, the neutron source was installed in the probe and the probe was placed in operation check standard 2A. Using the SMMS data acquisition van, data from the detector was collected for 5 minutes to provide baseline count rates for each detector. The probe was removed from the irradiation facility 6 times during the irradiation. Each time the probe was removed the above described test in check standard 2A was repeated in order to assess the status of the probe calibration as a function of accumulated exposure. The functioning of the probe temperature sensors was qualitatively assessed during each of these tests, by noting whether or not their readings were consistent with the expected temperatures (between 15 and 30°C). The board mounted temperature sensor is usually a few degrees warmer than the detector 1 mounted sensor and they both should be between the temperature of the irradiation facility water tank (about 15.5 °C) and their normal room operating temperatures of about 25/30 °C (detector1/board mount).

4.0 TEST RESULTS

For the probe to provide data that may be interpreted into moisture concentration profile information, the probe must remain calibrated for the duration of the in-tank tests. Calibrations, performed in the 306E building with known moisture standards, are known to still be valid in the field by using operational check standards both before and after tank deployment. Ideally, the probe detector responses to the check standard would remain, within counting statistics and accounting for source decay, identical to those obtained at the time of the calibration measurements.

Figure 2 shows the measured response rates for each of the three detectors as a function of integrated gamma exposure. The count rate for each detector is seen to nearly linearly increase with increasing total exposure. At about 14×10^4 rad, the response of detector 1 appears to decrease only because hardware lower level discriminator (LLD) setting was too high to count all interesting counts because of the large reduction in signal gain. This same effect occurs for detectors 2 and 3 at the final measured accumulated

Figure 2. The Measured Detector Count Rates in Operational Check Standard 2A as a Function of Accumulated Gamma Exposure.

exposure of 2.8×10^5 rad (not plotted). The accumulated effect of gamma exposure is significant. Once the probe has reached an exposure of only about 4×10^4 rad, each of the detector count rates has increased by on the order of 10 percent, which is significant enough to invalidate the calibration if no correction is possible.

Figures 3, 4 and 5 show the neutron capture signal spectra (smoothed for clarity), one for each of the three detectors, for increasing total exposure. Data begins between about channel 40 and 70, depending upon the hardware LLD setting for each detector. As the total exposure increases, the spectrum is compressed toward lower channels, most likely because the supply voltage and corresponding tube amplification is reduced (see section 5). The data post processing code, Curvecut, determines the detector count rate by integrating the total number of counts under the curve above a software chosen LLD channel. This LLD channel is a constant number of channels below a software determined reference point on each spectrum curve. The reference point is the channel at which the maximum slope occurs in the spectrum to the right of the initial steep slope region found in each spectrum. This software chosen LLD method is designed to remove the effects of simple linear shifts in the signal offset/gain. The Curvecut code would need to be modified to correct for changes in the spectrum like those seen in these tests.

The probe was irradiated for a total of 2.8×10^5 rad at which time a final measurement was made in the calibration fixture. The probe continued to function, but the signal gain had dropped so significantly that it was not possible to collect a significant portion of the neutron capture spectrum without increasing the main amplifier gains for each detector in the SMMS van data acquisition system. Adjustment of these main gains is a possible step that could be used to obtain viable data from the probe, but this change does complicate the interpretation of the data. Proper correction for the gain change could be made by characterizing the signal amplification as a function of gain setting for these amplifiers. This work was not done for this report, so the calibration standard data taken after the total irradiation was completed is not analyzed in detail.

The in-probe temperature sensors produced temperature readings completely consistent with those expected until the final measurements were taken after 2.8×10^5 rad. Table 1 shows the measured temperature results for increasing total probe exposure. The results are all consistent with expectation except the final readings, where the detector 1 sensor reports a reading that is several degrees colder than the ambient temperatures to which the probe was exposed. It is clear that between 1.5×10^5 rad and 2.8×10^5 rad, the temperature sensors function, but the calibration of at least the detector 1 mounted one is no longer valid. Tests show that the temperature sensors remain responsive to temperature changes even after the total exposure, but the responses show a shift in the calibration. Other variations in the temperature readings are likely related to the length of time that the probe was removed from the gamma facility, the ambient room temperature, and the length of time that the probe boards were energized.

Figure 3. Detector 1 Pulse Height Spectra for Increasing Total Accumulated Gamma Exposure.

Figure 4. Detector 2 Pulse Height Spectra for Increasing Total Accumulated Gamma Exposures.

Figure 5. Detector 3 Pulse Height Spectra for Increasing Accumulated Gamma Exposure.

Table 1. Internal Probe Temperatures Measured with Irradiated Probe Solid State Temperature Sensors.

Total Exposure (rad)	Measured Temperatures (°C)	
	Detector 1 Mounted	Electronic Board Mounted
0	23	27
10500	18	22
43300	17	20
54600	22	30
101000	15	16
145000	18	19
279000	11	16

Table 2 lists gamma irradiation periods and summarizes phenomena observed on the strip chart recorders.

Table 2 Gamma Irradiation Test Record Sheet					
Period No.	In/Out	Date	Time	Exposure Time (hours)	Comments/Anomalies Noted
1	IN	4/22	0922		1. HVPS Current dropped and then increased during first 75 minutes after placement in irradiation facility. 2. Temperature sensors are functional at the end of period 1. 3. Count rate from gamma radiation is fairly constant over period for all three detectors. The chart speed for detector #3 count rate ran out during this period.
	OUT	4/22	1442	5.33	
2	IN	4/22	1524		1. HVPS Current dropped and then increased during first 75 minutes after placement in irradiation facility. 2. Temperature sensors are functional at the end of period 2. 3. The count rate for all three detectors decreased over period. The gain of NIM Bin amplifiers had been increased prior to start of test to increase count rate; count pulses of higher amplitude.
	OUT	4/23	0806	16.70	
3	IN	4/23	0844		1. HVPS Current dropped and then increased during first 75 minutes after placement in irradiation facility. 2. Temperature sensors are functional at the end of period 3. 3. The count rate for all three detectors decreased over the period. The gain of NIM Bin amplifiers had been increased prior to start of test to increase count rate; count pulses of higher amplitude.
	OUT	4/23	1428	5.73	

Table 2
Gamma Irradiation Test Record Sheet

Period No.	In/Out	Date	Time	Exposure Time (hours)	Comments/Anomalies Noted
4	IN	4/24	0831		<ol style="list-style-type: none"> 1. HVPS Current dropped and then increased during first 75 minutes after placement in irradiation facility. There is a abrupt drop in HVPS current during this period, about 0.25 mA. 2. Temperature sensors were not functional at the end of period 4. 3. The count rate for all three detectors decreased over the period. The gain of NIM Bin amplifiers had be increased prior to start of test to increase count rate; count pulses of higher amplitude.
	OUT	4/25	0800	23.48	<ol style="list-style-type: none"> 4. Nim Module Settings: Det#1: Amplifier (EG&G 408A): 15 Count Rate Meter Full Scale Setting: 100 counts per second Det#2: Amplifier (EG&G 408A): 15 Count Rate Meter Full Scale Setting: 30 counts per second Det#3: Amplifier (EG&G 575): Coarse: 4 Fine: 5.16 (Net Gain: 20.48) Count Rate Meter Full Scale Setting: 10' counts per second
5	IN	4/25	0922		<ol style="list-style-type: none"> 1. HVPS Current dropped and then increased during first 75 minutes after placement in irradiation facility. 2. Temperature sensors were not functional at the end of period 5. 3. The count rate for all three detectors decreased over the period. The gain of NIM Bin amplifiers had be increased prior to start of test to increase count rate; count pulses of higher amplitude.
	OUT	4/26	0800	22.63	<ol style="list-style-type: none"> 4. Nim Module Settings: Det#1: Amplifier (Tennelec 242): Coarse: 100 Fine: 1.18 (Net Gain 118) Count Rate Meter Full Scale Setting: 10' count per second Det#2: Amplifier (Tennelec 242): Coarse: 100 Fine: 0.722 (Net Gain 72.2) Count Rate Meter Full Scale Setting: 10' counts per second Det#3: Amplifier (EG&G 575): Coarse: 40 Fine: .874 (Net Gain 34.7) Count Rate Meter Full Scale Setting: 3 x 10' counts per second

Table 2
Gamma Irradiation Test Record Sheet

Period No.	In/Out	Date	Time	Exposure Time (hours)	Comments/Anomalies Noted
6	IN	4/26	1150		<ol style="list-style-type: none"> 1. HVPS Current dropped and then increased during first 75 minutes after placement in irradiation facility. 2. Temperature sensors were not functional at the end of period 6. 3. The count rate for all three detectors decreased over the period. The gain of NIM Bin amplifiers had been increased prior to start of test to increase count rate; count pulses of higher amplitude. 4. Nim Module Settings: Det#1: Amplifier (Tennelec 242): Coarse: 100 Fine: 1.118 (Net Gain 118) Count Rate Meter Full Scale Setting: 10^6 count per second Det#2: Amplifier (Tennelec 242): Coarse: 100 Fine: 0.77 (Net Gain 77) Count Rate Meter Full Scale Setting: 10^6 counts per second Det#3: Amplifier (EG&G 575): Coarse: 40 Fine: 1.25 (Net Gain 34.7) Count Rate Meter Full Scale Setting: 3×10^6 counts per second
	OUT	4/29	0809	68.32	
Total				142.19	

5.0 IDENTIFICATION OF ELECTRONIC COMPONENT DEGRADATIONS

5.1 PHYSICAL CHANGES NOTED BY VISUAL INSPECTION

The physical appearance of probe components did not change except as noted below during the irradiation test. The glass ceramic seals of the detector tubes were browned from the gamma radiation. The surface of the polyolefin tubing and the polyvinyl chloride insulated wiring did not have the surface sheen that they had prior to irradiation. The Teflon¹ (Polytetrafluoroethylene) terminals used for standoffs for high voltage components did not visually appear to be damaged. It should be noted that the Teflon¹ terminals have been replaced with an alkyd phthalate insulated terminal on the final assemblies. Available radiation damage literature indicates that the Teflon¹ terminals should have been severely damaged at 2×10^6 Rads while the replacement terminals insulated with the alkyd phthalate insulated terminals do not show damage until 10^6 Rad.

¹Teflon is DuPont's registered trademark.

5.2 ELECTRICAL CHANGES OBSERVED IN THE HIGH VOLTAGE/LOW VOLTAGE POWER SUPPLY BOARD

The high voltage power supply voltage dropped from 650 V to 560 V. The proportional gas gain of the Boron-10 lined neutron detectors decreases by a factor of 2 to 4 per 100 volts of bias change. The peak in the neutron energy spectrum decreased by more than a factor of two from the beginning to the end of the gamma irradiation test. Crude proportional gas gain measurements made in January, 1996 show that the detector pulse shapes became non-linear (ugly shaped) in the region of 500 to 550 V of tube bias. The decrease in pulse amplitude or spectrum shift appears to be caused from the decrease in the internal reference voltage in the voltage regulator integrated circuit and the increase in bias current from the feedback pin. Table 3 shows the results of the pre-test and post-test measurements for the high voltage/low voltage power supply board and the line driver board. Analysis of the data shows that the internal reference voltage, voltage at U1-Pin 7, of the voltage regulator integrated circuit (National Semiconductor LP2951ACM) dropped about 8% while the high voltage output voltage dropped 14%. NASA has performed radiation testing on this integrated circuit and the test results are in Attachment B. Their testing results are similar to our results with exception that the increase in ground current (internal regulator supply current, I_q and I_o) did not increase to the levels shown in NASA's test data. The other 6% of voltage drop can be attributed to changes in bias current from the feedback pin of the voltage regulator and possibly changes in the resistance of voltage divider network. The output voltage of the regulator is given by:

$$V_{out} = V_{ref} * \frac{(R_2 + R_1)}{R_1} - I_{bias} * R_2$$

where R_2 is the resistor (100 Megohms) connected between the high voltage power supply output and the feedback pin, pin 7, and R_1 is the resistor (approximately 200 kilohms) connected between the feedback pin and ground or circuit common. V_{ref} is the voltage (nominally 1.23 V) of the voltage regulator internal reference. I_{bias} is the bias current (nominally 60 nanoamperes) of the feedback pin. Normally the feedback pin bias current is 60 nanoamperes out of the pin. The voltage divider network for the high voltage supply bleeds about 7 to 10 microamperes from the high voltage power supply output to ground or circuit common. If the feedback pin bias current increased by 6 to 7 microamperes then remaining 6% voltage drop may be attributed to it. The input circuit at the feedback pin in voltage regulator integrated circuit is the base of a PNP transistor. Changes in the required base current of PNP transistors of this order of magnitude for a given collector current are not uncommon with the gamma radiation dose that the neutron moisture probe received. It is unlikely that resistance values of voltage divider network changed because of gamma radiation. The resistance of the resistors in the voltage divider network was not measured.

The low voltage power supply voltage dropped about 10%. The same voltage regulator integrated circuit is used for the high voltage power supply and the low voltage power supply. As discussed above, the output voltage drop between

pre-test and post-test can be attributed a decrease in the internal reference voltage and an increase in the feedback pin bias current. A voltage drop of 10% is tolerable for continued operation of neutron moisture probe.

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Table 3
High Voltage/Low Voltage Power Supply Board and Line Driver Board Pre-Test and Post-Test Measurements

Parameter	Pre-Test	Post-Test
High Voltage Power Supply (HVPS)		
High Voltage Output as Set	650 V	560 V
HVPS Current Draw as Set	12.24 mA ¹	11.45 mA
Input Voltage to Eldec K-15 DC-DC Converter (red to black wires) at as Set	6.088 V ² (interpolated value from previous measurements)	5.701 V (measured value after irradiation) 5.335 V (interpolated value from measurements)
Eldec K-15 DC-DC Converter Current Draw as Set	9.2 mA ¹ (interpolated value from previous measurements)	7.7 mA (interpolated value from measurements)
Maximum High Voltage Output (adj. full cw)	730 V ¹	650 V
Input Voltage to Eldec K-15 DC-DC Converter (red to black wires) at Maximum Output	6.756 V ² (interpolated value from previous measurements)	6.541 V (measured value after irradiation) 6.088 V ² (interpolated from previous measurements)
HVPS Current Draw at Maximum Output	13.88 mA ¹	13.693 mA
Eldec K-15 DC-DC Converter Current Draw at Maximum Output	10.5 mA ² (interpolated value from previous measurements)	9.7 mA ² (interpolated value from previous measurements)
Minimum High Voltage Output (adj. full cw)	565 V ¹	500 V
Input Voltage to Eldec K-15 DC-DC Converter (red to black wires) at Minimum Output	5.376 V ² (interpolated value from previous measurements)	5.156 V (measured value after irradiation) 4.836 V ² (interpolated value from previous measurements)
HVPS Current Draw at Minimum Output	9.72 mA ¹	9.959 mA
Eldec K-15 DC-DC Converter Current Draw at Minimum Output	7.8 mA ² (interpolated value from previous measurements)	6.66 mA ² (interpolated value from previous measurements)
U1-Pin 7 Feed Back Voltage to Ground at Minimum Output	1.2335 V ¹	1.1334 V

Table 3
High Voltage/Low Voltage Power Supply Board and Line Driver Board Pre-Test and Post-Test Measurements

Parameter	Pre-Test	Post-Test
Low Voltage Power Supply (LVPS)		
Output Voltage	11.879 V ¹	10.735 V
U2-Pin 7 Feed Back Voltage to Ground	1.2335 ¹	1.1368 V
Line Driver Board Measurements		
Temperature +5 V Reference Voltage	5.001 V ¹	4.961 V
<p>Notes</p> <p>¹ Voltage measurements obtained from assembled production probe. Electronic circuit and layout are nearly identical.</p> <p>² Interpolated values are calculated from laboratory measurements made on Eldec K-15 DC-DC converter with 100 Megohms load on output. Values were interpolated between measurements points using a simple two point interpolation. Measurements are for information only as instruments used did not have calibration that is traceable to NIST standards. Measurements were made on 12/12/95 and are recorded in WHC-N-1237, pp. 51 to 52.</p>		

5.3 ELECTRICAL CHANGES OBSERVED IN THE PREAMPLIFIER AND LINE DRIVER BOARDS

Very little change was observed in the pulse amplifier circuits in the neutron moisture probe. The measurement results are shown in Table 4. Although there seems to be systematic error present in the pre-test measurements, the pre-test and post-test measurements show that no major degradation took place in the neutron probe preamplifiers and line drivers with respect to pulse amplification. Attachment C is a plot of the gain and noise performance for the charge sensitive amplifiers, Amptek A225, as a function of gamma radiation dose. This plot was furnished by the manufacturer of the charge sensitive amplifiers. The plot shows that the Amptek A225 charge sensitive amplifier are fully functional to about 10^7 Rads with some increase in noise. The solid state temperature sensors lost calibration during test. Table 3 shows the temperature +5 V reference voltage output change decreased about 0.8%.

Table 4
Preamplifier and Line Driver Board Pre-Test and Post-Test Measurements

Charge Sensitive Amplifier Input	50 mV		100 mV		200 mV		250 mV	
	Charge Sensitive Amplifier Output	Probe Output (line driver)	Charge Sensitive Amplifier Output	Probe Output (line driver)	Charge Sensitive Amplifier Output	Probe Output (line driver)	Charge Sensitive Amplifier Output	Probe Output (line driver)
Detector #1 Irradiation Test Pre-Test Value (1/27/96)	1.5 V	0.6 V	2.8 V	1.4 V	5.6 V	2.5 V	7.2 V	2.9 V
Detector #1 Irradiation Test Post-Test Value (5/2/96)	1.7 V	0.7 V	3.4 V	1.5 V	7.0 V	2.8 V	8.0 V	3.5 V
Detector #2 Irradiation Test Pre-Test Value (1/27/96)	1.2 V	0.7 V	3.1 V	1.4 V	6.1 V	2.7 V	7.6 V	3.4 V
Detector #2 Irradiation Test Post-Test Value (5/2/96)	1.6 V	0.7 V	3.3 V	1.4 V	6.7 V	2.8 V	8.4 V	3.5 V
Detector #3 Irradiation Test Pre-Test Value (1/27/96)	1.3 V	0.6 V	2.7 V	1.3 V	5.5 V	2.5 V	6.7 V	3.2 V
Detector #3 Irradiation Test Post-Test Value (5/2/96)	1.6 V	0.7 V	3.1 V	1.4 V	6.2 V	2.9 V	7.8 V	3.7 V

Notes

- Measurements made on 1/27/96 are information only. The oscilloscope used to make these measurements did not have a calibration that is traceable to NIST standards.
- The input voltage was applied to high voltage coupling capacitor through a 5 ± 0.5 picofarad capacitor. The pulse had a 1 microsecond or faster rise time and a fall time greater than 500 microseconds. The pulse were negative-going and act with an oscilloscope.
- The accuracy of the pulse measurements is about 5 to 10% as the measurement were made by reading the pulse height on the graticule of an oscilloscope.

6.0 CONCLUSIONS AND RECOMMENDATIONS

It is clear that the accumulated gamma exposure received by the probe does have a gradual and predictable effect upon the probe calibration over at least the first 1.5×10^5 rad. There are several ways that this effect may be accounted for in the data analyses. Figure 6 shows a graph of the data processing software spectrum reference point (channel) plotted as a function of the accumulated exposure. This graph is proportional to plotting the position of the spectrum peak (or signal gain) as a function of the accumulated exposure. The change in the spectrum reference point with increasing exposure is linear for all three detectors. This graph essentially provides a calibration relating the change in the reference point value with the total accumulated exposure. This calibration can be used in conjunction with the results from Figure 2 to provide a correction to the data that allows for moisture interpretations based upon the original moisture calibration. This technique should be applicable for at least the first 1.5×10^5 rad accumulated by the probe. In order to confirm the accumulated exposure information derived from this method, it would be highly desirable to have two thermoluminescent or other small gamma dosimeters placed in the probe to measure the total exposure received by the probe during deployment. The exposure rate could be assumed to be constant and the exposure calculated for the time of each measurement for comparison with this technique.

Obviously, the most desirable solution for reducing the effects of probe gamma exposure is to deploy the probe, obtain measurements, and remove the probe from the tank in as short of a period of time as possible. Current plans make it possible to complete this work so that the probe is actually in the tank for less than a week. For most tanks, such as BY-110, a week of gamma exposure on the surface of the waste will amount to less than 1×10^4 rad. This low of an accumulated exposure would require negligible corrections be made to the data.

Increasing the detector bias voltage will prolong the radiation exposure life of the probe by increasing the time for the bias supply to decrease past 600 V. The detector bias voltage can be increased past 725 V with addition of three components on the preamplifier board, a charge divider network. The gain of the charge sensitive amplifier will not permit the bias voltage from being increased beyond 725 V because of reaching the end of its linear range. The charge divider divides the charge. The loss in pulse amplitude as a result of detector bias voltage decrease can be eliminated by increasing the gain of the amplifiers in the instrumentation van as long as the detector tubes are operated in their proportional gas gain region.

It might be advisable to change out the voltage regulator integrated circuit prior to each use in a tank. Surface mount dual-in-line package sockets may be available that will allow changing the voltage regulator chip without de-soldering and soldering operations. We will make inquiry with National Semiconductor about obtaining a radiation hardened version of the integrated circuit.

Figure 6. The Spectrum Discriminator Reference Position for Each Detector as a Function of Accumulated Gamma Exposure.

ATTACHMENT A 3730 ⁶⁰Co FACILITY CALIBRATION

Date December 5, 1984
To G. L. Jones
From J. L. Pappin
Subject 3730 ⁶⁰Co FACILITY CALIBRATION

Results for the recent calibration of all exposure tubes at the 3730 ⁶⁰Co Facility are attached. Calibration data were collected from 8/24/84 thru 10/5/84. The calibrations were formed using an ion chamber and thermoluminescent dosimeters (TLD's).

The ion chamber measurements were made using a Capintec PR-06C chamber with build up cap, S/N CIIG 64053, and a Keithley electrometer, S/N 115092. The ion chamber is a transfer standard which carries a calibration certificate for ⁶⁰Co from the National Bureau of Standards dated 5/28/82. The calibration of this chamber was confirmed by direct comparison with a Capintec PM-30 chamber which carries a calibration certificate for ⁶⁰Co from the National Bureau of Standards dated 1/25/84. The ion chamber calibration measurements were performed in Tube #21 with the chamber centered 6, 8, and 10 inches from the bottom of the tube on 8/24/84, which is the official date of calibration for all tubes. Ion chamber calibration results are given in Table 1.

Table 1: Ion Chamber Calibration Tube 21, 8/24/84

<u>Position inches from bottom</u>	<u>Calibrated 10⁵ R/h</u>
6	4.76
8	5.06
10	5.16

TLD exposures were made by placing packets containing three TLD 800's inside the center of a 33" long x 1 1/2" diameter plastic (lucite) tube having 32 positions at 1" intervals. This tube provides electronic equilibrium and reproducible geometry and is shown in photo #1. The lucite tube has three holes drilled thru it such that plastic rods may be inserted for alignment at the center at the ^{60}Co exposure tubes. During TLD exposures the lucite tube containing TLD 800 packets is lowered down until it rests on the bottom and in the center of a ^{60}Co exposure tube. The exposure times for the TLD's were controlled and recorded.

The TLD 800's ($\text{Li}_2\text{Br}_4\text{O}_7\text{:Mn}$) were calibrated by placing TLD packets in the lucite rod at positions that correspond to the positions of the NBS traceable ion chamber calibrations. A series of TLD exposures for varying times provided data to determine the TLD response versus exposure data. These data were then fit using the power function $X=(y/a)^{1/b}$ where x = exposure, 10^4R , and y = TLD response. The resulting formula was used to calculate the calibrated R/h from TLD response data in all the ^{60}Co exposure tubes at the 3730 facility. The calibrated exposure rates for the ^{60}Co exposure tubes at the 3730 facility are presented in Table 2

PNL TABLE 1. Ion Chamber Calibration, 8/24/84, TUBE 21

<u>POSITION (INCHES FROM BOTTOM)</u>	<u>CALIBRATED</u>
	FLUX: 10^5 R/h
6	4.76
8	5.06
10	5.16

**PNL TABLE 2. Calibrated Exposure Rates
3730 ⁶⁰Co FACILITY, 8/24/84.**

POSITION (INCHES FROM BOTTOM)	FLUX:	TUBE #1 10 ⁶ R/h	TUBE #2 10 ⁵ R/h	TUBE #3 10 ⁵ R/h	TUBE #4 10 ⁵ R/h	TUBE #5 10 ⁴ R/h	TUBE #6 10 ⁴ R/h
1		0.862	2.50	2.22	1.50	8.83	2.07
3		1.28	3.51	2.79	1.59	8.86	5.78
5		2.32	4.83	3.42	1.56	8.99	6.44
7		3.97	7.44	4.21	1.67	9.35	6.48
9		5.78	9.37	4.58	1.64	9.73	6.77
11		6.33	10.7	5.01	1.61	9.65	6.67
13		6.47	11.0	5.06	1.51	9.29	6.63
15		6.01	10.7	4.72	1.38	9.37	6.91
17		5.18	9.00	4.49	1.28	9.17	6.71
19		3.37	6.79	3.52	1.17	8.69	6.51
21		1.79	4.94	3.02	1.04	7.94	6.26
23		0.93	3.16	2.43	0.70	7.66	6.12
25		0.53	2.33	1.83	0.48	7.05	6.17
27		0.33	1.57	1.42	0.32	3.00	4.55
29		0.18	1.04	1.04	0.24	1.83	2.13
31		0.12	0.69	0.67	0.17	1.35	1.15

POSITION (INCHES FROM BOTTOM)	FLUX:	TUBE #7 10 ⁴ R/h	TUBE #8 10 ⁴ R/h	TUBE #9 10 ⁴ R/h	TUBE #10 10 ⁴ R/h	TUBE #11 10 ⁵ R/h	TUBE #12 10 ⁵ R/h
1		5.16	1.26	1.01	0.22	3.01	2.82
3		5.77	3.21	3.16	0.50	3.70	4.09
5		5.72	4.05	3.57	1.46	4.39	5.34
7		5.82	4.23	3.62	2.36	4.79	6.63
9		5.74	4.22	3.58	2.92	5.45	7.94
11		5.56	4.18	3.82	3.12	5.53	8.30
13		5.65	4.49	3.66	3.06	4.94	8.41
15		5.40	4.58	3.62	3.16	4.07	7.12
17		5.23	4.47	3.66	3.08	3.55	6.42
19		5.09	4.41	3.62	3.07	2.84	4.89
21		4.68	4.05	3.50	2.99	2.16	3.38
23		2.36	4.24	3.59	3.02	1.61	2.42
25		1.36	3.92	3.46	3.09	1.08	1.66
27		0.86	2.89	2.19	2.98	0.76	1.02
29		0.59	1.34	0.97	2.90	0.50	0.73
31		0.50	0.91	0.58	1.59	0.35	0.54

PNL TABLE 2. Calibrated Exposure Rates (Continued)
3730 ⁶⁰Co FACILITY, 8/24/84.

POSITION (INCHES FROM BOTTOM)	FLUX:	TUBE #13	TUBE #14	TUBE #15	TUBE #15A	TUBE #15B	TUBE #16
		10 ⁵ R/h	10 ⁵ R/h	10 ⁵ R/h	10 ⁵ R/h	10 ⁴ R/h	10 ⁵ R/h
1		3.30	3.16	1.73	1.03	1.96	5.12
3		4.59	3.97	2.18	1.26	2.26	7.93
5		6.26	4.73	2.67	1.39	2.70	11.4
7		7.15	5.66	3.03	1.52	2.90	13.1
9		8.02	6.02	3.10	1.55	2.96	14.6
11		8.28	5.79	3.11	1.67	2.95	14.6
13		8.02	5.53	3.06	1.59	2.84	14.6
15		6.99	4.79	2.82	1.45	2.70	13.2
17		5.74	3.93	2.63	1.36	2.51	11.4
19		4.35	3.29	2.18	1.16	2.18	8.38
21		3.07	2.59	1.79	1.03	1.93	4.95
23		2.54	1.87	1.46	0.85	1.61	2.93
25		1.61	1.38	1.13	0.68	1.33	1.69
27		1.07	0.90	0.77	0.52	1.07	1.10
29		0.76	0.61	0.57	0.41	0.84	0.65
31		0.53	0.50	0.40	0.32	0.70	0.47

POSITION (INCHES FROM BOTTOM)	FLUX:	TUBE #17	TUBE #18	TUBE #19	TUBE #20	TUBE #21 ¹	TUBE #21 ²
		10 ⁵ R/h	10 ⁵ R/h	10 ⁵ R/h	10 ⁵ R/h	10 ⁵ R/h	10 ⁵ R/h
1		1.83	1.45	1.43	1.55	1.81	2.14
3		2.40	2.09	2.07	2.29	3.16	3.34
5		2.86	2.50	2.77	3.05	4.36	4.28
7		3.40	3.19	3.39	3.54	5.05	5.03
9		3.37	3.44	3.62	3.78	5.38	5.52
11		3.29	3.39	3.73	3.87	5.28	5.67
13		3.19	3.48	3.50	3.69	5.17	5.52
15		2.76	3.28	3.15	3.43	4.40	4.72
17		2.30	2.69	2.77	2.72	3.95	4.14
19		1.62	1.99	2.11	2.07	2.70	2.84
21		1.11	1.31	1.41	1.32	1.62	1.74
23		0.67	0.84	0.82	0.78	0.94	1.05
25		0.44	0.55	0.49	0.49	0.57	0.64
27		0.30	0.36	0.33	0.34	0.37	0.43
29		0.21	0.26	0.23	0.23	0.26	0.31
31		0.16	0.18	0.18	0.17	0.18	0.22

PNL TABLE 2. Calibrated Exposure Rates (Continued)
3730 ⁶⁰Co FACILITY, 8/24/84.

POSITION (INCHES FROM BOTTOM)	TUBE #22	TUBE #23A	TUBE #24A	TUBE #25A	TUBE #26A	TUBE #27A
FLUX:	10 ⁵ R/h	10 ⁴ R/h	10 ⁴ R/h	10 ⁴ R/h	10 ⁴ R/h	10 ³ R/h
1	1.86	1.92	2.24	1.72	0.96	5.15
3	2.74	2.39	2.70	1.96	1.14	6.66
5	3.71	3.05	3.46	2.53	1.46	7.43
7	4.11	3.28	3.97	2.96	1.61	9.23
9	4.78	3.59	4.05	3.08	1.67	9.36
11	4.85	3.90	4.27	3.34	1.74	9.67
13	4.82	3.71	4.24	3.07	1.76	9.25
15	4.42	3.69	4.01	2.97	1.77	9.53
17	3.68	3.45	3.68	2.76	1.53	8.44
19	2.68	2.90	3.13	2.43	1.46	7.82
21	1.70	2.46	2.54	2.09	1.24	6.94
23	0.99	1.94	1.94	1.61	1.03	5.84
25	0.58	1.36	1.40	1.19	0.81	4.64
27	0.38	1.04	1.06	0.83	0.61	3.65
29	0.24	0.78	0.80	0.65	0.45	2.81
31	0.19	0.66	0.61	0.49	0.33	2.29

POSITION (INCHES FROM BOTTOM)	TUBE #28A	TUBE #29A	TUBE #30A	TUBE #31A	TUBE #32A	TUBE #33A
FLUX:	10 ³ R/h	10 ³ R/h	10 ³ R/h	10 ² R/h	10 ² R/h	10 ³ R/h
1	2.55	1.54	0.74	4.36	3.40	2.39
3	3.17	1.77	0.85	4.64	4.23	3.22
5	3.79	2.13	1.05	6.46	5.94	3.44
7	3.95	2.41	1.11	6.77	7.50	3.84
9	4.24	2.34	1.17	7.97	8.91	3.89
11	4.74	2.51	1.29	8.50	9.19	4.03
13	4.65	2.43	1.24	8.89	9.98	4.11
15	4.46	2.39	1.21	8.71	10.50	4.09
17	4.28	2.36	1.20	8.53	9.80	4.20
19	3.79	2.24	1.17	8.82	10.60	4.18
21	3.38	1.91	1.08	8.45	10.60	4.06
23	3.04	1.76	0.98	7.74	10.10	3.61
25	2.64	1.51	0.90	6.81	9.38	2.73
27	2.20	1.31	0.81	6.48	9.03	2.06
29	1.76	1.14	0.74	5.49	7.73	1.64
31	1.46	0.93	0.60	5.36	6.26	1.22

Sources of error that exist in the 3730 ^{60}Co facility include source decay and exposure geometry. No source decay was applied to TLD data during the month of TLD exposures following the traceable ion chamber calibration of Tube 21. The ion chamber calibration made on 8/24/84 is the official data of calibration for all tubes. The exposure rate at the facility also changes with geometry caused radiation scatter and attenuation. The calibration of Tube 21 was effected by the presence of a dense object in Tube 16. Dense objects were also present in Tubes 5, 7, and 28A during the calibration (see exposure tube map). A graph of the Tube 21 exposure rates with and without the dense object in Tube 16 is presented.

Sources of error for this calibration include: exposure geometry, ion chamber measurement error, TLD response error, calibration curve fit error, and source decay error. The estimated uncertainty associated with the TLD readings at each position is 10%. The overall average tube calibration uncertainty is estimated to be 6% (near the maximum). This calibration is recorded in long BNW 50560.

ATTACHMENT B Radiation Test Data for National Semiconductor LP291 Voltage Regulator

DEVICE: LP2951H/883B TEST AGENCY: GODDARD SPACE FLIGHT CENTER

DESCRIPTION: Adjustable Micropower Voltage Regulator MFG: NSC

TEST NO.: 6012.SMY TEST DATE: 12/12/90 DATE CODE: 8811

THIS DATA IS ASSUMED CORRECT AND RELIABLE. HOWEVER, JPL ASSUMES NO RESPONSIBILITY FOR THE CONTENT.

A radiation evaluation was performed on LP2951H/883 to determine the total dose tolerance of these parts. A brief summary of the test results is provided below. For detailed information, refer to Tables I through IV.

The total dose testing was performed using a cobalt-60 gamma ray source. During the radiation testing, two parts were irradiated under bias and one part was used as a control sample. The total dose radiation steps were 2, 5, 10, 20, 45, 70 and 100 krad. After 100 krad, parts were annealed at 25C for 24 and 168 hours, and then the irradiation was continued to 200 krad (cumulative). The dose rate was between 0.1 - 5.0 krad/hour, depending on the total dose level (see Table II for radiation schedule). After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits listed in Table III.

All (2) parts passed all tests on irradiation up to 45 krad. At 70 krad, both parts significantly exceeded the specification limits on Ground Current I_{Q+} , (readings were 18.08 and 32.17 mA against the specification limit of 12 mA). Also, both parts failed (marginally) to meet the minimum specification limit for Output Voltage ($V_{O/M}$). At 100 krad, parts showed increased degradation in

both of the above parameters. Additionally, the parts also exceeded the specification limits on Load Regulation and Error Output Low Voltage ($V_{REF/M}$).

On annealing for 24 and 168 hours, the parts showed partial recovery. Table IV provides the mean and standard deviation values for each parameter after different radiation exposures and annealing treatments.

TABLE I. Part Information

Generic Part Number:	LP2951H/883B
ISTP Common Buy Part Number:	LP2951H/883B
ISTP Common Buy Control Number:	3845
Manufacturer:	National Semiconductor Corp.
Lot Date Code:	8811
Quantity Tested:	3
Serial Numbers of Radiation Samples:	85, 86
Serial Numbers of Control Sample:	84

Voltage Regulator

Part Technology:	Bipolar
Package Style:	8-Lead Can

TABLE II. Radiation Schedule

EVENTS	DATE
1) Initial Electrical Measurements	12/12/90
2) 2 krad irradiation @ 100 rads/hr	12/26/90
Post 2 krad Electrical Measurements	12/27/90
3) 5 krad irradiation @ 150 rads/hr	12/27/90
Post 5 krad Electrical Measurements	12/28/90
4) 10 krad irradiation @ 74 rads/hr	12/28/90
Post 10 krad Electrical Measurements	12/31/90
5) 20 krad irradiation @ 227 rads/hr	12/31/90
Post 20 krad Electrical Measurements	01/02/91
6) 45 krad irradiation @ 1250 rads/hr	01/02/91
Post 45 krad Electrical Measurements	01/03/91
7) 70 krad irradiation @ 1250 rads/hr	01/03/91
Post 70 krad Electrical Measurements	01/04/91
8) 100 krad irradiation @ 441 rads/hr	01/04/91
Post 100 krad Electrical Measurements	01/07/91
9) 24 hrs annealing	
Post 24 hr Electrical Measurements	01/08/91
10) 168 hrs annealing	
Post 168 hr Electrical Measurements	01/14/91
11) 200 krad irradiation @ 5000 rads/hr	01/14/91
Post 200 krad Electrical Measurements	01/15/91

Notes:

- 1) All parts were radiated under bias at the cobalt-60 gamma ray facility at GSFC.
- 2) All electrical measurements were performed off-site at 25C.
- 3) Annealing performed at 25C under bias.

Table III. Electrical Characteristics of LP2951H/883

(TA = 25C, VIN = 6V, CI = 1uF unless otherwise specified.)

Test	Conditions	Limits		Units
		Min	Max	
Iq+	I1 = 100uA		120	uA
IQ+	I1 = 100mA		12	mA
VO/m		4.97		V
VO/M			5.03	V
VREF/m		3.0		V
VREF/M	VIN = 4.5V		250	mV
REG/1d	100uA < I1 < 100mA		5.0	mV
REG/1n	6V < VIN < 30V		5.0	mV
VDIF/m	VIN - VOUT = 100mV		80	mV

TABLE IV: Summary of Electrical Measurements after
Total Dose Exposures and Annealing for LP2951H/883 1/, 2/

		Total Dose Exposure (krads)							
		Initials		10		20			
Spec. Limits									
Parameters		min	max	mean	sd	mean	sd	mean	sd
Iq+	uA		120	70.4	0.2	88.0	1.0	88.2	0.2
IQ+	mA		12	6.5	0.5	7.7	0.3	8.3	0.4
VO/m	V	4.97		5.01	0	5.0	0	5.0	0
VO/M	V		5.03	5.01	0	5.0	0	4.99	0
VREF/m	V	3.0		4.26	0	4.25	0	4.27	.01
VREF/M	mV		250	141	1	145	3	150	1
REG/1d	mV		5	-0.8	0.2	-0.9	0.2	0.35	0.35
REG/1n	mV		5	1.4	0.4	1.1	0.3	2.0	0.4
VDIF/m	mV		80	PASS		PASS		PASS	
=====									
		Total Dose Exposure (krads)							
		45		70		100			
Spec. Limits									
Parameters		min	max	mean	sd	mean	sd	mean	sd
Iq+	uA		120	91.0	9.0	57.1	0	48.0	1.0
IQ+	mA		12	9.0	0.1	25	7	>128	-
VO/m	V	4.97		4.98	.01	4.95	.01	4.82	.02
VO/M	V		5.03	4.98	.01	4.94	.01	4.83	.02
VREF/m	V	3.0		4.26	0	4.26	0	4.26	0
VREF/M	mV		250	183	1	183	4	700	400
REG/1d	mV		5	2.1	0.3	4.6	1.5	13.0	1.2
REG/1n	mV		5	1.8	0.1	1.2	1.2	2.1	1.2
VDIF/m	mV		80	PASS		PASS		PASS	
=====									
		Anneal		Total Dose					
		168 hrs		200k					
Spec. Limits									
Parameters		min	max	mean	sd	mean	sd		
Iq+	uA		120	51.0	2.0	43.9	0.3		
IQ+	mA		12	>128	-	>128	-		
VO/m	V	4.97		4.84	.02	4.73	.03		
VO/M	V		5.03	4.85	.03	4.72	.02		
VREF/m	V	3.0		4.28	.01	4.26	0		
VREF/M	mV		250	355	130	over			
REG/1d	mV		5	6.93	.03	over			
REG/1n	mV		5	1.9	0.2	6.0	0.4		
VDIF/m	mV		80	PASS		PASS			
=====									

Notes:

1/ The mean and standard deviation values were calculated over the two parts irradiated in this testing. The control sample remained constant throughout the testing and is not included in this table.

2/ Table IV provides radiation characteristics of parts at selected total dose exposures and annealing treatments. The data at other radiation exposures and annealing treatments is available and can be obtained upon request.

Attachment 1 to SMMS96-052

SMMS TRAINING OUTLINE

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