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

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Abstract: This test plan specifies the requirements and conditions for the injection of tracer gases into eight tanks. Eight single shell tanks shall be injected with inert tracer gas, Helium (He), and then samples taken periodically to measure breathing rates. The eight tanks to be tested are: A-101, AX-102, AX-103, BY-105, C-107, U-103 (tested once in the winter and will be tested once in the summer), and U-105. The headspace of these tanks shall be sampled and analyzed periodically to obtain breathing rate information.

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

J. A. Andersen
SGN Eurisys Services Corporation
June 1997
Revision 1

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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 gas (Helium (He)) into single shell tanks to determine breathing rates using periodic sampling. The eight tanks which have been selected for this Test Plan are A-101, AX-102, AX-103, BY-105, C-107, U-103 (U-103 is counted twice, once during the winter months and once during the summer), and U-105.

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 vapor cognizant engineer shall assign the injection and sample testing point for each tank and document the point in the field work package. SUMMATM canisters, equipped in-line with dual particulate air filters, 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.

Pacific Northwest National Laboratory (PNNL) shall supply the tracer gas injection system and shall perform the analysis on the headspace samples.

Tank Waste Remediation System (TWRS) Characterization Project Operations (CPO) shall inject the tracer gas and perform the sampling.

Refer to Engineering Task Plan HNF-SD-TWR-ETP-002 for a detailed description of the responsibilities for this task.

2.0 BACKGROUND

The primary goal of this activity is to use tracer gas to measure breathing rates of passively ventilated single shell tanks. Proof of concept for tracer gas injection was performed on tank S-102 to determine breathing rates and mixing characteristics. The testing of tank S-102 used Helium and Sulfur Hexafluoride (SF₆) as tracer gases. Results from the initial testing of tank S-102 indicated both tracer gases to be effective for determining breathing rates. Document WHC-SD-WM-TP-492 describes the testing process and how it was conducted. Subsequent testing in tanks AX-103 and C-107 revealed that SF₆ was not as reliable as helium as a trace gas and therefore use of SF₆ for breathing has been discontinued.

¹ SUMMATM trade mark of Molectrics, Inc.

Development and application of the tracer gas breathing rate measurement technique has been accomplished by following a series of planned tests. These tests and the test plan used to specify the test requirements are listed in Table 1, Document and Date of Test Sampling. It is anticipated that test specification for future breathing rate measurements will be by revision of this test plan.

Table 1. Document and Date of Testing Sampling.

Tank	Test Plan	Test Period
S-102	WHC-SD-WM-TP-492, Rev 0	9/96 – 2/97
U-103 (Winter Period)	HNF-SD-WM-TP-529, Rev 0	2/97 – 5/97
C-107	HNF-SD-WM-TP-529, Rev 0	2/97 - 4/97
BY-105	HNF-SD-WM-TP-529, Rev 0	2/97 – 5/987
AX-103	HNF-SD-WM-TP-529, Rev 0	2/97 – 3/97
AX-102	HNF-SD-WM-TP-529, Rev 1	6/97 – 8/97 (Planned)
A-101	HNF-SD-WM-TP-529, Rev 1	6/97 – 8/97 (Planned)
U-103 (Summer Period)	HNF-SD-WM-TP-529, Rev 1	7/97 – 8/97 (Planned)
U-105	HNF-SD-WM-TP-529, Rev 1	6/97 – 8/97 (Planned)

3.0 DESCRIPTION OF TEST

Helium will be injected into the headspace of the designated tank through the assigned riser as appointed by the vapor cognizant engineer. The flow rate of the tracer gas being injected into the tank will be controlled to less than 227 L/min (8 CFM) by the use of an orifice, which will be supplied by PNNL.

Prior to the tracer gas injection, a set of two baseline SUMMA™ 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).

Approximately 24 hours after the tracer gas injection is complete; another set of SUMMA™ canister samples will be taken. These will be considered time zero samples. This procedure will be repeated at 7days after the tracer gas is 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. Because it is present in ambient air at about 4 ppmv injection of enough gas to raise the initial

concentration to 2,000 ppmv would result in a measurable range spanning 3 orders of magnitude. This is adequate for the anticipated range of breathing rates. It is anticipated that a maximum 300 cubic feet of Helium would be required to reach the Helium concentration levels required by these tests.

4.1 EQUIPMENT AND FACILITIES

The equipment needed for testing each tank is:

Tracer gas injection system (Figure 1 & 2).

10 available SUMMA™ canisters supplied by PNNL.

10 Particulate air filters for SUMMA™ canisters supplied by CPO.

4.2 DATA

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

5.0 DATA EVALUATION

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

6.0 EXPECTED RESULTS

- 1) Injection of tracer gas will bring initial concentration close to target starting concentration.
- 2) Tracer gas concentration will decay with time as the tank breathes.
- 3) Measured ventilation rates will be in the range of 28.3 – 566 L/min (1-20 CFM).

7.0 TEST PROCEDURE

Baseline Sample Procedure (Refer to Figure 1)

- 7.A1 Collect two SUMMA™ canister samples from the sample line per field work package and steps 7.A2 through 7.A17. Record the date and start/stop times of sample collection in the data sheet in Appendix B.
- 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 to the quick-disconnect installed on the sample line. The particulate air filters (F1) shall be closest to the riser.

Figure 1
Sampling Apparatus

Figure 2
Injection Apparatus

- 7.A4 A short piece of c-flex should be placed on the downstream side of the dual particulate air filter (F1). 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. For the 24 hour sample only the purge shall be a minimum of 20 minutes. For all other sampling periods a 5 minute purge shall be used.
- 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 field work package.
- 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 field work package.
- 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 (V3) 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 B, in the Start Pressure area.

- 7.B4 Open the isolation valve (V1) located on the riser.
- 7.B5 Open the valve (V2) at the outlet of the He cylinder. Record the date and start/stop times in the data sheet located in Appendix B.
- 7.B6 The Helium cylinder contents shall be injected into the tank, valve (V3) located on the Helium cylinder shall be closed prior to the high pressure reading a display of 25 psig. Record the high pressure reading and the time in Appendix B, in the Stop Pressure area.
- A-101 Exception. The amount of Helium injected into tank A-101 will be less than an entire cylinder, the amount of Helium injected shall be specified in the field work package.
- 7.B7 Close the outlet valve (V2) on the He cylinder.
- 7.B8 Close the isolation valve (V1) and disconnect the tracer gas injection system.

Post Injection Sampling Procedure

- 7.C1 After approximately one day, replace the dual particulate air filters (Fl) and repeat steps 7.A1 through 7.A17.
- 7.C2 Collect two SUMMA™ canister samples from the sample point per field work package and steps 7.A1 through 7.A17. Record the date and start/stop times of sample collection in the data sheet in Appendix B.
- 7.C3 Label and control the SUMMA™ canister samples per Appendix A.
- 7.C4 Repeat steps 7.C1 and 7.C3 to collect samples at the following approximate intervals:

+7 days following tracer gas injection
+30 days following tracer gas injection
+90 days following tracer gas injection

The sampling intervals that have been described are only a guideline. The actual dates will vary depending on the previous sample set. If a tank is breathing a rate higher than anticipated the sampling interval will be adjusted accordingly, less number of days between sample sets. Conversely, a tank breathing at a slower rate than anticipated may have more days between sample sets then the guideline.

U-103 Winter Sample Exception

During the U-103 tracer gas sampling period there will be a push mode sample taken from U-103. One additional tracer gas sample will be taken to determine if push mode

sampling has any affect on tank breathing rates. As a result samples will be collected on the following timetable for U-103 winter samples only:

- +7 days following tracer gas injection
- +30 days following tracer gas injection (pre-push mode sample)
- +TBD days following tracer gas injection (post-push mode sample)
- +90 days following 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.

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. 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 samples 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, 1996, *Test Plan for Measuring the Breathing Rate of Tank S-102 by Use of Tracer Gases*, WHC-SD-WM-TP-492, Revision 0, Westinghouse Hanford Company, Richland, Washington

WHC, 1996, *Safety Analysis Manual*, WHC-CM-4-46, Revision 21, Westinghouse Hanford Company, Richland, Washington

PNNL, 1995, *Shipping, receiving, and Handling Procedure for PNL Waste Tank Samples*, PNL-TVP-07, Revision 1, Pacific Northwest National Laboratory, Richland, Washington

PNNL, 1994, *Cleaning SUMMA Canisters and the Validation of the Cleaning Process*, PNL-TVP-02, Revision 0, Pacific Northwest National Laboratory, Richland, Washington

PNNL, 1996, *QA Plan for PNNL Flammable Gas Project*, MCS-027, Revision 2, Pacific Northwest National Laboratory, Richland, Washington

Appendix A

Radiation Screening

A-1 RADIATION SCREENING

Characterization Project Operations (CPO) shall maintain all vapor samples under chain-of-custody requirements 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. See Radiation Survey Plan (RSP) in the field work package.

A-2 SAMPLING OPERATIONS

CPO 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 CPO has received the sample collection media 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.

Applicable operating procedures for the tank vapor space sampling activities are contained in the appropriate work package.

All sampling activities shall be documented in the field work package maintained by CPO and shall contain, but are not limited to:

- Identification of tank and riser number and photographs (as applicable) 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,

A2.1 U-103 WINTER SAMPLE NUMBERING

The sampling of U-103 may have an additional set of samples taken, this is based on the push mode samples being taken sometime during the tracer gas sampling period. Because there will be one additional sample set taken the U-103 sample numbering will be unique from the described sample numbering in this test plan. The sampling for U-103 will provide for a baseline sample, tracer gas injection, +24 hour, +7 day, +30 day (pre-push mode sample), floating sample (post-push mode sample), and +90 day sample. The numbering for the U-103 sampling will be as follows:

Sample Set 1	A01	
	A02	
Sample Set 2 (+24 HR)	B01	
	B02	
Sample Set 3 (+7 Days)	C01	
	C02	
Sample Set 4 (+30 Days)	D01	(Pre-Push Mode)
	D02	
Sample Set 5 (Floating)	E01	(Pre-Push Mode)
	E02	
Sample Set 6 (+90 Days)	F01	
	F02	

Appendix B Data Sheets

DATA SHEET

	Sample No.	Date	Time		Recorded By
			Start	Stop	
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				