**ENGINEERING CHANGE NOTICE**

2. ECN Category (mark one)  
- Supplemental  
- Direct Revision  
- Change ECN  
- Temporary  
- Standby  
- Supersede  
- Cancel/Void

3. Originator's Name, Organization, MSIN, and Telephone No.  
JA Andersen, 08E00, B4-51, 376-1327

4. USQ Required?  
Yes  
No

5. Date  
06/10/97

6. Project Title/No./Work Order No.  
Safety Programs

7. Bldg./Sys./Fac. No.  
2006

8. Approval Designator  
Q

9. Document Numbers Changed by this ECN (includes sheet no. and rev.)  
HNF-SD-WM-TP-529, REV. 0

10. Related ECN No(s).  
NA

11. Related PO No.  
NA

12a. Modification Work  
[ ] Yes (fill out Blk. 12b)  
[ X] No (NA Blks. 12b, 12c, 12d)

12b. Work Package No.  
NA

12c. Modification Work Complete  
NA

12d. Restored to Original Condition (Temp. or Standby ECN only)  
NA

Design Authority/Cog. Engineer Signature & Date

13a. Description of Change  
COMPLETE RE-WRITE

13b. Design Baseline Document?  
[ ] Yes  
[ X] No

14a. Justification (mark one)  
- Criteria Change  
- Design Improvement  
- Environmental  
- Facility Deactivation

- As-Found  
- Facilitate Const  
- Const. Error/Omission  
- Design Error/Omission

14b. Justification Details

Updating test plan to include the second set of tanks to be tested for breathing rates.

15. Distribution (include name, MSIN, and no. of copies)  
JA Andersen B4-51 ML McElroy S7-07  
JL Huckaby K6-80 RE Bauer S7-14  
GS Caprio S3-90 CE Hanson S7-12  
DD Wanner S7-12 Central Files A3-88
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19. 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 13. Enter the affected document number in Block 20.

- Seismic/Stress Analysis
- Stress/Design Report
- Interface Control Drawing
- Calibration Procedure
- Installation Procedure
- Maintenance Procedure
- Engineering Procedure
- Operating Instruction
- Operating Procedure
- Operational Safety Requirement
- IED Drawing
- Call Arrangement Drawing
- Essential Material Specification
- Fac. Proc. Samp. Schedule
- Inspection Plan
- Inventory Adjustment Request
- Complete revision

20. 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.

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DEPARTMENT OF ENERGY
Signature or a Control Number that tracks the Approval Signature

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

JA Andersen
SGN Eurisy Services Corporation, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 640493    UC: 2070
Org Code: OBEOO   Charge Code: N2012
B&R Code: EW3120074    Total Pages: 22

Key Words: Breathing rates, tracer gas, single shell tanks, risers, headspace.

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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Approved for Public Release

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

**Document Number**
HNF-SD-WM-TP-529, REV 1

**Page**
1

**Revision**
0

**Description of Change**
- Replace, Add, and Delete Pages EDJ-520245, 7/27/97
- COMPLETE RE-WRITE ECN-640493 and Inc. ECNs-640415, 640419, 640433 & 639145

**Authorized for Release**
JA ANDERSEN RE BAUER 07/14/97

**Cog. Engr.**
JA ANDERSEN

**Cog. Mgr.**
RE BAUER

**Date**
07/14/97
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 at the time this Test Plan was developed 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. Other tanks to be sampled will be assigned by Pacific Northwest National Laboratory (PNNL) at a later date in the study process as resources allow, the document shall be revised as required.

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 vapor cognizant engineer shall assign the injection and sample testing point for each tank and document the point in the field work package. SUMMA™ 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 SUMMA™ 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 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.

Development and application of the tracer gas breathing rate measurement technique has been accomplished by following a series of planned test. These tests and the test plan used to specify

---

1 SUMMA™ trade mark of Moletrics, Inc.
the test requirements are listed in Table 1. It is anticipated that test specification for future breathing rate measurements will be by revision of this test plan.

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<tr>
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<th>Test Plan</th>
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<td>HNF-SD-WM-TP-529, Rev 0</td>
<td>2/97 - 5/97</td>
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3.0 DESCRIPTION OF TEST

Helium will be injected into the headspace of the designated tank through the assigned riser as appointed by the tank farm 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.

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) for five minutes. 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 7 days 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.
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.
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 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 LO-80-403 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 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.
Figure 1
Sampling Apparatus

- F1 Dual Particulate Air Filter
- F2 Silica Gel Sorbent Trap
- C1 Quick Disconnect
- F2 Silica Gel Sorbent Trap
- V1 Isolation Valve
- Assigned Riser
- Tubing C-Flex Connector
- CGM/OVM
- SUMMA
- V2 Valve
Figure 2
Injection Apparatus

R1 Regulator

Flow Orifice

V2 He Outlet

V3 He Tank Valve

V1 Isolation Valve

C1 Quick Disconnect

Assigned Riser
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 SUMMATM 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 SUMMATM canister downstream of the silica gel traps.


7.A11 Collect the SUMMATM sample per LO-80-403.


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 SUMMATM sample per LO-80-403.


7.A17 Label and control the two SUMMATM 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.

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 time 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 A.

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 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 LO-80-403 and steps 7.A1 through 7.A17. Record the date and time of sample collection in the data sheet in Appendix B.

7.C3  Repeat steps 7.C1 and 7.C2 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.

7.C4 Record the date and time of sample collection in the data sheet in Appendix A.
7.C5 Label and control the SUMMATM 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 SUMMATM canister cleaning and PNL-TVP-02 for SUMMATM 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


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

Appendix A

Radiation Screening
A-1 RADIATION SCREENING

The Vapor Team (VT) 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. 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

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<td>$&lt; 2000$</td>
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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.
LLL = 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 LO-90-450 "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 LO-80-403 "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.

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

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 that 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.
Appendix B
Data Sheets
## DATA SHEET

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U-103 Winter Sampling Only

## DATA SHEET

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