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Tank 241-BY-112 Vapor Sampling and Analysis Tank Characterization Report (WHC-SD-WM-ER-441)		ECN No.

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44(2)
MAY 31 1995

ENGINEERING DATA TRANSMITTAL

Page 1 of 1
1. EDT No 612333

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) Tank Vapor Characterization Program	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: Characterization	6. Cog. Engr.: J. W. Osborne	7. Purchase Order No.: N/A
8. Originator Remarks: N/A		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: N/A
11. Receiver Remarks: N/A		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: N/A

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	WHC-SD-WM-ER-441	N/A	0	Tank 241-BY-112 Vapor Sampling and Analysis Tank Characterization Report	N/A	2	1	1

16. KEY		
Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

(G)	(H)	17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)								(G)	(H)
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1	/	Cog. Eng. J. W. Osborne	<i>J. W. Osborne</i>	5-31-95							
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18. <i>J. W. Osborne</i> J. W. Osborne Signature of EDT Originator Date 5-31-95	19. _____ Authorized Representative for Receiving Organization Date	20. <i>T. J. Kelley</i> T. J. Kelley Cognizant Manager Date 5/31/95	21. DOE APPROVAL (if required) Ctrl. No. <input type="checkbox"/> Approved <input type="checkbox"/> Approved w/comments <input type="checkbox"/> Disapproved w/comments
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Document Number: WHC-SD-WM-ER-441, REV 0

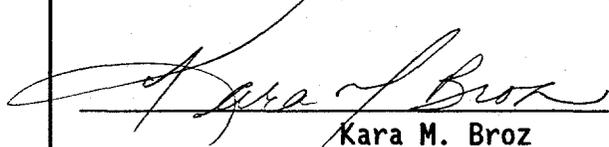
Document Title: Tank 241-BY-112 Vapor Sampling and Analysis Tank
Characterization Report

Release Date: 5/31/95

**This document was reviewed following the
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May 31, 1995

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SUPPORTING DOCUMENT

1. Total Pages *21*

2. Title

Tank 241-BY-112 Vapor Sampling and Analysis Tank Characterization Report

3. Number

WHC-SD-WM-ER-441

4. Rev No.

0

5. Key Words

241-BY-112, headspace vapor samples, organic analytes, VSS, SUMMA™, inorganic gases and vapors

6. Author

Name: J. L. Huckaby

Signature *J L Huckaby*

Organization/Charge Code
75600/N4AB1

7. Abstract

Tank 241-BY-112 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-BY-112 was vapor sampled in accordance with "Data Quality Objectives for Generic In-Tank Health and Safety Issue Resolution (Osborne et al., 1994).

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Tank 241-BY-112 Vapor Sampling and Analysis Tank Characterization Report

X.0 INTRODUCTION

Tank BY-112 headspace gas and vapor samples were collected and analyzed to help determine the potential risks of fugitive emissions to tank farm workers. 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 BY-112 was vapor sampled in accordance with *Data Quality Objectives for Generic In-Tank Health and Safety Issue Resolution* (Osborne et al. 1994). Results presented here represent the best available data on the headspace constituents of tank BY-112.

X.1 SAMPLING EVENT

Headspace gas and vapor samples were collected from tank BY-112 using the vapor sampling system (VSS) on November 18, 1994 by WHC Sampling and Mobile Laboratories (WHC 1995). Sample collection and analysis were performed as directed by *Tank 241-BY-112 Tank Characterization Plan* (the TCP), (Homi 1994). The tank headspace temperature was determined to be 23.3 °C. Air from the BY-112 headspace was withdrawn from a single elevation via a 7.9-m long heated sampling probe mounted in riser 21, and transferred via heated tubing to the VSS sampling manifold. All heated zones of the VSS were maintained at approximately 50 °C. All tank air samples were collected between 11:06 a.m. and 2:26 p.m., with no anomalies noted.

Sampling media were prepared and analyzed by WHC, Oak Ridge National Laboratories (ORNL), and Pacific Northwest Laboratories (PNL). The 40 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 14 trip blanks and 2 field blanks provided by the laboratories.

A general description of vapor sampling and sample analysis methods is given by Huckaby (1995a). The sampling equipment, sample collection sequence, sorbent trap sample air flow rates 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

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

million by volume (ppmv). Inorganic analyte sorbent traps and SUMMA™ canisters were prepared and analyzed by PNL (Clauss et al. 1995).

X.2.1 Ammonia, Hydrogen, and Nitrous Oxide

The reported ammonia concentration, 63 ppmv, is over 2 times the National Institute of Occupational Safety and Health (NIOSH) 8-hr recommended exposure limit (REL) of 25 ppmv for ammonia (NIOSH 1995). Ammonia has been observed in virtually all of the passively ventilated waste tanks sampled to date, at concentrations ranging from about 3 ppmv in tank C-108 (Lucke et al. 1995), to 1040 ppmv in BY-108 (McVeety et al. 1995).

The concentration of hydrogen in tank BY-112 was determined to be < 94 ppmv. Hydrogen in the waste tanks is of concern as a fuel. Given that the lower flammability limit (LFL) for hydrogen in air is about 4 % by volume, 94 ppmv hydrogen concentration in tank BY-112 corresponds to about 0.24 % of its LFL. At this level, hydrogen is not a flammability concern in tank BY-112.

The nitrous oxide concentration in tank BY-112, 40 ppmv, is above the NIOSH 8-hr REL of 25 ppmv for nitrous oxide (NIOSH 1995). Nitrous oxide, also known as laughing gas, has been detected in other passively ventilated waste tanks at concentrations as low as about 12 ppmv in tank TX-105 (Klinger 1995), and as high as about 800 ppmv in tank C-103 (Huckaby and Story 1994).

X.2.2 Carbon Monoxide and Carbon Dioxide

Carbon monoxide in the tank BY-112 headspace, characterized as < 12 ppmv, is below the NIOSH 8-hr REL of 35 ppmv for carbon monoxide. In ambient air it typically ranges from 0.05 to 0.15 ppmv. Because different analytical methods have been used to measure carbon monoxide in the waste tanks sampled to date, the information on carbon monoxide has varied from tank to tank. However, elevated waste tank headspace carbon monoxide concentrations are common, and are thought to be due to the decomposition of organic waste in the tanks. Carbon monoxide has not been measured at very high levels in any of the waste tanks, the highest level measured to date was 26.7 ppmv in tank C-103 (Huckaby and Story 1994).

The average carbon dioxide concentration in the tank BY-112 headspace, 121 ppmv, is significantly lower than it is in ambient air. Carbon dioxide is normally present in the ambient air at a concentration of 350 to 400 ppmv, and is typically lower than ambient in the waste tank headspaces. 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. The 121 ppmv of carbon dioxide measured in tank BY-112 is about average for the waste tanks sampled to date.

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

Nitric oxide and nitrogen dioxide concentrations in the tank BY-112 headspace were determined to be 0.18 ppmv and \leq 0.02 ppmv, respectively. These are both

acid gases that would have very low equilibrium concentrations above the high pH sludge in tank BY-112. 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 BY-112 was determined to be about 11.2 mg/L, at the measured tank headspace temperature of 23.3 °C and pressure of 1001 mbar (751 torr), (WHC 1995). This corresponds to a water vapor partial pressure of 15.3 mbar (11.5 torr), to a dew point of 13.3 °C, and to a relative humidity of 53 %.

Silica gel sorbent traps were used to test 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. Radiochemical analysis of the silica gel trap indicated the total activity of the headspace to be less than 50 pCi/L (WHC 1995).

X.2.4 Discussion of Inorganic Gases and Vapors

Aside from water and carbon dioxide, the most abundant waste constituents in the tank BY-112 headspace are ammonia and nitrous oxide. These have been detected in most tank headspaces sampled to date, and along with hydrogen, are usually the dominate waste species.

The relative standard deviations of the inorganic gas and vapor results given in the last column in Table X-2 are very good. Relative standard deviations range from 8.6 % for carbon dioxide to 15 % for nitrous oxide results. Because 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.), the small relative standard deviations suggest proper control was maintained both in the field and in the laboratories.

For comparison and perspective, Table X-3 presents selected inorganic gas and vapor concentrations for tanks BY-110, BY-111, and BY-112. Tanks BY-110 and BY-111 are connected via an underground cascade line, and a similar cascade line connects tanks BY-111 with BY-112. Compared to the headspaces of the tanks to which it is connected, tank BY-112 is the coolest, most humid, and has the lowest concentrations of carbon dioxide and nitrous oxide.

X.3 ORGANIC VAPORS

Organic vapors in the tank BY-112 headspace were sampled using SUMMA™ canisters, which were analyzed by PNL, and triple sorbent traps (TSTs), which were analyzed by ORNL. Gas chromatography (GC) and mass spectroscopy (MS)

were used by PNL and ORNL to separate, identify, and quantitate the analytes. Descriptions of sample device cleaning, sample preparations, and analyses are given by Jenkins et al. (1995) and Clauss et al. (1995).

SUMMA™ sample results should be considered to be the primary organic vapor data for tank BY-112. 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 Compounds

Positive identification of organic analytes using the methods employed by PNL and ORNL involves matching the GC retention times and MS data from a sample with that obtained when known compounds were analyzed. The concentration of an analyte in the sample is said to be quantitatively measured if the response of the GC/MS has been established at several known concentrations of that analyte (i.e., the GC/MS has been calibrated for that analyte), and the MS response to the analyte in the sample is between the lowest and highest responses to the known concentrations (i.e., the analyte is within the calibration range).

ORNL and PNL were assigned different lists of organic compounds, or target analytes, to positively identify and measure quantitatively. The ORNL target analyte list was derived from a review of the tank C-103 headspace constituents by a panel of toxicology experts (Mahlum et al. 1994). The PNL target analyte list included the 40 compounds in the Environmental Protection Agency (EPA) task order 14 (TO-14) method, which are primarily halocarbons and common industrial solvents (EPA 1988), plus 14 analytes selected mainly from the toxicology panel's review of tank C-103.

Table X-4 lists the organic compounds positively identified and quantitated in SUMMA™ samples. SUMMA™ organic analyses were performed according to the TO-14 methodology, except for methane analysis, which was analyzed with the inorganic gases (Clauss et al. 1995). Only 2 of the 40 TO-14 target analytes and only 2 of the 14 additional target analytes were measured to be above the 0.005 ppmv detection limit of the analyses. Averages reported are from analyses of 3 SUMMA™ canister samples.

Jenkins et al. (1995) report the positive identification of 24 of 27 target analytes in TST samples. 1,1-Dichloroethene, dibutyl butylphosphonate, and tributyl phosphate were the only TST target analytes not detected in the TST samples. The average concentrations of the detected target analytes, from the analysis of 3 TSTs, are given in Table X-5. Despite calibration of the instrument over about a 20-fold concentration range, 15 of the compounds listed in Table X-5 were outside of the calibration range in at least 2 of the TST samples.

Eleven target analytes were common to both TST and SUMMA™ analyses. Table X-6 lists these, and their reported average concentrations in TST and SUMMA™ samples. The data given in Table X-6 indicate these methods agree that 8 of the 11 listed analytes are at or below about 0.006 ppmv. Acetone, acetonitrile, and toluene are each reported to be at higher concentrations in TST samples than in SUMMA™ samples. While the differences are significant in terms of the accuracy specified by the TCP, none of these 3 compounds appear to be at levels of concern. The NIOSH 8-hr RELs for acetone, acetonitrile, and toluene are 250, 20, and 100 ppmv, respectively.

The most abundant analytes in Tables X-3 and X-4 are acetone, trichlorofluoromethane, 2-butanone, and acetonitrile, each of which was measured to be at or above 0.1 ppmv. At the reported concentrations, the target analytes do not individually or collectively represent a flammability hazard.

X.3.2 Tentatively Identified Organic Compounds

In addition to the target analytes, the ORNL and PNL analytical procedures allow the tentative identification of other organic compounds. Tentative identification of analytes was performed 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 may also determine its molecular weight. The method usually does not, however, allow the unambiguous identification of structural isomers, and this ambiguity increases with analyte molecular weight. Many analytes can be tentatively identified with reasonable confidence without having to inject each into the GC/MS to determine their GC retention times or specific MS patterns.

By the nature of the sampling devices, virtually all organic vapors present in the tank headspace are collected by both TST and SUMMA™ samples. Analyses of the samples are designed to recover, separate, and identify the organic vapors in the samples. TSTs are not good for collecting highly volatile compounds (i.e., molecules more volatile than propane), but are quite good for most others. In contrast, the recovery of very low volatility compounds (i.e., molecules with more than about 15 carbon atoms) and some polar compounds with moderate volatility (i.e., butanal) from SUMMA™ samples has been problematic.

The list of tentatively identified compounds recovered from SUMMA™ samples, with estimated concentrations, is given in Table X-7. Compounds are listed in Table X-7 in the order by which they eluted chromatographically, and only non-zero results are included in the reported averages. The list of tentatively identified compounds detected in TST samples, and their estimated concentrations, is given in Table X-8. Compounds are listed in Table X-8 according to the order by which they eluted chromatographically. The averages reported by ORNL in Table X-8 are all 3-sample averages, and if an analyte was not detected in a sample, its concentration in that sample was considered to be zero for averaging purposes. Estimated concentrations are in mg/m³, based on dry air at 0 °C and 1.01 bar.

The ORNL and PNL methods used to tentatively identify and estimate concentrations are described by Jenkins et al. (1995) and Clauss et al. (1995), respectively, and should be reviewed before this data is used for decision making. The quantitative measurement 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.

Concentrations given in Tables X-7 and X-8 should be considered rough estimates. Results in Tables X-7 and X-8 are presented in terms of observed peaks, and are not adjusted for the occurrence of split chromatographic peaks (e.g., Cmpd # 6 and 7 in Table X-8) or the assignment of the same identity to different peaks (e.g., Cmpd # 53 and 58 in Table X-8). In these instances, the estimated concentration of a compound appearing in different peaks is simply the sum of the individual peak estimates.

X.3.4 Discussion of Organic Compounds

A convenient way to consider the organic compounds listed in Tables X-4 through X-8 is to separate them into 2 categories: 1) Organic compounds added to tank BY-112 as waste that are still evaporating; and 2) organic compounds that have been generated by reactions of the original waste.

The first category encompasses all organic compounds that were placed into the tank as waste. It includes the tentatively identified alkyl-substituted decahydronaphthalenes, and semivolatile branched and straight-chain alkanes, which were used as diluents of tributyl phosphate in various plutonium extraction processes. The semivolatile straight-chain alkanes (i.e., n-undecane, n-dodecane, n-tridecane, n-tetradecane, and n-pentadecane) are often referred to in Hanford site literature as the normal paraffinic hydrocarbons (NPHs). Halogenated solvents, such as trichlorofluoromethane, were probably also placed into the waste tanks as waste.

Trace amounts of a tentatively identified cyclosiloxane (i.e., Cmpd # 23 in Table X-7) may also be in the category of waste additions. Small quantities of siloxanes may have been introduced to the waste tank through their use as process surfactants, but they may also be present in the headspace due to their use in liquid traps at the tank's breather riser.

The second category includes all organic compounds that have been generated via radiolytic and chemical reactions of the waste. The majority of compounds listed in Tables X-4 through X-8 fall into this category, including the alcohols, aldehydes, ketones, nitriles, alkenes, alkyl nitrates, and volatile alkanes, all of which have been associated with the degradation of the NPHs. While both larger and smaller molecules are generated from the waste, the most abundant of these in the headspace are the smaller, short-chain volatile compounds.

Small amounts of the tributyl phosphate diluents and their degradation products is reason to expect trace amounts of tributyl phosphate to be present in the tank waste. The low volatility of tributyl phosphate, and its tendency to adsorb on glass fiber filters during sampling, apparently preclude its measurement in the tank BY-112 samples. 1-Butanol, known to be a product of the hydrolysis of tributyl phosphate, is at a relatively low concentration in the tank BY-112 samples. In TST samples, 1-butanol and other alcohols are at similar concentrations; the average methanol, ethanol, 2-propanol, and 1-butanol concentrations in TSTs samples are 0.36, 0.083, 0.13, and 0.20 mg/m³, respectively. Based on these considerations, it is likely that the amounts of tributyl phosphate in the tank BY-112 waste and headspace are very low.

The total organic vapor concentration of tank BY-112 was estimated by Jenkins et al. to be about 5.8 mg/m³. This is the summation of concentrations of positively and tentatively identified compounds in 3 TST samples by GC/MS. While this estimated total organic vapor concentration is not completely equivalent to the total nonmethane organic compound (TNMOC) concentration obtained using the EPA task order 12 (TO-12) method, they are comparable. TNMOC measurements of other waste tanks have ranged from as high as 5,000 mg/m³ in tank C-103 (Rasmussen and Einfeld 1994), to as low as 0.18 mg/m³ in tank C-111 (Rasmussen 1994), while the TNMOC concentration of clean ambient air ranges from about 0.03 to 0.1 mg/m³.

Tank BY-112 is known to have contained liquid tributyl phosphate "diluted with degraded kerosene" (Schulz 1968). Schulz's assessment of the organic liquid was in preparation for application of the In Tank Solidification (ITS) process to tank BY-112, and he states that "All, or, at least most, of the organic solution will likely steam distill during ITS operations in the 112 BY tank." The vapor samples collected in November 1994, seem to support Schulz' prediction. The total organic vapor concentration has been estimated to be relatively low, even compared to the other tanks to which it is connected (Table X-3). Furthermore, the principle signature of tributyl phosphate in the headspace, 1-butanol, is also present at a relatively low concentration.

In summary, the tank BY-112 headspace has a moderate to low level of organic vapors. While having many of the same organic vapors as NPH-rich tanks, the alcohols are more prominent and the aldehydes less prevalent in tank BY-112. The organic liquid present in tank BY-112 before operation of the ITS process, while leaving its signature, apparently does not still exist.

**Table X-1
Tank BY-112 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	0.1, 0.5, and 2.0	Organic vapors	12 tank air samples, + 2 trip blanks + 2 field blanks
			Ammonia	6 tank air samples + 3 trip blank
			Nitrogen Dioxide	6 tank air samples + 3 trip blank
Pacific Northwest Laboratories	Acidified Carbon Sorbent Trap	3.0	Nitric Oxide	6 tank air samples + 3 trip blank
			Water vapor	6 tank air samples + 3 trip blanks
			Carbon dioxide, Carbon monoxide, Hydrogen, Methane, Nitrous oxide, Organic vapors	3 tank air samples + 2 ambient air samples
WHC 222-S Laboratory	SUMMA™ canister	6.0	Tritium-Substituted Water Vapor	1 tank air sample
			Water vapor	6 tank air samples + 3 trip blanks
			Triethanolamine Sorbent Trap	6 tank air samples + 3 trip blank
WHC 222-S Laboratory	Silica Gel Sorbent Trap	3.0	Ammonia	6 tank air samples + 3 trip blank
			Nitrogen Dioxide	6 tank air samples + 3 trip blank
			Nitric Oxide	6 tank air samples + 3 trip blank
WHC 222-S Laboratory	Silica Gel Sorbent Trap	3.0	Water vapor	6 tank air samples + 3 trip blanks
			Carbon dioxide, Carbon monoxide, Hydrogen, Methane, Nitrous oxide, Organic vapors	3 tank air samples + 2 ambient air samples
			Tritium-Substituted Water Vapor	1 tank air sample

Table X-2
 Tank BY-112 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	63	6	9.5
Carbon Dioxide, CO ₂	124-38-9	SUMMA™	3	121	10	8.6
Carbon Monoxide, CO	630-08-0	SUMMA™	3	< 12	--	--
Hydrogen, H ₂	1333-74-0	SUMMA™	3	< 94	--	--
Nitric Oxide, NO	10102-43-9	Sorbent Trap	6	0.18	0.02	11
Nitrogen Dioxide, NO ₂	10102-44-0	Sorbent Trap	6	≤ 0.02	--	--
Nitrous Oxide, N ₂ O	10024-97-2	SUMMA™	3	40	6	15
Water Vapor, H ₂ O	7732-18-5	Sorbent Trap	6	15,300 (11.2 mg/L)	1,300 (1.0 mg/L)	9

1. CAS = Chemical Abstracts Service.

2. RSD = relative standard deviation.

Table X-3
Comparison of Tank BY-110, BY-111, and BY-112 Headspace Constituents

Tank:	BY-110 ¹	BY-111 ²	BY-112 ³
Date sampled, (mo/day/yr)	11/11/94	5/11/94 11/16/94	11/18/94
Headspace temperature, (°C)	27	27	23.2
Ammonia, (ppmv)	401	59	63
Hydrogen, (ppmv)	< 160	67	< 94
Carbon dioxide, (ppmv)	229	219	121
Carbon monoxide, (ppmv)	< 76	< 1	< 12
Nitric oxide, (ppmv)	≤ 0.09	≤ 0.15	0.18
Nitrogen dioxide, (ppmv)	≤ 0.05	≤ 0.05	≤ 0.02
Nitrous oxide, (ppmv)	103	98.9	40
Water vapor, (mg/m ³)	8.0	6.9	11.2
Water vapor, (% relative humidity)	31	27	53
Ethanenitrile (acetonitrile), (ppmv)	0.81	0.050	0.10
Propanone (acetone), (ppmv)	3.8	0.48	1.0
1-Butanol, (ppmv)	0.30	< 0.0011	0.059
n-Dodecane, (ppmv)	0.079	< 0.00046	0.0097
n-Tridecane, (ppmv)	0.13	0.0015	0.020
Total nonmethane organic compounds, (mg/m ³)	29	9.6	5.8

1. Data are from Huckaby 1995b; results for organic vapors are from TST samples; TST analyses were used to estimate total nonmethane organic compound concentration.

2. Data are from Huckaby 1995c; carbon monoxide, hydrogen, nitrous oxide, and total nonmethane organic compound results are from samples collected May 11, 1994, all other results are from samples collected November 16, 1994; results for organic vapors are from TST samples.

3. Total nonmethane organic compound concentration was estimated from TST sample results.

Table X-4
Tank BY-112 Positively Identified Organic Compounds in SUMMA™ Samples

Cmpd #	Compound	CAS ¹ Number	Average (ppmv)	Standard Deviation (ppmv)	RSD ² (%)
1	Trichlorofluoromethane	75-69-4	0.21	0.02	10
2	Toluene	108-88-3	0.041	0.0004	1
3	2-Butanone	78-93-3	0.12	0.01	8
4	Propanone (acetone)	67-64-1	4.11	0.59	14

1. CAS = Chemical Abstract Service.
2. RSD = relative standard deviation.

Table X-5
Tank BY-112 Positively Identified Organic Compounds in TST Samples

Cmpd #	Compound	CAS ¹ Number	Average (ppmv)	Standard Deviation (ppmv)	RSD ² (%)
1	Ethanenitrile (acetonitrile)	75-05-8	0.10	0.08	76
2	Propanone ³ (acetone)	67-64-1	1.00	0.12	12
3	Dichloromethane ³ (methylene chloride)	75-09-2	0.0016	0.0003	19
4	Propanenitrile ³	107-12-0	0.0024	0.0005	19
5	Butanal	123-72-8	0.016	0.013	87
6	n-Hexane	110-54-3	0.0057	0.0004	7
7	Benzene ³	71-43-2	0.0020	0.0005	23
8	1-Butanol	71-36-3	0.059	0.001	2
9	Butanenitrile ³	109-74-0	0.0049	0.0005	10
10	2-Pentanone	107-87-9	0.020	0.004	17
11	n-Heptane ³	142-82-5	0.0062	0.0040	64
12	Toluene	108-88-3	0.015	0.001	9
13	Pentanenitrile ³	110-59-8	0.0012	0.00002	2
14	2-Hexanone ³	591-78-6	0.0054	0.0009	17
15	n-Octane ³	111-65-9	0.0026	0.0009	35
16	Hexanenitrile ³	628-73-9	0.00093	0.00004	5
17	2-Heptanone ³	110-43-0	0.0040	0.0003	7
18	n-Nonane ³	111-84-2	0.0019	0.0004	23
19	Heptanenitrile ³	629-08-3	0.00077	0.00006	7
20	2-Octanone ³	111-13-7	0.0015	0.0001	4
21	n-Decane ³	124-18-5	0.0017	0.0001	5
22	n-Undecane	1120-21-4	0.0062	0.0005	8
23	n-Dodecane	112-40-3	0.0097	0.0008	8
24	n-Tridecane	629-50-5	0.020	0.006	29
Sum of positively identified compounds:			3.6 mg/m ³		

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1. CAS = Chemical Abstract Service.
2. RSD = relative standard deviation.
3. Two or more samples were outside calibration range.

Table X-6
Tank BY-112 Comparison of Positively Identified Organic
Compounds in TST and SUMMA™ Samples

Compound	CAS ¹ Number	TST Average (ppmv)	SUMMA™ Average (ppmv)
1,1-Dichloroethene (vinylidene chloride)	75-35-4	< 0.0023	< 0.005
Dichloromethane (methylene chloride)	75-09-2	< 0.0053	< 0.005
Propanone (acetone)	67-64-1	1.0	4.1
Ethanenitrile (acetonitrile)	75-05-8	0.10	< 0.005
Propanenitrile	107-12-0	0.0024	< 0.005
Butanenitrile	109-74-0	0.0049	< 0.005
Benzene	71-43-2	0.0020	< 0.005
Toluene	108-88-3	0.015	0.041
n-Hexane	110-54-3	0.0057	< 0.005
n-Heptane	142-82-5	0.0062	< 0.005
n-Decane	124-18-5	0.0017	< 0.005

1. CAS = Chemical Abstract Service.

Table X-7
Tank BY-112 Tentatively Identified Organic Compounds in SUMMA™ Samples

Cmpd #	Compound	CAS ¹ Number	Average (mg/m ³)	Standard ² Deviation (mg/m ³)
1	Propene ³	115-07-1	0.05	0.01
2	Propane	74-98-6	0.063	0.015
3	Cyclopropane	75-19-4	0.12	0.01
4	Ethanal (acetaldehyde)	75-07-0	0.16	0.02
5	Butane	106-97-8	0.12	0.03
6	Ethanol	64-17-5	0.10	0.01
7	n-Pentane	109-66-0	0.073	0.04
8	2-Methyl-2-propanol	75-65-0	0.24	0.02
9	Butanal	123-72-8	0.076	0.006
10	3-Methyl-2-butanone	563-80-4	< 0.04	--
11	1-Butanol	71-36-3	0.087	0.006
12	2-Pentanone	107-87-9	0.077	0.006
13	4,4-Dimethyl-2-pentanone	590-50-1	0.13	0.02
Sum of tentatively identified compounds:			1.31	

1. CAS = Chemical Abstract Service.

2. When the analyte was detected in only 2 samples, the entry is the relative difference (i.e., their difference divided by 2).

3. Detected in only two samples.

Table X-8
Tank BY-112 Tentatively Identified Organic Compounds in TST Samples

Cmpd #	Compound	CAS ¹ Number	Average (mg/m ³)	Standard Deviation (mg/m ³)
1	Methyl nitrite	624-91-9	0.0049	0.0084
2	Cyclopropane	75-19-4	0.011	0.010
3	1-Propene, 2-methyl	115-11-7	0.046	0.041
4	Methanol	67-56-1	0.36	0.45
5	Ethanol	64-17-5	0.083	0.018
6	Trichlorofluoromethane	75-69-4	0.43	0.06
7	Trichlorofluoromethane	75-69-4	0.076	0.131
8	2-Propanol	67-63-0	0.13	0.12
9	2-Propanol, 2-methyl	75-65-0	0.0044	0.0076
10	1-Propanol	71-23-8	0.063	0.012
11	Acetic acid	64-19-7	0.072	0.125
12	2-Butanone	78-93-3	0.075	0.066
13	2-Butanone, 3-methyl	563-80-4	0.016	0.002
14	Nitric acid, propyl ester	627-13-4	0.0047	0.0081
15	2-Pentene, 4-methyl and others		0.0058	0.0101
16	3-Pentanone	96-22-0	0.0083	0.0072
17	2-Butanone, 3,3-dimethyl	75-97-8	0.031	0.023
18	2-Butanone, 3,3-dimethyl	75-97-8	0.013	0.011
19	Formamide	75-12-7	0.0028	0.0049
20	1-Butanol, 3-methyl-	123-51-3	0.0060	0.0052
21	1-Butanol, 3-methyl-, nitrate	543-87-3	0.0028	0.0049
22	2-Pentanone, 4,4-dimethyl	590-50-1	0.055	0.006
23	Cyclotrisiloxane, hexamethyl	541-05-9	0.0088	0.0081
24	2,2,4-Trimethyl-3-pentanone	5857-36-3	0.011	0.00008
25	Ethylbenzene	100-41-4	0.0099	0.0004
26	1-Hexanol	111-27-3	0.0052	0.0045

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Cmpd #	Compound	CAS ¹ Number	Average (mg/m ³)	Standard Deviation (mg/m ³)
27	Benzene, 1,3-dimethyl-	108-38-3	0.023	0.0007
28	3-Heptanone	106-35-4	0.023	0.002
29	p-Xylene	106-42-3	0.0024	0.0041
30	3-Heptanone, 6-methyl	624-42-0	0.011	0.0002
31	2-Heptanone, 6-methyl	928-68-7	0.031	0.002
32	Benzaldehyde	100-52-7	0.015	0.002
33	1-Hexanol, 2-ethyl-	104-76-7	0.0019	0.0034
34	2(3H)-Furanone, dihydro-4,4-dimethyl	13861-97-7	0.0020	0.0035
35	C10-Alkane		0.020	0.002
36	2-Heptanone, 4,6-dimethyl	19549-80-5	0.0020	0.0035
37	1-Octanol	111-87-5	0.0022	0.0038
38	Acetophenone	98-86-2	0.0029	0.0051
39	Nonanal	124-19-6	0.0021	0.0037
40	Undecane, 2,6-dimethyl-	17301-23-4	0.0094	0.0023
41	Cyclohexane, hexyl	4292-75-5	0.0039	0.0067
42	Tridecane, 7-methyl-	26730-14-3	0.026	0.006
43	Methenamine	100-97-0	0.0026	0.0046
44	Undecane, 5-ethyl-	17453-94-0	0.012	0.003
45	Cyclohexane, pentyl	4292-92-6	0.014	0.004
46	Tridecane, 2-methyl-	1560-96-9	0.0097	0.0019
47	Tridecane, 3-methyl-	6418-41-3	0.0087	0.0017
48	Dodecane, 2,6,10-trimethyl-	3891-98-3	0.073	0.013
49	n-Tetradecane	629-59-4	0.10	0.02
50	Tridecane, 4,8-dimethyl	55030-62-1	0.011	0.001
51	Cyclohexane,1,1,3-trimethyl2-(3-methylpentyl)	54965-05-8	0.0097	0.0009
52	Dodecane, 2,6,10-trimethyl-	3891-98-3	0.0018	0.0031
53	n-Hexadecane	544-76-3	0.057	0.006

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Cmpd #	Compound	CAS ¹ Number	Average (mg/m ³)	Standard Deviation (mg/m ³)
54	n-Heptadecane	629-78-7	0.045	0.007
55	Cyclohexane, 1,2-dimethyl-3-pentyl-		0.0062	0.0055
56	3-Ethyl-2-methyl-2-heptanol		0.0046	0.0040
57	6-Dodecanol		0.0047	0.0041
58	n-Hexadecane	544-76-3	0.0096	0.0025
59	Butyric acid, thio-, S-decyl ester	2432-55-5	0.013	0.002
60	Diethyl phthalate	84-66-2	0.029	0.012
61	1,1'-Biphenyl, 2,2'-dichloro	13029-08-8	0.0021	0.004
62	Benzenesulfonamide, N-butyl	3622-84-2	0.052	0.023
63	Benzenesulfonamide, N-ethyl-4-methyl	80-39-7	0.0042	0.0073
64	Benzenesulfonamide, N-butyl	3622-84-2	0.015	0.026
65	Dibutyl phthalate		0.0020	0.0035
66	Isopropyl palmitate	142-91-6	0.012	0.002
Sum of tentatively identified compounds:			2.22	

1. CAS = Chemical Abstract Service.

X.4 REFERENCES

- Clauss, T. W., M. W. Ligothke, K. H. Pool, R. B. Lucke, B. D. McVeety, G. S. Klinger, K. B. Olsen, M. McCulloch, J. S. Fruchter, and S. C. Goheen, 1995, *Vapor Space Characterization of Waste Tank 241-BY-112: Results from Samples Collected Through the Vapor Sampling System on 11/18/94*, PNL-xxxxx UC-606, Pacific Northwest Laboratory, Richland, Washington.
- 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.
- Homi, C. S., 1994, *Tank 241-BY-112 Tank Characterization Plan*, WHC-SD-WM-TP-281 Rev. 0, Westinghouse Hanford Company, Richland, Washington.
- Huckaby, J. L., 1995a, *Waste Tank Headspace Gas and Vapor Characterization Reference Guide*, WHC-SD-WM-ER-430 Rev. 0, Westinghouse Hanford Company, Richland, Washington.
- Huckaby, J. L., 1995b, *Tank 241-BY-110 Vapor Sampling and Analysis Tank Characterization Report*, WHC-SD-WM-ER-429, Westinghouse Hanford Company, Richland, Washington.
- Huckaby, J. L., 1995c, *Tank 241-BY-111 Vapor Sampling and Analysis Tank Characterization Report*, WHC-SD-WM-ER-440, 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, M. A. Palausky, J. T. Skeen, and C. K. Bayne, 1995, *Analysis of Tank 241-BY-112 Headspace Components*, ORNL-CASD-FR-241BY112.95 Rev. 0, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- Klinger, G. S., T. W. Clauss, M. W. Ligothke, K. H. Pool, R. B. Lucke, B. D. McVeety, O. P. Bredt, J. S. Young, M. McCulloch, J. S. Fruchter, and S. C. Goheen, 1995, *Vapor Space Characterization of Waste Tank 241-TX-105: Results from Samples Collected Through the Vapor Sampling System on 12/20/94*, PNL-xxxxx UC-606, Pacific Northwest Laboratory, Richland, Washington.
- Lucke, R. B., M. W. Ligothke, K. H. Pool, T. W. Clauss, A. K. Sharma, B. D. McVeety, M. McCulloch, J. S. Fruchter, and S. C. Goheen, 1995, *Vapor Space Characterization of Waste Tank 241-C-108: Results from Samples*

Collected Through the Vapor Sampling System on 8/5/94, PNL-xxxxx 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.
- McVeety, B. D., T. W. Clauss, M. W. Ligothe, K. H. Pool, R. B. Lucke, G. S. Klinger, J. S. Young, M. McCulloch, J. S. Fruchter, and S. C. Goheen, 1995, *Vapor Space Characterization of Waste Tank 241-BY-108: Results from Samples Collected on 10/27/94*, PNL-xxxxx UC-606, 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, 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., 1994, *Air Samples Collected at Waste Tank 241-C-111 on September 13, 1994 by Westinghouse Hanford in 6-L SS SUMMA® Canisters*, Oregon Graduate Institute of Science and Technology, Beaverton, Oregon.
- Rasmussen, R. A., and W. Einfeld, 1994, *Hanford Tank 103-C Analyses and Method Validation Development Phase*, SAND94-1807, Sandia National Laboratories, Albuquerque, New Mexico.
- Schulz, W. W., 1968, *Characterization of the Organic Material in the 112 BY Tank*, BNWL-CC-1517, Pacific Northwest Laboratory, Richland, Washington.
- WHC 1995, *Vapor and Gas Sampling of Single-Shell Tank 241-C-107 Using the Vapor Sampling System*, WHC-SD-WM-RPT-129, Westinghouse Hanford Company, Richland, Washington.