

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	J. W. Osborne	Date May 31, 1995
Project Title/Work Order		EDT No.
Tank 241-C-109 Vapor Sampling and Analysis Tank Characterization Report (WHC-SD-WM-ER-424)		ECN No. 623547

Name	MSIN	Text With All Attach.	Text Only	Attach./Appendix Only	EDT/ECN Only
<u>RL</u>					
S. O. Branch	S7-54	X			
C. R. Briggs	A5-55	X			
P. R. Hernandez	S7-54	X			
M. F. Jarvis	S7-54	X			
T. Noble	S7-54	X			
C. O. Olaiya	S7-54	X			
J. F. Thompson	S7-54	X			
<u>ECOLOGY</u>					
A. B. Stone	B5-18	X			
<u>MACTEC</u>					
J. P. Haney	S7-73	X			
S. T. Murff	S7-73	X			
<u>PNL</u>					
J. S. Fruchter	K6-96	X			
S. C. Goheen	P8-08	X			
J. L. Huckaby	K6-80	X			
M. W. Ligothke	P7-59	X			
<u>WHC</u>					
Central Files	L8-04	X			
H. Babad	S7-30	X			
D. R. Bratzel	S7-31	X			
D. R. Carls	R3-01	X			
R. J. Cash	S7-15	X			
G. T. Dukelow	S7-15	X			
S. J. Eberlein	R2-12	X			
L. F. Ermold	S7-84	X			
E. R. Hewitt	R3-01	X			
G. D. Johnson	S7-15	X			
T. J. Kelley	S7-30	X			
N. W. Kirch	R2-11	X			
J. G. Kristofzski	T6-06	X			
J. W. Lentsch	S7-15	X			
E. J. Lipke	S7-15	X			
N. G. McDuffie	S7-15	X			
J. E. Meacham	S7-15	X			
R. D. Mitchell	R3-01	X			
M. A. Payne	S7-84	X			
D. A. Turner	S7-15	X			
O.S.T.I. (2)	L8-07	X			

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, make any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. 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. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN **No 623547**

Proj. ECN

2. ECN Category (mark one) Supplemental <input type="checkbox"/> Direct Revision <input checked="" type="checkbox"/> Change ECN <input type="checkbox"/> Temporary <input type="checkbox"/> Standby <input type="checkbox"/> Supersedure <input type="checkbox"/> Cancel/Void <input type="checkbox"/>	3. Originator's Name, Organization, MSIN, and Telephone No. J. W. Osborne/Vapor Sampling/S7-15/3-5379		3a. USQ Required? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	4. Date May 31, 1995
	5. Project Title/No./Work Order No. Vapor Sampling		6. Bldg./Sys./Fac. No. 200 Gen	7. Approval Designator N/A
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-ER-424, Rev 0		9. Related ECN No(s).	10. Related PO No. N/A
11a. Modification Work <input type="checkbox"/> Yes (fill out Blk. 11b) <input checked="" type="checkbox"/> 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 Addition of caveat regarding Oak Ridge National Laboratory quality assurance assessment in the organic vapor chapter. Minor editorial changes also.				
13a. Justification (mark one) Criteria Change <input type="checkbox"/> Design Improvement <input type="checkbox"/> Environmental <input type="checkbox"/> Facility Deactivation <input type="checkbox"/> As-Found <input type="checkbox"/> Facilitate Const <input type="checkbox"/> Const. Error/Omission <input type="checkbox"/> Design Error/Omission <input checked="" type="checkbox"/>				
13b. Justification Details New information regarding Oak Ridge National Laboratory analytical results pertaining to document was added.				
14. Distribution (include name, MSIN, and no. of copies) See attached distribution sheet			RELEASE STAMP OFFICIAL RELEASE <input checked="" type="checkbox"/> BY WHC DATE MAY 31 1995 	

RELEASE AUTHORIZATION

Document Number: WHC-SD-WM-ER-424, REV 1

Document Title: Tank 241-C-109 Vapor Sampling and Analysis Tank Characterization Report

Release Date: 5/31/95

This document was reviewed following the procedures described in WHC-CM-3-4 and is:

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:


Kara M. Broz

May 31, 1995

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.

This report has been reproduced from the best available copy. Available in paper copy and microfiche. Printed in the United States of America. Available to the U.S. Department of Energy and its contractors from:

U.S. Department of Energy
Office of Scientific and Technical Information (OSTI)
P.O. Box 62
Oak Ridge, TN 37831
Telephone: (615) 576-8401

Available to the public from:

U.S. Department of Commerce
National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161
Telephone: (703) 487-4650

SUPPORTING DOCUMENT

1. Total Pages 19

2. Title

Tank 241-C-109 Vapor Sampling and Analysis Tank Characterization Report

3. Number

WHC-SD-WM-ER-424

4. Rev No.

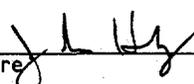
1

5. Key Words

241-C-109, Headspace vapor samples, organic analytes, VSS, SUMMA™, inorganic gases and vapors

6. Author

Name: J. L. Huckaby

Signature 

Organization/Charge Code

75600/N4AB1

7. Abstract

Tank 241-C-109 headspace gas and vapor samples were collected and analyzed to help determine the potential risks to tank farm workers due to fugitive emissions from the tank. The drivers and objectives of waste tank headspace sampling and analysis are discussed in "Program Plan for the Resolution of Tank Vapor Issues" (Osborne and Huckaby 1994). Tank 241-C-109 was vapor sampled in accordance with "Data Quality Objectives for Generic In-Tank Health and Safety Issue Resolution (Osborne et al., 1994).

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. 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. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

8. RELEASE STAMP

OFFICIAL RELEASE	(2)
BY WHC	
DATE	MAY 31 1995
	<i>St 4</i>

Tank 241-C-109 Vapor Sampling and Analysis Tank Characterization Report

X.0 INTRODUCTION

Tank C-109 headspace gas and vapor samples were collected and analyzed to help determine the potential risks to tank farm workers due to fugitive emissions from the tank. The drivers and objectives of waste tank headspace sampling and analysis are discussed in *Program Plan for the Resolution of Tank Vapor Issues* (Osborne and Huckaby 1994). Tank C-109 was vapor sampled in accordance with *Data Quality Objectives for Generic In-Tank Health and Safety Issue Resolution* (Osborne et al. 1994).

X.1 SAMPLING EVENT

Headspace gas and vapor samples were collected from tank C-109 using the vapor sampling system (VSS) on August 10, 1994 by WHC Sampling and Mobile Laboratories (WHC 1995). Sample collection and analysis were performed as directed by the sample and analysis plan (WHC 1995, Appendix A). The tank headspace temperature was determined to be 27 °C. Air from the tank C-109 headspace was withdrawn via a 7.9 m-long heated sampling probe mounted in riser 4, and transferred via heated tubing to the VSS sampling manifold. All heated zones of the VSS were maintained at approximately 50 °C.

Sampling media were prepared and analyzed by WHC, Oak Ridge National Laboratories (ORNL), Pacific Northwest Laboratories (PNL), and Oregon Graduate Institute of Science and Technology (OGIST) through a contract with Sandia National Laboratories. The 39 tank air samples and 2 ambient air control samples collected are listed in Table X-1 by analytical laboratory. Table X-1 also lists the 16 trip blanks provided by the laboratories.

A general description of vapor sampling and sample analysis methods is given by Huckaby (1995). The sampling equipment, sample collection sequence, sorbent trap sample air flowrates and flow times, chain of custody information, and a discussion of the sampling event itself are given in WHC 1995 and references therein.

X.2 INORGANIC GASES AND VAPORS

Analytical results of sorbent trap and SUMMA^{TM,1} canister tank air samples for selected inorganic gases and vapors are given in Table X-2 in parts per million by volume (ppmv). Inorganic analyte sorbent traps were prepared and analyzed by PNL. SUMMATM canisters were analyzed for inorganic analytes by

¹ SUMMA is a trademark of Molectrics, Inc., Cleveland, Ohio.

OGIST. Reports by PNL (Pool et al. 1995) and OGIST (Rasmussen 1994) describe sample preparation and analyses.

The small relative standard deviations of the results, given in the last column in Table X-2, indicate the precision of reported results is good. Relative standard deviations range from 0.6 % for nitrous oxide results, to 18 % for nitric oxide results. The precision reported depends both on sampling parameters (e.g., sample flow rate and flow time for sorbent traps) and analytical parameters (e.g., sample preparation, dilutions, etc.), and the small relative standard deviations suggest a high degree of control was maintained both in the field and in the laboratories.

X.2.1 Ammonia, Hydrogen, and Nitrous Oxide

The reported ammonia concentration, 10.1 ppmv, is lower than the National Institute of Occupational Safety and Health (NIOSH) 8-hr recommended exposure limit (REL) of 25 ppmv (NIOSH 1995). Ammonia concentrations have typically been observed to be higher than this level in the waste tank headspaces. The relatively low ammonia concentration in tank C-109 may be related to the fact that only a small quantity of relatively cool waste is stored in tank C-109.

Hydrogen and nitrous oxide are commonly detected gases in the waste tanks. Believed to be products of chemical reactions and radiolysis of the waste, they have been found above the 1 ppmv level in virtually all the tank headspaces sampled to date. In general, hydrogen is of concern as a fuel. The measured 125 ppmv of hydrogen in tank C-109, however, represents only about 0.3 % of the lower flammability limit (LFL) for hydrogen in air, and is not a flammability concern at this level. The nitrous oxide concentration in tank C-109, 369 ppmv, is almost 15 times the NIOSH 8-hr REL of 25 ppmv (NIOSH 1995).

X.2.2 Carbon Dioxide and Carbon Monoxide

The average measured headspace carbon dioxide concentration, 3 ppmv, is markedly lower than normal ambient air concentrations of about 400 ppmv, and is the lowest measured in any waste tank to date. Little data on waste tank headspace carbon dioxide concentrations is available, but lower than ambient concentrations are expected. Carbon dioxide introduced by air exchange with the atmosphere is readily absorbed by caustic supernatant and interstitial liquids of the waste tanks, and converted to carbonate in solution. It is reasonable to expect the level of carbon dioxide in a tank headspace will therefore depend on the tank's breathing rate, and the pH and surface area of aqueous waste (i.e., supernate, interstitial liquid, and condensate) in the tank. For comparison, the carbon dioxide concentrations of the cascaded tanks BY-104, BY-105, and BY-106 are 10.5 ppmv, 94 ppmv, and 47.6 ppmv, respectively (Rasmussen 1994b, 1994c, 1994d).

Carbon monoxide in the tank C-109 headspace, at about 0.41 ppmv, is at a higher concentration than is usually found in ambient air, where it typically ranges from 0.05 to 0.15 ppmv. Elevated waste tank headspace carbon monoxide

concentrations are common (e.g., carbon monoxide concentration in tank C-103 was 26.7 ppmv, Huckaby and Story 1994), and are thought to be due to the decomposition of organic waste in the tanks.

X.2.3 Nitric Oxide, Nitrogen Dioxide, Water and Tritium

Nitric oxide and nitrogen dioxide concentrations in the tank C-109 headspace were determined to be 0.51 ppmv and ≤ 0.06 ppmv, respectively. These are both acid gases that would have very low equilibrium concentrations above the high pH sludge in tank C-109. The measurable presence of nitric oxide may be due to its formation from oxygen and nitrogen in the radiation field of the headspace. The NIOSH 8-hr REL is 25 ppmv for nitric oxide, and the 15-minute short term exposure limit (STEL) for nitrogen dioxide is 1 ppmv.

The water vapor concentration of tank C-109 was determined to be about 20.4 mg/L, at the tank headspace temperature of 27 °C and pressure of 992 mbar (744 torr), (WHC 1995). This corresponds to water vapor partial pressure of 28.2 mbar (21.2 torr), to a dew point of 23.1 °C, and to a relative humidity of 79 %.

Silica gel sorbent traps were used to sample for tritium. It is assumed that tritium produced by the waste combines with hydroxide ions to form tritium-substituted water. Evaporation of the tritium-substituted water would then result in airborne radioactive contamination. Silica gel sorbent traps adsorb virtually all (normal and tritium-substituted) water vapor from the sampled tank air, and are analyzed at the WHC 222-S laboratory. Analysis of the silica gel indicated the total activity of the headspace to be below 50 pCi/L (WHC 1995).

X.3 ORGANIC VAPORS

Organic vapors in the tank C-109 headspace were sampled using SUMMA™ canisters, which were analyzed at PNL, and triple sorbent traps (TSTs), which were analyzed by ORNL. None of the positively or tentatively identified organic analytes were at or above levels of concern. Both laboratories used gas chromatography and mass spectrometry to separate, identify, and quantitate the analytes. Descriptions of sample device cleaning, sample preparations, and analyses are given by Jenkins et al. (1994) and Pool et al. (1995). A quantitative measurement of the total organic vapor concentration by the U.S. Environmental Protection Agency (EPA) task order 12 (TO-12) method was also performed by OGIST (EPA 1988, Rasmussen 1994a).

SUMMA™ sample results should be considered to be the primary organic vapor data for tank C-109. ORNL analyses of TST samples from this and other waste tanks generally agree with, support, and augment the SUMMA™ sample results. However, because certain WHC quality assurance requirements were not satisfied by ORNL, the quality assurance assessment of ORNL by Hendrickson (1995) should be reviewed before results unique to the TST samples are used for decision making.

X.3.1 Positively Identified Organic Analytes

ORNL positively identified and quantitated 17 of 27 analytes selected by WHC, (10 analytes were below detection limits). These analytes, and their average concentrations from the analysis of 4 TSTs, are given in Table X-3. The 27 TST target analytes for tank C-109 were based on the tank C-103 target analytes, which were selected by a PNL panel of toxicology experts as being of potential toxicological concern (Mahlum et al. 1994). Of the 17 analytes positively identified by ORNL, only acetone and 1-butanol were within the calibration range of the method. The acetonitrile concentration was above the upper calibration limit, and the other 14 positively identified analytes were below the lower calibration limit. These concentrations are known with much greater certainty than the concentrations of tentatively identified compounds in Table X-5, but are not technically quantitative.

Also given in Table X-3 are the organic compounds positively identified and quantitated in SUMMA™ canister samples by PNL and OGIST. PNL performed analyses according to the EPA TO-14 methodology (EPA 1988, Pool et al. 1995). Only 1 of the 40 TO-14 analytes was observed to be above the 0.002 ppmv quantitation limit of the analyses (Pool et al. 1995 provide the complete TO-14 analyte list). The results for methane are those of OGIST (Rasmussen 1994a). Averages reported are from analyses of 3 SUMMA™ canister samples.

Three target analytes were common to both the ORNL and PNL analyses: dichloromethane, benzene, and toluene. Neither ORNL nor PNL detected dichloromethane. ORNL detected trace amounts of benzene and toluene, but these were both below the limit of detection of PNL (0.002 ppbv).

The 2 most abundant analytes in Table X-3 are methane and acetonitrile. At 0.927 ppmv, the methane concentration in tank C-109 is above ambient levels, which are typically about 0.2 ppmv. Elevated methane concentrations have been observed in other waste tank headspaces, and methane is probably formed during the chemical and radiolytic degradation of organic wastes. For methane, 1 ppmv corresponds to roughly 0.002 % of its LFL. Acetonitrile, at 0.26 ppmv, similarly presents virtually no flammable risk, and is well below its NIOSH 8-hour REL of 20 ppmv.

X.3.2 Tentatively Identified Organic Analytes

In addition to targeted analytes, both ORNL and PNL analytical procedures allow the tentative identification of other organic vapors. By the nature of the samples and their analysis, virtually all 3 to 15 carbon organic compounds present in the tank headspace above analytical detection limits are observable. The PNL list of tentatively identified compounds, with estimated concentrations, is given in Table X-4, and the ORNL list of tentatively identified compounds, and their estimated concentrations, is given in Table X-5. Estimated concentrations are in mg/m³, based on dry air at 0 °C and 1.01 bar.

Both ORNL and PNL tentatively identify analytes by comparing the MS molecular fragmentation patterns with a library of known MS fragmentation patterns. This method allows an organic analyte to be identified (with reasonable certainty) as an alkane, a ketone, an aldehyde, etc., and also determines its molecular weight (which specifies the number of carbon atoms in the molecule). The method usually does not, however, allow the unambiguous identification of structural isomers, and this ambiguity increases with analyte molecular weight. Entries in Table X-5, particularly near the bottoms of the table where the analytes have higher molecular weights, illustrate this.

The PNL and ORNL methods used to tentatively identify and estimate concentrations are described by Jenkins et al. (1994) and Pool et al. (1995), respectively, and should be reviewed before this data is used for decision making. Results in Tables X-4 and X-5 are presented in terms of observed peaks, and are not adjusted for the occurrence of split chromatographic peaks (e.g., Compd # 12 and 13 in Table X-5). In these instances, the estimated concentration of a compound appearing as a doublet or triplet is simply the sum of the individual peak estimates.

Concentrations given in Tables X-4 and X-5 should be considered rough estimates. The proper quantitation of all observed analytes is outside the scope and budget of these analyses, and the estimation of concentrations involves several important assumptions. The validity of each assumption depends on the analyte, and such factors as the specific configuration of the analytical instrumentation.

X.3.3 Total Nonmethane Organic Compounds

OGIST measured the total nonmethane organic compound (TNMOC) concentration in 3 SUMMA™ canister samples using the EPA TO-12 method (Rasmussen 1994a). The sample mean was 0.65 mg/m³, with a standard deviation of 0.03 mg/m³. Though data on other tanks is very limited, this value is low compared to most other waste tanks sampled to date. For comparison, the TNMOC concentration in clean ambient air may range from 0.030 to 0.100 mg/m³.

X.3.4 Discussion of Organic Analytes

In general, the organic analytes observed in the waste tank headspaces are indicative of the types of organic waste that have been stored in each tank. Examination of the data provides clues to both the current organic constituents and the chemical reactions that they undergo.

Some of the compounds listed in Tables X-3, X-4, and X-5 were introduced to the tank with process waste streams, and are detected in the headspace because the original inventory has not been completely evaporated or degraded. Examples of these are tributyl phosphate, which was used as an extractant in several Hanford processes; dibutyl butylphosphonate, which was a contaminant of tributyl phosphate; and the semivolatile normal paraffinic hydrocarbons (NPHs), (i.e., n-undecane, n-dodecane, n-tridecane, and n-pentadecane) that were used as a diluent for tributyl phosphate.

Notably absent from the tank C-109 headspace are the semivolatile cyclic alkanes (e.g., methylated decahydronaphthalenes, cyclopentanes, and cyclohexanes) that have been observed in the 241-BY tank farm. This suggests that, like tank C-103, the semivolatile organic waste in tank C-109 may be from the Plutonium Uranium Extraction (PUREX) process, which in the late 1960's used a relatively pure form of semivolatile NPHs as a process diluent.

Most of the compounds in Tables X-3, X-4, and X-5 are believed to be chemical reaction and radiolytic reaction products of the semivolatile or nonvolatile organic waste stored in the tank. For example, 1-butanol is known to be formed by the hydrolysis of tributyl phosphate, and it has been suggested that the alcohols, aldehydes, ketones, nitriles, alkenes, and short chain alkanes are all degradation products of NPHs.

Examination of the compounds listed in Tables X-3, X-4 and X-5 suggests many of the volatile species (presumed to be degradation products of the NPHs) have functional groups on the molecule's first or second carbon atom. For example, most alcohols are 1-alkanols, and ketones generally have the double bonded oxygen atom on the second carbon atom.

Though their concentrations are not significant, many alcohols and acids were tentatively identified by ORNL (Table X-5). These have generally not been observed to be as numerous in other NPH-rich tank headspaces, which tend to be dominated by aldehydes, ketones, alkanes, and alkenes.

Table X-1
Tank C-109 Gas and Vapor Sample Type and Number

Laboratory	Sampling Device	Nominal Sample Volume (L)	Target Analytes	Number of Samples
Oak Ridge National Laboratories	Triple Sorbent Trap	1.0 and 4.0	Organic vapors	8 tank air samples + 2 trip blanks
Oregon Graduate Institute of Science and Technology	SUMMA™ canister	6.0	Hydrogen, Nitrous Oxide, Carbon Dioxide, Carbon Monoxide	3 tank air samples
Pacific Northwest Laboratories	Acidified Carbon Sorbent Trap	3.0	Ammonia	6 tank air samples + 3 trip blanks
	Triethanolamine Sorbent Trap	3.0	Nitrogen Dioxide	6 tank air samples + 3 trip blanks
	Oxidation bed + Triethanolamine Sorbent Trap	3.0	Nitric Oxide	6 tank air samples + 3 trip blanks
	Silica Gel Sorbent Trap	3.0	Water vapor	6 tank air samples + 3 trip blanks
	SUMMA™ canister	6.0	Organic vapors	3 tank air samples + 2 ambient air samples
WHC 222-S Laboratory	Silica Gel Sorbent Trap	1.0	Tritium-Substituted Water Vapor	1 tank air sample

Table X-2
Tank C-109 Inorganic Gas and Vapor Concentrations

Compound	CAS ¹ number	Sample Type	Number of samples	Average (ppmv)	Standard Deviation (ppmv)	RSD ² (%)
Ammonia, NH ₃	7664-41-7	Sorbent Trap	6	10.1	0.8	8
Carbon Dioxide, CO ₂	124-38-9	SUMMA™	3	3	≤ 0.3	≤ 10
Carbon Monoxide, CO	630-08-0	SUMMA™	3	0.41	0.01	2
Hydrogen, H ₂	1333-74-0	SUMMA™	3	125	0.6	0.5
Nitric Oxide, NO	10102-43-9	Sorbent Trap	6	0.51	0.09	18
Nitrogen Dioxide, NO ₂	10102-44-0	Sorbent Trap	6	≤ 0.06	--	--
Nitrous Oxide, N ₂ O	10024-97-2	SUMMA™	3	369	2	0.6
Water Vapor, H ₂ O	7732-18-5	Sorbent Trap	6	28,400 (20.4 mg/L)	1,100 (0.8 mg/L)	4

1. CAS = Chemical Abstracts Service.

2. RSD = relative standard deviation.

Table X-3
 Tank C-109 Positively Identified Organic Compound Average Concentrations

Compound	CAS ¹ number	Sample Type	Average (ppmv)	Standard Deviation (ppmv)	RSD ² (%)
Methane	74-82-8	SUMMA ^{TM,3,4}	0.927	0.006	0.6
Trichlorofluoromethane	75-69-4	SUMMA TM	0.0071	0.00005	0.7
Acetonitrile ⁵	75-05-8	TST	0.26	0.04	15
Acetone	67-64-1	TST	0.012	0.006	53
Propanenitrile ⁵	107-12-0	TST	0.0013	0.0009	73
Butanal ⁵	123-72-8	TST	0.0015	0.0010	70
Benzene ⁵	71-43-2	TST SUMMA TM	0.00013 < 0.002	0.00012 --	98 --
1-Butanol	71-36-3	TST	0.0032	0.0023	71
Butanenitrile ⁵	109-74-0	TST	0.00020	0.00014	70
2-Pentanone ⁵	107-87-9	TST	0.00049	0.00036	73
Toluene ⁵	108-88-3	TST SUMMA TM	0.000019 < 0.002	0.000039 --	200 --
2-Hexanone ⁵	591-78-6	TST	0.00012	0.00009	72
Octane ⁵	111-65-9	TST	0.000069	0.000056	81
2-Heptanone ⁵	110-43-0	TST	0.000084	0.000057	68
Nonane ⁵	111-84-2	TST	0.00011	0.00006	52
2-Octanone ⁵	111-13-7	TST	0.000063	0.000042	67

Compound	CAS ¹ number	Sample Type	Average (ppmv)	Standard Deviation (ppmv)	RSD ² (%)
Nonanenitrile ⁵	2243-27-8	TST	0.000010	0.000021	200
Dodecane ⁵	112-70-3	TST	0.00026	0.00006	23
Tridecane ⁵	629-50-5	TST	0.00047	0.00008	18
Sum of nonmethane positively identified compounds:			0.29		

1. CAS = Chemical Abstract Service.
2. RSD = relative standard deviation.
3. Methane analyses by OGIST (Rasmussen 1994a), all other SUMMATM canister results by PNL (Pool et al. 1995).
4. SUMMATM canister results based on analyses of 3 samples.
5. Two or more samples fell outside of calibration range.

Table X-4
Tank C-109 Tentatively Identified Organic Compounds in SUMMA™ Samples

Cmpd #	Compound	CAS ¹ number	Average (mg/m ³)	Standard Deviation (mg/m ³)
1	Acetonitrile	75-05-8	0.15	0.01
2	Acetone	67-64-1	0.05	0.00
3	Alkyl nitrate	598-58-3	0.12	0.00
Sum of tentatively identified compounds:			0.31	

1. CAS = Chemical Abstracts Service.

Table X-5
Tank C-109 Tentatively Identified Organic Compounds in TST Samples

Cmpd #	Compound	CAS ¹ Number	Average (mg/m ³)	Standard Deviation (mg/m ³)
1	Acetaldehyde and CO ₂	75-07-0	0.007	0.013
2	CO ₂ and argon	124-38-9 7440-37-1	0.010	0.020
3	Methane, trichlorofluoro-	75-69-4	0.006	0.012
4	Fluoroethylene		0.412	0.128
5	Nirtic acid, ethyl ester	625-58-1	0.007	0.005
6	Acetic acid	64-19-7	0.018	0.021
7	Nitric acid, propyl ester	627-13-4	0.004	0.005
8	Unknown		0.003	0.004
9	Siloxane		0.003	0.006
10	Hexanal	66-25-1	0.001	0.003
11	Butanoic acid	107-92-6	0.007	0.010
12	Hexamethylcyclotrisiloxane	541-05-9	0.017	0.034
13	Cyclotrisiloxane, hexamethyl-	541-05-9	0.005	0.010
14	Heptanal	111-71-7	0.002	0.001
15	Unknown		0.002	0.001
16	Hexanoic acid	142-62-1	0.002	0.002
17	Cyclotetrasiloxane, octamethyl-	556-67-2	0.020	0.016
18	Octanal	124-13-0	0.005	0.002
19	1-Hexanol, 2-ethyl-	104-76-7	0.002	0.002
20	1-Octanol and alkanolic acid	111-87-5	0.001	0.001
21	Isothiazole	288-16-4	0.001	0.001
22	Ethanone, 1-phenyl-	98-86-2	0.017	0.006
23	Benzenemethanol, .alpha.,.alpha.-dimethyl-	617-94-7	0.011	0.008
24	Nonanal	124-19-6	0.010	0.001
25	2-Nonenal, (E)-	18829-56-6	0.001	0.002
26	Hexanoic acid, 2-ethyl-	149-57-5	0.001	0.001

WHC-SD-WM-ER-424 REV. 1

Cmpd #	Compound	CAS ¹ Number	Average (mg/m ³)	Standard Deviation (mg/m ³)
27	Benzoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester		0.003	0.005
28	2-Dodecanal	4826-62-4	0.001	0.002
29	1-Nonanol	143-08-8	0.001	0.001
30	3-Undecene, (E)- and others	1002-68-2	0.001	0.002
31	Decanal	112-31-2	0.009	0.005
32	Perfluorotributylamine	311-89-7	0.021	0.042
33	Benzothiazole	95-16-9	0.001	0.001
34	1,3,5,7-Tetraazatricyclo-[3.3.1.1 ^{3,7}]decane	100-97-0	0.004	0.004
35	Phenol, 4-(1,1-dimethylethyl)-	98-54-4	0.001	0.001
36	Dodecanal	112-54-9	0.001	0.001
37	Alkanoic acid		0.001	0.001
38	Butanoic acid, anhydride and others	106-31-0	0.001	0.001
39	Undecanal	112-44-7	0.002	0.001
40	Alkane and alkanolic acid		0.001	0.001
41	Alkane and others		0.001	0.001
42	Alkane		0.001	0.001
43	Butanoic acid, hexyl ester	2639-63-6	0.001	0.001
44	Hexadecane, 2,6,10,14-tetramethyl-	638-36-8	0.001	0.001
45	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester	74367-34-3	0.003	0.002
46	Tetradecane	629-59-4	0.004	0.002
47	Dodecanal	112-54-9	0.001	0.001
48	Alkane		0.002	0.001
49	1-Decanol	112-30-1	0.002	0.001
50	1,12-Dodecanediol	5675-51-4	0.001	0.001

WHC-SD-WM-ER-424 REV. 1

Cmpd #	Compound	CAS ¹ Number	Average (mg/m ³)	Standard Deviation (mg/m ³)
51	Undecane, 5-methyl-	1632-70-8	0.001	0.001
52	1-Tetradecanol	112-72-1	0.002	0.001
53	Mixture		0.001	0.002
54	Cyclododecane		0.002	0.001
55	2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)-	719-22-2	0.002	0.001
56	Alkane		0.002	0.002
57	Pentadecane	629-62-9	0.001	0.002
58	Dodecanoic acid	143-07-7	0.005	0.002
59	Alkane		0.001	0.001
60	Hexadecane	544-76-3	0.002	0.001
61	Alkanoic acid		0.043	0.004
62	Benzenamine, N-phenyl-	122-39-4	0.008	0.007
63	Alkene and others		0.004	0.002
64	Hexadecane	544-76-3	0.001	0.001
65	Alkane		0.001	0.001
66	Octyl phenol isomer		0.001	0.001
67	Nonylphenol isomer and siloxane		0.001	< 0.001
68	Cyclohexane, 1-(cyclohexyl-methyl)-4-ethyl-cis		0.003	0.003
69	Mixture		0.001	0.003
70	Tetradecanoic acid	544-63-8	0.046	0.023
71	Alkane		0.001	0.002
72	Alkane		0.002	0.002
73	Benzene, (ethylsulfonyl)-	599-70-2	0.088	0.046
74	Tetradecanoic acid	5746-58-7	0.004	0.002
75	Alkene		0.002	0.002
76	Pentadecanoic acid	1002-84-2	0.029	0.015
77	1-Hexadecanol	36653-82-4	0.009	0.007

WHC-SD-WM-ER-424 REV. 1

Cmpd #	Compound	CAS ¹ Number	Average (mg/m ³)	Standard Deviation (mg/m ³)
78	7-Acetyl-1,1,3,4,4,6-hexamethyl tetralin		0.001	< 0.001
79	9-Hexadecenoic acid	2091-29-4	0.047	0.021
80	Hexadecanoic acid	57-10-3	0.100	0.055
81	1-Heptadecanol, acetate and others	8222-20-8	0.001	0.001
82	1-Nonadecene	18435-45-5	0.001	0.001
83	Hexadecanoic acid, 1-methylethyl ester	142-91-6	0.001	0.003
84	Mixture		0.001	0.001
85	Alkane		0.005	0.009
Sum of tentatively identified compounds:			1.040	

1. CAS = Chemical Abstracts Service.

X.4 REFERENCES

- EPA 1988, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*, PB90-127374, U.S. Environmental Protection Agency, Washington, D.C.
- Hendrickson, R. W., 1995, *Tank Vapor Characterization Oak Ridge National Laboratories Quality Assurance Assessment*, TWRSQA-95-0012, Westinghouse Hanford Company, Richland, Washington.
- Huckaby, J. L., 1995, *Waste Tank Headspace Gas and Vapor Characterization Reference Guide*, WHC-SD-WM-ER-430 Rev. 0, Westinghouse Hanford Company, Richland, Washington.
- Huckaby, J. L., and M. S. Story, 1994, *Vapor Characterization of Tank 241-C-103*, WHC-EP-0780 Rev. 0, Westinghouse Hanford Company, Richland, Washington.
- Jenkins, R. A., A. B. Dindal, C. E. Higgins, C. Y. Ma, and J. T. Skeen, 1994, *Analysis of Tank 241-C-109 Headspace Components*, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- Pool, K. H., T. W. Clauss, M. W. Ligothe, R. B. Lucke, B. D. McVeety, A. K. Sharma, M. McCulloch, J. S. Fruchter, and S. C. Goheen, 1994, *Vapor Space Characterization of Waste Tank 241-C-109: Results from Samples Collected on 8/10/94*, PNL-xxxx UC-606, Pacific Northwest Laboratory, Richland, Washington.
- Mahlum, D. D., J. Y. Young, and R. E. Weller, 1994, *Toxicologic Evaluation of Analytes from Tank 231-C-103*, PNL-10189, Pacific Northwest Laboratory, Richland, Washington.
- NIOSH 1995, *NIOSH Pocket Guide to Chemical Hazards*, U.S. Department of Health and Human Resources, National Institute for Occupational Safety and Health, Cincinnati, Ohio.
- Osborne, J. W., and J. L. Huckaby, 1994, *Program Plan for the Resolution of Tank Vapor Issues*, WHC-EP-0562 Rev. 1, Westinghouse Hanford Company, Richland, Washington.
- Osborne, J. W., J. L. Huckaby, T. P. Rudolph, E. R. Hewitt, D. D. Mahlum, J. Y. Young, and C. M. Anderson, 1994, *Data Quality Objectives for Generic In-Tank Health and Safety Issue Resolution*, WHC-SD-WM-DQO-002, Westinghouse Hanford Company, Richland, Washington.
- Rasmussen, R. A., 1994a, *Oregon Graduate Institute Vapor Analysis Results, Tank 241-C-109, August 1994*, Oregon Graduate Institute of Science and Technology, Beaverton, Oregon.

WHC-SD-WM-ER-424 REV. 1

Rasmussen, R. A., 1994b, *Air Samples Collected at Waste Tank 241-BY-104 on June 24, 1994 by Westinghouse Hanford in 6-L SS SUMMA® Canisters*, Oregon Graduate Institute of Science and Technology, Beaverton, Oregon.

Rasmussen, R. A., 1994c, *Air Samples Collected at Waste Tank 241-BY-105 on July 7, 1994 by Westinghouse Hanford in 6-L SS SUMMA® Canisters*, Oregon Graduate Institute of Science and Technology, Beaverton, Oregon.

Rasmussen, R. A., 1994d, *Air Samples Collected at Waste Tank 241-BY-106 on July 8, 1994 by Westinghouse Hanford in 6-L SS SUMMA® Canisters*, Oregon Graduate Institute of Science and Technology, Beaverton, Oregon.

WHC 1995, *Vapor and Gas Sampling of Single-Shell Tank 241-C-109 Using the Vapor Sampling System*, WHC-SD-WM-RPT-111, Westinghouse Hanford Company, Richland, Washington.