JAN 27 1997 Sta. 37	ENGINEERING DATA TRANSMITTAL	Page 1 of 1 620245 1. EDT
------------------------	-------------------------------------	--

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) Remote Sensing and Sampling Equipment Engineering	4. Related EDT No.: NA
5. Proj./Prog./Dept./Div.: Characterization	6. Design Authority/ Design Agent/Cog. Engr.: RE Bauer	7. Purchase Order No.: NA
8. Originator Remarks: For approval		9. Equip./Component No.: NA
		10. System/Bldg./Facility: NA
11. Receiver Remarks: 11A. Design Baseline Document? ☐ Yes ☒ No		12. Major Assm. Dwg. No.: NA
		13. Permit/Permit Application No.: NA
		14. Required Response Date: 01/27/97

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	HNFDSDWMTP529	A11	0	Test Plan for Determining Breathing Rates in Single Shell Tanks Using Tracer Gases	Q	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 2. Release 5. Post-Review 3. Information 6. Dist. (Receipt Acknow. Required)	1. Approved 4. Reviewed no/comment 2. Approved w/comment 5. Reviewed w/comment 3. Disapproved w/comment 6. Receipt acknowledged	

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)											
(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
		Design Authority				1	1	Proj Mgr RE Bauer		S7-14	
		Design Agent				1	1	Proj. Eng. JA Andersen		B4-5	
		Cog.Eng.				1	1	Proj. Mgr. CE Hanson		S7-12	
		Cog. Mgr.				1	1	JL Huckaby		K6-80	
1	1	QA ML McElroy	<i>M. L. McElroy</i>	1-27-97	S7-07						
		Safety									
		Env.				3		Central Files		A3-80	

18. Signature of EDT Originator <i>Jim Andersen</i> 1-27-97	19. Authorized Representative/ Date for Receiving Organization <i>RE Bauer</i> 1/27/97	20. Design Authority/ Cognizant Manager <i>N/A</i>	21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments
--	---	---	--

Test Plan for Determining Breathing Rates in Single Shell Tanks Using Tracer Gases

J. A. Andersen

SGN Eurisys Services Corporation, Richland, WA 99352

U.S. Department of Energy Contract DE-AC06-87RL10930

EDT/ECN: 620245

UC: 2070

Org Code: S1200

Charge Code: N2012

B&R Code: EW3120074

Total Pages: 15

Key Words: Tracer gases, tanks, headspace

Abstract: This test plan specifies the requirements and conditions for the injection of tracer gases into twelve tanks. Of the twelve tanks only four have been assigned at this time; AX-103, BY-105, C-107, and U-103. The remaining tanks to be sampled will be assigned by Pacific Northwest National Laboratory (PNNL) at a later date in the study process, at that time this document shall be revised. The two inert tracer gases that will be injected are Helium (He) and Sulfur Hexafluoride (SF₆). The headspace of these tanks shall be sampled and analyzed periodically to obtain breathing rate information.

TRADEMARK DISCLAIMER. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

Printed in the United States of America. To obtain copies of this document, contact: WHC/BCS Document Control Services, P.O. Box 1970, Mailstop H6-08, Richland WA 99352, Phone (509) 372-2420; Fax (509) 376-4989.

Janis Bishop 1-27-97
Release Approval Date
Release Stamp

Approved for Public Release

**TEST PLAN FOR DETERMINING BREATHING
RATES IN SINGLE SHELL TANKS
USING TRACER GASES**

**J. A. Andersen
SGN Eurisys Services Corporation
January 1997**

TABLE OF CONTENTS

1.0 INTRODUCTION	2
2.0 BACKGROUND	2
3.0 DESCRIPTION OF TEST	3
4.0 TEST ITEMS	3
4.1 EQUIPMENT AND FACILITIES	4
4.2 DATA	4
5.0 DATA EVALUATION	4
6.0 EXPECTED RESULTS	4
7.0 TEST PROCEDURE	4
Figure 1	5
Figure 2	6
8.0 QUALITY ASSURANCE	9
9.0 SAFETY	9
10.0 REFERENCES	9
APPENDIX A	10

TEST PLAN FOR DETERMINING BREATHING RATES IN SINGLE SHELL TANKS (SST) USING TRACER GASES

1.0 INTRODUCTION

This test plan specifies the requirements and conditions for the injection of tracer gases into twelve tanks. Twelve single shell tanks shall be injected with inert tracer gases, Helium (He) and Sulfur Hexafluoride (SF₆), and sampled periodically to determine breathing rates. Of the twelve tanks only four have been assigned at the time this Test Plan was developed. The four tanks are AX-103, BY-105, C-107, and U-103. The remaining tanks to be sampled will be assigned by Pacific Northwest National Laboratory (PNNL) at a later date in the study process, at that time this document shall be revised. The headspace of these tanks shall be sampled and analyzed periodically to obtain information to estimate breathing rate.

The sampling of headspace for each of these tanks shall be performed using available risers or the Standard Hydrogen Monitoring System (SHMS) cabinet as available. The tank farm cognizant engineer shall assign the injection and sample testing point for each tank and document the point in the work package. SUMMATM canisters, equipped in-line with dual particulate air filters and two silica gel sorbent traps, will be used to collect the gas samples. The purpose of dual Particulate air filters is to ensure no radioactive particulates are transferred to the SUMMATM canisters. The silica gel sorbent traps will effectively eliminate any tritiated water vapor that may be present in the sample gas stream. PNNL shall supply the tracer gases injection system and shall perform the analysis on the headspace samples. TWRS Characterization project shall inject the tracer gases and perform the sampling. Refer to Engineering Task Plan HNF-SD-TWR-ETP-002 a detailed description of the responsibilities for this task.

2.0 BACKGROUND

The primary goal of this testing was to test the use of tracer gases to measure passive tank breathing rates. Proof of concept for tracer gas injection was to determine breathing rates and mixing characteristics was performed on tank S-102. Document WHC-SD-WM-TP-492 describes the process, of how the test was conducted. Tanks S-102 breathing rates were determined by measuring the concentration of the injected inert tracer gases, He and SF₆. The rate of decrease in the concentration of the tracer gases is directly related to the breathing rate. Preliminary results from the initial testing of tank S-102 indicate both tracer gases to be effective for determining breathing rates. Agreement between ventilation rates indicated by the two tracer gases was good, and consistent with hydrogen monitoring data analysis. While the results from tank S-102 are very promising, administrative delays in sampling prevented the completion of the comparison of helium and sulfur hexafluoride.

SUMMA is a trademark of Moletrics, Inc.

3.0 DESCRIPTION OF TEST

The He and SF₆ will be injected into the headspace of the designated tank through the assigned riser as appointed by the tank farm cognizant engineer. The flow rate of the tracer gases being injected into the tanks will be controlled to less than 28.3 L/min (1 CFM) by the use of an orifice. The flow rate of 28.3 L/min (1 CFM) will ensure that the tank is not over pressurized.

Prior to the tracer gas injection, a set of two baseline SUMMATM canister samples will be collected from the head space through the injection/sample point. These samples will become the baseline samples for that tank. Prior to the baseline samples being taken the system shall be purged using a Combustible Gas Meter (CGM) or Organic Vapor Monitor (OVM) for five minutes. Approximately 24 hours after the tracer gas injection is complete, another set of SUMMATM canister samples will be taken. These will be considered time zero samples. This procedure will be repeated at 7 day, 30 day, and 90 days after the tracer gases are injected, see section 7.C3 for detailed information concerning the sampling time line.

4.0 TEST ITEMS

Helium is inert (even in the radiation field of the headspace) and essentially insoluble in the waste. Helium is lighter than air, and should mix within the headspace similar to hydrogen. SF₆ is also very inert, but it may be ionized in the radiation field of the headspace. In contrast to He, SF₆ is heavier than air.

An advantage of SF₆ is that the range of measurable concentrations is very large. PNNL is set up to measure SF₆ concentrations between about 10 parts per trillion by volume (pptv) to 100 parts per billion by volume (ppbv), giving a usable concentration range of four orders of magnitude. This large range will allow less frequent sampling, greater flexibility in the sampling schedule, and a longer integrated measurement of the breathing rate. For example, if the initial concentration of SF₆ is 100 ppbv, and the breathing rate of the tank is a relatively large 5% per day, then even after 90 days the concentration of SF₆ would still be about 1000 pptv, and it wouldn't drop below the 10 pptv level until another 90 days had passed. The 100 ppbv concentration in a typical headspace would be obtained by introducing about 300 mL of SF₆.

By contrast, the measurable range for He concentrations is relatively small. Introducing about 283 L (10 ft³) of helium to a typical headspace would raise its concentration to about 100 ppmv. Because it is present in ambient air at about 4 ppmv, this would restrict its measurable range to only about a factor of 20. Though this would be ample if the breathing rate is due solely to barometric pressure fluctuation pumping (about 0.5% per day), in tanks where breathing is enhanced by other effects, the narrow measurement

range limits the useful lifetime of He. Larger quantities of He could be released into the headspaces, but that may entail logistical (e.g., delivery, mixing) complications.

4.1 EQUIPMENT AND FACILITIES

The equipment needed for testing only one tank is:

- Tracer gas injection system (Figure 1 & 2).
- 10 SUMMA™ Canisters, supplied by PNNL.
- 20 Silica gel sorbent traps (8 mm, 450 mg), supplied by vapor team.
- 10 Particulate air filters for SUMMA™ canisters, supplied by vapor team.

4.2 DATA

The test data that will be required is identified in the data sheet in Appendix A.

5.0 DATA EVALUATION

The evaluation and reporting of the data from the SUMMA™ canisters shall be performed by PNNL.

6.0 EXPECTED RESULTS

This testing and sampling will verify the breathing rates of passively ventilated single shell tanks (SSTs) for the target set of tanks. In addition, this effort will establish the upper and lower bounds of breathing rates for passively ventilated SSTs, in particular the hydrogen tanks. The testing will also determine which tanks tend to breath greater and less volume of air.

7.0 TEST PROCEDURE

Baseline Sample Procedure (Refer to Figure 1)

- 7.A1 Collect two SUMMA™ canister samples from the sample line per WHC-IP-1127, Sect. 4.11 (Appendix B) and steps 7.A2 through 7.A17. Record the date and time of sample collection in the data sheet in Appendix A.
- 7.A2 Connect a Single Ended, shut-off, quick disconnect body (Swagelok part #QC4) to the assigned attachment point for the sample.
- 7.A3 Connect (in series) two particulate air filters and two silica gel sorbent traps to the quick-disconnect installed on the sample line. The

Figure 1
Sampling Apparatus

Figure 2
Injection Apparatus

particulate air filters (F1) shall be closest to the riser with the silica gel sorbent traps (F2) on the down stream side of the air filters.

Note: The silica gel sorbent traps must be replaced after each SUMMA™ canister sample set.

- 7.A4 A short piece of c-flex should be placed on the downstream side of the silica gel sorbent traps (F2). This will allow for the quick connection between the CGM/OVM and SUMMA™ canisters.
- 7.A5 Connect the CGM/OVM to the c-flex.
- 7.A6 Open the sample line isolation valve, V1.
- 7.A7 Purge the sample line for 5 minutes using the CGM/OVM.
- 7.A8 Close the isolation valve, V1.
- 7.A9 Disconnect the CGM/OVM from the c-flex and connect the SUMMA™ canister downstream of the silica gel traps.
- 7.A10 Open isolation valve, V1.
- 7.A11 Collect the SUMMA™ sample per WHC-IP-1127, Sect. 4.11 (Appendix B).
- 7.A12 Close isolation valve, V1.
- 7.A13 Disconnect the canister from the c-flex and then connect the second canister.
- 7.A14 Open isolation valve, V1.
- 7.A15 Collect the second SUMMA™ sample per WHC-IP-1127, Sect. 4.11 (Appendix B).
- 7.A16 Close isolation valve, V1.
- 7.A17 Label and control the two SUMMA™ canister samples per Appendix A.

Tracer Gas Injection Procedure (Refer to Figure 2)

- 7.B1 Connect the tracer gas injection system to the sample line (as shown in figure 2) at connection C1.
- 7.B2 Open the valve (V6) located on the He cylinder and adjust the two stage regulator until the low pressure side of the regulator reads approximately 40 psig .
- 7.B3 Record the high pressure reading of the He cylinder in Appendix A.
- 7.B4 Open the isolation valve (V1) located on the riser.

- 7.B5 Open the valve (V3) at the outlet of the SF6 cylinder.
- 7.B6 Open the valve (V4) at the inlet of the SF6 cylinder.
- 7.B7 Open the valve (V5) at the outlet of the He cylinder. Record the date and time in the data sheet located in Appendix A.
- 7.B8 Close the valve (V6) located on the He cylinder when the high pressure reading decreases by approximately 250 psig. Record the high pressure reading and the time in Appendix A.
- 7.B9 Close the outlet valve (V5) on the He cylinder.
- 7.B10 Close the valve (V4) at the inlet of the SF6 cylinder.
- 7.B11 Close the valve (V3) at the outlet of the SF6 cylinder.
- 7.B12 Close the isolation valve (V1) and disconnect the tracer gas injection system.

Post Injection Sampling Procedure

- 7.C1 After approximately one day, replace the silica gel sorbent traps and dual particulate air filters (F1 and F2) and repeat steps 7.A1 through 7.A17.
- 7.C2 Collect two SUMMA™ canister samples from the sample point per WHC-IP-1127, Sect 4.11 (Appendix B) and steps 7.A1 through 7.A17. Record the date and time of sample collection in the data sheet in Appendix A.
- 7.C3 Repeat steps 7.C1 and 7.C2 to collect samples at the following approximate intervals:

- 7 days from the end of tracer gas injection
 - 30 days from the end of tracer gas injection
 - 90 days after tracer gas injection

Note: The time line that has been established is approximate. Sampling events are not required to take place on the exact date. There is flexibility built into each of these dates, the actual sampling date will be selected based on scheduling availability and the results of the previous sampling event. For example if the breathing rates of the one day sample were high, the seven day sample could be taken on day three. Conversely, if the one day sample showed low breathing rates the seven day sample could be taken on day ten.

- 7.C4 Record the date and time of sample collection in the data sheet in Appendix A.

7.C5 Label and control the SUMMA canister samples per Appendix A.

8.0 QUALITY.ASSURANCE

No QC hold points are required for this testing.

The PNNL Vapor Analytical Laboratory procedure's PNL-TVP-07 for SUMMA™ canister cleaning and PNL-TVP-02 for SUMMA canister shipping, receiving, and handling (chain-of-custody) shall be used. Analyses for He shall be performed by PNNL at a Quality Assurance Impact Level (QA-IL) Two by mass spectrometry. Analyses for SF6 shall also be performed by PNNL at a QA-IL Two by gas chromatography with electron capture detection (PNNL-SF6-97). Preliminary results shall be reported via electronic mail as they become available. The PNNL QA Plan is "FY97 Flammable Gas QA Plan" with document number MCS-027 rev. 2.

Quality assurance shall be required for the approval of the engineering task plan, test plan, and the work packages.

9.0 SAFETY

There is no anticipated safety impact with this testing. The tracer gas injection system has been setup so that it is not possible to over pressurize the tank and all sample will be protected from contamination by double Particulate air filters. The equipment being used for the testing is classified as "General Service" per WHC-CM-4-46, Sect 9.0. An unreviewed safety question (USQ) screening has been completed for this testing and will be included in the JCS work package.

10.0 REFERENCES

WHC-SD-WM-TP-492, Test Plan For Measuring The Breathing Rate of Tank S-102 By Use of Tracer Gases, by G. A. Barnes.

H-2-87275, Standard Hydrogen Monitoring System Drawing Index Tree

H-2-817851, Standard-B Hydrogen Monitoring System Piping and Instrument Diagram

H-2-85268, Single Heated Vapor Tube Installation

H-2-85270, Single Vapor Tube Spool Installation

APPENDIX A

A-1 RADIATION SCREENING

All vapor samples shall be maintained under chain-of-custody requirements by the Vapor Team (VT) while performing a radiological survey of certain items used during sampling. Surveys are conducted to assure compliance with Department of Transportation (DOT) shipping regulations and offsite laboratory acceptance criteria. If the limits in Table A are exceeded the survey samples will be re-counted every few days until the activity level drops below the limits in Table A. If the survey samples won't drop below limits in Table A (i.e., Cs-137), the program office will provide guidance to the VT for sample media handling (dispose, ship to PNNL as radioactive material, etc.).

The results from the radiation screening are submitted to and shall be evaluated by the VT to ensure the samples meet the analytical criteria specified in Table A. VT shall provide a Format II report to each analytical laboratory to specify survey results.

Table A. Limits For Acceptable Radionuclide

Activity Levels

Organization	Total α	Total β/γ	Total $\alpha/\beta/\gamma$	Units
PNNL Vapor Laboratory	< 5	< 15	N/A	pCi/g
WHC-CM-2-14	N/A	N/A	< 2000	pCi/g

A-2 SAMPLING OPERATIONS

VT shall provide unique sample label and identification numbers to the laboratories. Each sample identification number shall have the following format:

VXXXX-WYY-LLLL

where,

XXXX = unique number assigned to the sampling event,
 W = a letter code indicating the day of a multi-day sampling event,
 YY = a 2-digit sample code found in the data sheet at the end of this Appendix.
 LLLL = a special lab assigned code.

Once the sample collection media has been received by VT from the laboratory, it shall remain in the physical control of the custodian, locked in a secure area, or prepared for shipping with tamper evident tape under conditions specified on the chain-of-custody form and in accordance with laboratory operating procedure WHC-IP-1127(1.3) "Chain-of-Custody, Acceptance,

and Disposal.

Applicable operating procedures for the tank vapor space sampling activities are contained in the appropriate work package. Vapor samples, trip blanks, and field blanks are to be collected in accordance with operating procedure WHC-IP-1127 (4.1.1) "Collection of SUMMA Canister Samples; and shipped to the laboratory in accordance with Hazardous Material Packaging and Shipping, WHC-CM-2-14.

All sampling activities shall be documented in controlled field logbooks maintained by sampling personnel (VT) and shall contain, but are not limited to:

- identification of tank and riser number and photographs of the sample location in which the sampling is conducted,

- if any anomalies are observed, corresponding sample identification numbers, flow rates, pressures, temperatures, and other operational parameters affecting the sample,

- any conditions that the sampler may observe during the sampling event (i.e., odors, nearby machinery in operation, etc.),

- names and titles of personnel involved in the field activity and their responsibilities,

VT is responsible for documenting any problems and procedural changes affecting the validity of the sample in a controlled field notebook and shall enter this information in the comment section of the chain-of-custody form for addition to the data reports.

A-3 SAMPLE CUSTODIAN

The sample custodian is the designated VT cognizant scientist or assisting scientific technician, lead sampler, or laboratory scientist or technician who signs the received by block on the chain-of-custody form. Transfer of custodianship occurs when the custodian signs the relinquished by block on the chain-of-custody form and releases the sample(s) to the new custodian signature.

A-4 PHYSICAL CONTROL

Physical control of a sample includes being in the sight of the custodian, in a room which shall signal an alarm when entered, or locked in a cabinet.

A-5 FORMAT II REPORTING

Results of the Laboratory's radiological survey shall be reported by the VT as Format II reports to PNNL, listing the picocuries per sample (pCi/g/sample) for each sample submitted for analysis. This Format II report should also provide the sample collection sequence and volumes, verification of trip and field blank use, and any anomalous sampling conditions. This report is to accompany, if possible, the shipment of samples. Alternatively, this sampling report may be transmitted by FAX to PNNL within 48 hours after the samples have been shipped. The radiological survey must accompany the samples, or be transmitted before samples are shipped to PNNL.

DATA SHEET

		Sample No.	Date	Time	Recorded By
Sample Set 1		A01			
		A02			
Tracer Gas Injection:		N/A			
Start Pressure:		N/A			
Stop Pressure:		N/A			
Sample Set 2 (+24 HRS)		B01			
		B02			
Sample Set 3 (+7 Days)		C01			
		C02			
Sample Set 4 (+30 Days)		D01			
		D02			
Sample Set 5 (+90 Days)		E01			
		E02			