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											
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition			
1	WHC-SD-WM-ER-428	N/A	0	Tank 241-BY-103 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)		
Reason	Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	Reason	Disp.
1	/	Cog.Eng. J. W. Osborne		5-9-95							
1	/	Cog. Mgr. T. J. Kelley		5/9/95							
		QA									
		Safety									
		Env.									
18. J. W. Osborne Signature of EDT Originator		19. _____ Authorized Representative for Receiving Organization		20. T. J. Kelley Cognizant Manager		21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments					

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Document Number: WHC-SD-WM-ER-428, REV 0

Document Title: Tank 241-BY-103 Vapor Sampling and Analysis Tank Characterization Report

Release Date: 5/9/95

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

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

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May 9, 1995

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SUPPORTING DOCUMENT

1. Total Pages 21

2. Title

Tank 241-BY-103 Vapor Sampling and Analysis Tank Characterization Report

3. Number

WHC-SD-WM-ER-428

4. Rev No.

0

5. Key Words

241-BY-103, headspace vapor samples, organic analytes, VSS, SUMMA™, inorganic gases and vapors

6. Author

Name: J. L. Huckaby

Signature

Organization/Charge Code
Tank Vapor Characterization
Program/ N4AB1/ 75600

7. Abstract

Tank 241-BY-103 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-103 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-103 VAPOR SAMPLING AND ANALYSIS TCR CHAPTER

X.0 HEADSPACE GAS AND VAPOR SAMPLES

Tank BY-103 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 BY-103 was vapor sampled in accordance with *Data Quality Objectives for Generic In-Tank Health and Safety Issue Resolution* (Osborne et al. 1994).

Tank BY-103 was vapor sampled in May 1994 using the *in situ* sampling (ISS) method, and again in November 1994 using the more robust vapor sampling system (VSS) method. Because the ISS method samples were collected with inherently less accurate, less precise equipment, nearly all of results presented here are from the November 1994 sampling event.

X.1 SAMPLING EVENT

Headspace gas and vapor samples were collected from tank BY-103 using the vapor sampling system (VSS) on November 1, 1994 by WHC Sampling & Mobile Laboratories (S&ML), (WHC 1995). Sample collection and analysis were performed as directed by *Tank 241-BY-103 Tank Characterization Plan* (Carpenter 1994). The tank headspace temperature was determined to be 25.5 °C. Air from the tank BY-103 headspace was withdrawn via a 7.9 m-long heated sampling probe mounted in riser 10B, 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), and Pacific Northwest Laboratories (PNL).

The 32 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 11 trip blanks and 1 field blank that accompanied the samples. A general description of vapor sampling and sample analysis methods is given by Huckaby (1994). 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 million by volume (ppmv). Inorganic analyte sorbent traps and SUMMATM

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

canisters were prepared and analyzed by PNL. McVeety et al. (1995a) describe sample preparation and analyses.

The relative standard deviations of the results, given in the last column in Table X-2, are typical for the analytical methods used. Relative standard deviations range from 4 % for carbon dioxide and nitrous oxide, to 16 % for water vapor 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 relative standard deviations suggest there were no significant problems in the field or in the laboratories.

X.2.1 Ammonia, Hydrogen, and Nitrous Oxide

The reported ammonia concentration, 26 ppmv, is just above the National Institute of Occupational Safety and Health (NIOSH) 8-hr recommended exposure limit (REL) of 25 ppmv (NIOSH 1995). The measured 26 ppmv of ammonia in tank BY-103 is low compared to other tanks sampled to date.

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. Hydrogen was not detected in the tank BY-103 samples, being determined to be below the limit of detection of the analytical method, 99 ppmv. In general, hydrogen is of concern as a fuel. The 99 ppmv detection limit corresponds to about 0.25 % of the lower flammability limit (LFL) for hydrogen in air. The nitrous oxide concentration in tank BY-103, 16.5 ppmv, is about two-thirds the NIOSH 8-hr REL of 25 ppmv (NIOSH 1976, 1977).

For comparison, the measured concentrations of ammonia, hydrogen, and nitrous oxide for tank BY-103 and 6 other 241-BY farm tanks sampled recently are given in Table X-3. Among these 241-BY farms tanks, tank BY-103 has relatively low concentrations of these gases and vapors. There is a strong correlation between increased waste tank headspace organic vapor concentrations (the last column in Table X-3) and increased ammonia vapor concentrations, though this correlation is far from linear.

X.2.2 Carbon Dioxide and Carbon Monoxide

The average measured headspace carbon dioxide concentration, 126 ppmv, is about one-third of the normal ambient air concentration, which ranges from about 350 to 400 ppmv. Lower-than-ambient carbon dioxide concentrations are expected in the waste tank headspaces. Carbon dioxide introduced by air exchange with the atmosphere is readily absorbed by caustic supernatant and interstitial liquids in 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. The 126 ppmv carbon dioxide concentration measured in tank BY-103 is typical of other tanks sampled to date.

The carbon monoxide concentration in tank BY-103 was determined to be lower than the method detection limit of 12 ppmv. This is lower than the NIOSH 8-hr REL for carbon monoxide of 35 ppmv.

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

Nitric oxide and nitrogen dioxide concentrations in the tank BY-103 headspace were determined to be ≤ 0.09 ppmv and ≤ 0.02 ppmv, respectively. These are both acid gases that would have very low equilibrium concentrations above the high pH waste in tank BY-103. Nitric oxide is commonly found at trace concentrations, presumably 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-103 was determined to be about 11.6 mg/L, at the tank headspace temperature of 25.5 °C and pressure of 981 mbar (735.7 torr), (WHC 1995). This corresponds to a water vapor partial pressure of 15.9 mbar (11.9 torr), to a dew point of 14.0 °C, and to a relative humidity of 49 %. The relative standard deviation of the water vapor measurements is higher than typical for this measurement.

Tritium was tested for using silica gel sorbent traps. It is assumed that tritium ions produced by the waste combine 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, which would have trapped approximately 12 mg of water vapor, indicated the total activity of the sample to be below the method detection limit of 50 pCi (WHC 1995).

X.3 ORGANIC VAPORS

Organic vapors in the tank BY-103 headspace were sampled using SUMMA™ canisters, which were analyzed by PNL, and triple sorbent traps (TSTs), which were analyzed by ORNL. 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 McVeety et al. (1995a). A quantitative measurement of the total organic vapor concentration by the U.S. Environmental Protection Agency (EPA) task order 12 (TO-12) method (EPA 1988) was also performed by Oregon Graduate Institute of Science and Technology (OGIST) on samples collected in May 1994 by the ISS method (Pingel 1994, Rasmussen 1994a).

X.3.1 Positively Identified Organic Analytes

ORNL positively identified 24 of 25 target analytes selected by WHC. One target analyte, vinylidene chloride, was below the method detection limit. The detected analytes, and their average concentrations from the analysis of 3 TSTs, are given in Table X-4. The 25 TST target analytes for tank BY-103 are an extended set of the tank C-103 target analytes, which were selected by a PNL panel of toxicology experts as being of potential toxicological concern (Mahlum 1994). One of the target analytes, 1-butanol, was measured to be above the method's upper calibration limit. Also, 14 of the target analytes were positively identified by ORNL, but were below the method quantitation limit in at least 2 of the 3 TST samples.

Also given in Table X-4 are the organic compounds positively identified and quantitated in SUMMATM canister samples by PNL. Averages reported are from analyses of 3 SUMMATM canister samples. PNL performed analyses according to the EPA task order 14 (TO-14) methodology, but expanded the number of target analytes from 40 to 54 to include waste tank analytes of particular interest (EPA 1988, McVeety et al. 1995a). Of the original 40 TO-14 analytes, 39 were determined to be below the 0.002 ppmv quantitation limit of the analyses (McVeety et al. 1995a provide the complete TO-14 analyte list), with trichlorofluoromethane being the only TO-14 analyte above its lower quantitation limit. Of the 14 additional target analytes only 2-butanone, acetone, and tetrahydrofuran were above the 0.005 ppmv method quantitation limit.

Eleven target analytes were common to both the ORNL and PNL analyses. Comparison of the results from the 2 methods indicates the following:

- 1) Both methods agree that dichloromethane, propanenitrile, pentanenitrile, and certain nonpolar analytes (i.e., n-hexane, n-heptane, toluene, and n-decane) are at very low levels;
- 2) the methods are in adequate agreement for the propanone (acetone) concentration; and
- 3) acetonitrile at 0.026 ppmv, and butanenitrile at 0.090 ppmv, were found in TSTs, while analysis of SUMMATM samples indicate these to be below their quantitation limit of 0.005 ppmv.

Though the discrepancy between the TST and SUMMATM sample acetonitrile and butanenitrile results is currently not understood, this discrepancy has been observed in the analysis of other tank samples (e.g., tanks BY-107 and BY-108). Total ion mass spectra of SUMMATM canister samples collected in May 1994 do indicate small concentrations of acetonitrile, and trace quantities of propanenitrile, butanenitrile, pentanenitrile, and benzonitrile (Rasmussen 1994a). The reported nitrile concentrations in TSTs are not above action limits. The 0.026 ppmv acetonitrile concentration measured in TST samples is well below its NIOSH 8-hr REL of 20 ppmv. Similarly, the 0.090 ppmv of butanenitrile measured in the TST samples is well below its NIOSH 8-hr REL of 8 ppmv (NIOSH 1995).

1-Butanol, at 2.0 ppmv, and acetone, at 0.11 to 0.49 ppmv, were the only target analytes measured to be above 0.1 ppmv. None of the analytes in Table X-4 is above NIOSH recommended workplace guidelines.

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-5, and the ORNL list of tentatively identified compounds, and their estimated concentrations, is given in Table X-6. Estimated concentrations are in mg/m^3 , based on dry air at 0 °C and 1.013 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 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. Entries in Tables X-5 and X-6, particularly near the bottom of the tables where the analytes tend to have higher molecular weights, illustrate this.

The ORNL and PNL methods used to tentatively identify and estimate concentrations are described by Jenkins et al. (1994) and McVeety et al. (1995a), respectively, and should be reviewed before this data is used for decision making. Results in Tables X-5 and X-6 are presented in terms of observed peaks, and are not adjusted for the occurrence of split chromatographic peaks or the tentative assignment of the same identity to several peaks (e.g., Compd # 62, 68, 79, and 84 in Table X-6). In these instances, the estimated concentration of the compound is simply the sum of the individual peak estimates.

Concentrations given in Tables X-5 and X-6 should be considered rough estimates. The proper quantitation of all observed analytes is outside the scope and budget for 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 SUMMATM canister samples collected on May 5, 1994 (Pingel 1994) using the EPA TO-12 method (Rasmussen 1994a). The sample mean was $5.2 \text{ mg}/\text{m}^3$, with a standard deviation of $0.4 \text{ mg}/\text{m}^3$. Though data on other tanks is very limited, this value is about average compared to other waste tanks sampled to date.

For comparison, the TNMOC concentration in clean ambient air may range from 0.03 to 0.1 mg/m³, and tank C-103 is estimated to have 3,000 to 5,000 mg/m³ of TNMOC (Rasmussen and Einfeld 1994). Table X-3 also gives the TNMOC concentrations of several other 241-BY farm tanks.

X.3.4 Discussion of Organic Analytes

In general, the organic analytes observed in the waste tank headspaces are indicative of the types of volatile and semivolatile organic waste that reside in each tank. Examination of the data provides clues to both the current organic constituents and the chemical reactions that are taking place.

Some of the compounds listed in Tables X-4, X-5, and X-6 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 the semivolatile normal paraffinic hydrocarbons (NPHs), (i.e., n-dodecane, n-tridecane, n-tetradecane, n-pentadecane) and methyl-substituted decahydronaphthalenes that were used as diluents for tributyl phosphate.

Though there is no toxicological or flammability hazard associated with the 0.048 ppmv of trichlorofluoromethane measured in tank BY-103, its presence warrants an explanation. The origin of trichlorofluoromethane in the waste tanks has not been established, however, it has been used as a decontaminating (cleaning) solvent at the Hanford Site, and small amounts may have been placed in the waste tanks. Once there, its high density (1.47 g/ml) and low solubility in the aqueous liquid wastes may have caused it to pool at the bottom of the tank.

Some of the compounds in Tables X-4, X-5, and X-6 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.

Neither TST nor SUMMATM methods detected tributyl phosphate as a headspace constituent. The relatively high concentration of 1-butanol, however, is a strong indication that tributyl phosphate does exist in tank BY-103. That tributyl phosphate was not observed in the TST samples may be due to 1) the fact that tributyl phosphate has a very low vapor pressure, and 2) the tendency for tributyl phosphate to adsorb on the high efficiency particulate air (HEPA) filters used during sampling to protect the samples from radiological particulate contamination.

Semivolatiles dominate the tentatively identified compound lists. The abundance of branched alkanes, as well as the decahydronaphthalenes, has also been noted in other 241-BY farm tanks.

Table X-1
Tank BY-103 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	Organic vapors	4 tank air samples + 1 trip blank + 1 field blank
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 BY-103 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	26	2	8
Carbon Dioxide, CO ₂	124-38-9	SUMMA TM	3	126	5	4
Carbon Monoxide, CO	630-08-0	SUMMA TM	3	< 12	--	--
Hydrogen, H ₂	1333-74-0	SUMMA TM	3	< 99	--	--
Nitric Oxide, NO	10102-43-9	Sorbent Trap	6	≤ 0.09	--	--
Nitrogen Dioxide, NO ₂	10102-44-0	Sorbent Trap	6	≤ 0.02	--	--
Nitrous Oxide ³ , N ₂ O	10024-97-2	SUMMA TM	3	16.5	0.7	4
Water Vapor, H ₂ O	7732-18-5	Sorbent Trap	6	16,200 (11.6 mg/L)	2,550 (1.8 mg/L)	16

1. CAS = Chemical Abstracts Service.

2. RSD = relative standard deviation.

3. Detected in only 2 samples.

Table X-3
Comparison of Selected Analytes in Selected 241-BY Farm Tanks

Tank	Ammonia (ppmv)	Hydrogen (ppmv)	Nitrous Oxide (ppmv)	TNMOC ¹ (mg/m ³)
BY-103 ²	26	< 99	16.5	5.2
BY-104 ³	248	295	201	60.8
BY-105 ⁴	43	48	50	12.7
BY-106 ⁵	74	46	71	9.9
BY-107 ⁶	972	267	621	173
BY-108 ⁷	1040	399	641	594
BY-109 ⁸	46	56	10.7	16.1

1. TNMOC = total nonmethane organic compounds.
2. Ammonia, hydrogen, and nitrous oxide results are from McVeety et al. 1995a; TNMOC results are from Rasmussen 1994a.
3. Ammonia result is from Clauss et al. 1994; hydrogen, nitrous oxide, and TNMOC results are from Rasmussen 1994b.
4. Ammonia result is from Pool et al. 1995a; hydrogen, nitrous oxide, and TNMOC results are from Rasmussen 1994c.
5. Ammonia result is from Lucke et al. 1995; hydrogen, nitrous oxide, and TNMOC results are from Rasmussen 1994d.
6. Ammonia, hydrogen, and nitrous oxide results are from Clauss et al. 1995; TNMOC result is from Rasmussen 1994e.
7. Ammonia, hydrogen, and nitrous oxide results are from McVeety et al. 1995b; TNMOC result is from Rasmussen 1994e.
8. Ammonia results are from Pool et al. 1995b; hydrogen, nitrous oxide, and TNMOC results are from Rasmussen 1994f.

Table X-4
Tank BY-103 Positively Identified Organic Compound Average Concentrations

Compound	CAS ¹ Number	Sample Type	Average (ppmv)	Standard Deviation (ppmv)	RSD ² (%)
Trichlorofluoromethane	75-69-4	SUMMA ^{TM,3}	0.048	0.018	37
Ethanenitrile (acetonitrile)	75-05-8	TST ⁴ SUMMA TM	0.026 < 0.005	0.010 --	38 --
Propanone (acetone)	67-64-1	TST SUMMA TM	0.11 0.49	0.07 0.22	67 45
Dichloromethane ^{5,6}	75-09-2	TST SUMMA TM	< 0.0021 < 0.005	-- --	-- --
Propanenitrile ^{5,6}	107-12-0	TST SUMMA TM	< 0.0033 < 0.005	-- --	-- --
Butanal	123-72-8	TST	0.056	0.066	118
2-Butanone	78-93-3	SUMMA TM	0.068	0.003	4
n-Hexane ^{5,6}	110-54-3	TST SUMMA TM	< 0.0026 < 0.005	-- --	-- --
Benzene ⁵	71-43-2	TST SUMMA TM	0.0018 < 0.005	0.0009 --	49 --
1-Butanol ⁵	71-36-3	TST	2.0	0.5	23
Butanenitrile	109-74-0	TST SUMMA TM	0.090 < 0.005	0.14 --	156 --
2-Pentanone	107-87-9	TST	0.019	0.013	68
n-Heptane ^{5,6}	142-82-5	TST SUMMA TM	< 0.0013 < 0.005	-- --	-- --
Tetrahydrofuran ⁷	109-99-9	SUMMA TM	0.067	0.0004	6
Toluene ⁵	108-88-3	TST SUMMA TM	0.0015 < 0.005	0.0008 --	53 --
Pentanenitrile ^{5,6}	110-59-8	TST SUMMA TM	< 0.0030 < 0.005	-- --	-- --
2-Hexanone ⁵	591-78-6	TST	0.0049	0.0045	92
n-Octane ^{5,6}	111-65-9	TST	< 0.00098	--	--
Hexanenitrile ^{5,6}	628-73-9	TST	< 0.0018	--	--
2-Heptanone	110-43-0	TST	0.0061	0.0041	67
n-Nonane ^{5,6}	111-84-2	TST	< 0.0023	--	--

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Heptanenitrile ^{5,6}	629-08-3	TST	< 0.0036	--	--
2-Octanone ⁵	111-13-7	TST	0.0020	0.0017	85
n-Decane ^{5,6}	124-18-5	TST	< 0.0054	--	--
		SUMMA™	< 0.005	--	--
n-Undecane ^{5,6}	1120-21-4	TST	< 0.0048	--	--
n-Dodecane	112-40-3	TST	0.017	0.002	12
n-Tridecane	629-50-5	TST	0.029	0.003	10

1. CAS = Chemical Abstract Service.
2. RSD = relative standard deviation.
3. SUMMA™ canister results based on analyses of 3 samples.
4. TST results are based on analyses of 3 samples.
5. Two or more TST samples fell outside of calibration range.
6. Positively identified in TSTs, but below quantitation limits.
7. Detected in only 2 samples.

Table X-5
Tank BY-103 Tentatively Identified Organic Compounds in SUMMA™ Samples

Cmpd #	Compound	CAS ¹ Number	Average (mg/m ³)	Standard Deviation (mg/m ³)
1	Ethanol	64-17-5	0.13	0.03
2	Isopropyl Alcohol	67-63-0	0.16	0.06
3	Butanal ²	123-72-8	0.06	--
4	1-Butanol	71-36-3	2.48	0.49
5	2-Pentanone	107-87-9	0.06	0.01
6	Dodecane	112-40-3	0.21	0.05
7	2,6-Dimethylundecane	17301-23-4	0.09	0.03
8	Unknown C13 Alkene/Cycloalkane		0.06	0.01
9	Unknown C14 Alkane		0.18	0.06
10	Tridecane	629-50-5	0.51	0.15
11	Unknown Alkane ²		0.06	--
12	Unknown C13 Alkene/Cycloalkane		0.07	--
13	Unknown Alkane ²		0.07	--
14	Unknown C15 Alkane		0.31	0.18
15	Tetradecane	629-59-4	0.55	0.29
16	Unknown Alkane ³		0.07	0.02
17	Unknown Alkane ²		0.07	--
18	Unknown C16 Alkane		0.38	0.17
19	Unknown C15 Alkane ²		0.06	--
20	Pentadecane	629-62-9	0.22	0.03
Sum of tentatively identified compounds:			5.8	

1. CAS = Chemical Abstract Service.

2. Detected in only 1 sample.

3. Detected in only 2 samples.

Table X-6
Tank BY-103 Tentatively Identified Organic Compounds in TST Samples

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
1	methyl ether		0.178	0.0268
2	methane, trichlorofluoro-	75-69-4	0.260	0.1377
3	2-propanol	67-63-0	0.266	0.0767
4	1-propene, 2-fluoro- and cyclopropane		0.119	0.0311
5	2-butanone	78-93-3	0.099	0.1706
6	unknown		0.030	0.0289
7	acetic acid	64-19-7	0.038	0.0424
8	1-pentanol	71-41-0	0.027	0.0233
9	methylamine, n-(1-methylbutylidene)-	22431-09-0	0.011	0.0188
10	cyclotrisiloxane, hexamethyl-	541-05-9	0.023	0.0406
11	benzene, 1,2-dimethyl- and c3-cyclopropane		0.014	0.0137
12	cyclopropane, propyl- and c2-benzene		0.010	0.0179
13	3-heptanone	106-35-4	0.042	0.0246
14	heptanal	111-71-7	0.008	0.0138
15	3-buten-2-ol	598-32-3	0.092	0.0462
16	cyclotetrasiloxane, octamethyl-	556-67-2	0.020	0.0344
17	octanal	124-13-0	0.008	0.0134
18	1-hexanol, 2-ethyl-	104-76-7	0.008	0.0141
19	pentanal, 2-methyl-	123-15-9	0.008	0.0135
20	nonanal	124-19-6	0.012	0.0216
21	benzeneacetic acid, .alpha.,4-bis[(trimethylsilyl) oxy]-,methyl ester	55334-40-2	0.022	0.0218
22	heptane, 3-ethyl-2-methyl-	14676-29-0	0.023	0.0210
23	undecane, 2-methyl-	7045-71-8	0.020	0.0190
24	undecane, 3,7-dimethyl-	17301-29-0	0.007	0.0127

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25	cyclododecane	294-62-2	0.003	0.0057
26	cyclopentane, 1-hexyl-3-methyl-	61142-68-5	0.004	0.0061
27	decanal	112-31-2	0.010	0.0013
28	undecane, 2,6-dimethyl-	17301-23-4	0.072	0.0104
29	alkane and acetophenone, 2'-hydroxy-5'-methoxy-		0.002	0.0043
30	cyclohexane, 2-butyl-1,1,3-trimethyl-	54676-39-0	0.023	0.0022
31	dimethyl-decahydronaphthalene		0.005	0.0047
32	cyclohexane, hexyl-	4292-75-5	0.025	0.0046
33	dodecane, 6-methyl-	6044-71-9	0.007	0.0060
34	undecane, 2,4-dimethyl-	17312-80-0	0.008	0.0093
35	dodecane, 4-methyl-	6117-97-1	0.011	0.0100
36	dodecane, 2-methyl-	1560-97-0	0.036	0.0061
37	decane, 2,6,7-trimethyl-	62108-25-2	0.154	0.0193
38	c7-cyclohexane		0.005	0.0045
39	trimethyl-decahydronaphthalene		0.006	0.0049
40	1-tridecene	2437-56-1	0.015	0.0022
41	6-tridecene, 7-methyl-	24949-42-6	0.018	0.0056
42	1-tetradecene		0.008	0.0016
43	c14-alkene		0.011	0.0018
44	decane, 2,6,7-trimethyl-		0.009	0.0077
45	c13-alkene		0.006	0.0052
46	dodecane, 2,5-dimethyl	56292-65-0	0.023	0.0202
47	c7-cyclohexane		0.003	0.0044
48	c14-alkene		0.003	0.0047
49	tridecane, 6-methyl-	13287-21-3	0.012	0.0216
50	tridecane, 6-methyl-	13287-21-3	0.016	0.0014
51	c8-cyclohexane		0.042	0.0047
52	tridecane, 4-methyl-	26717	0.028	0.0029
53	tridecane, 2-methyl-	1560-96-9	0.044	0.0042

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54	alkyl-cyclohexane and others		0.009	0.0007
55	dodecane, 3-methyl-	17312-57-1	0.026	0.0025
56	dodecane, 2,6,10-trimethyl-	3891-98-3	0.209	0.0206
57	4-nonene, 2,3,3-trimethyl-, (Z)-	63830-68-2	0.031	0.0064
58	tetradecane	629-59-4	0.370	0.0342
59	c14-alkane		0.062	0.0056
60	tetradecane	629-59-4	0.016	0.0031
61	c14-alkane and others		0.011	0.0098
62	pentadecane	629-62-9	0.005	0.0087
63	alkane		0.003	0.0047
64	3-decanol	1565-81-7	0.018	0.0088
65	alkanol		0.038	0.0254
66	alkane		0.004	0.0068
67	1-octanol, 2-butyl-		0.009	0.0079
68	pentadecane	629-62-9	0.032	0.0288
69	c15-alkane		0.004	0.0073
70	c15-alkane		0.015	0.0268
71	hexadecane	544-76-3	0.136	0.1215
72	dodecane, 2-methyl-8-propyl-		0.072	0.1249
73	tetradecane, 3-methyl-	18435-22-8	0.015	0.0135
74	pentadecane, 2-methyl-	1560-93-6	0.008	0.0141
75	alkane		0.006	0.0057
76	hexadecane, 2,6,10,14-tetramethyl-	638-36-8	0.009	0.0079
77	c15-alkane		0.005	0.0090
78	1-dodecyn-4-ol		0.042	0.0286
79	pentadecane	629-62-9	0.259	0.0402
80	alkanol		0.005	0.0086
81	alkane		0.002	0.0032
82	tetradecane, 2,5-dimethyl-		0.007	0.0057
83	2,3-butanediol, 2,3-dimethyl-	76-09-5	0.003	0.0052

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84	pentadecane	629-62-9	0.003	0.0054
85	alkanoic acid		0.005	0.0093
86	tetradecane, 2,6,10-trimethyl-		0.017	0.0151
87	pentadecane, 2,6,10-trimethyl- (nor-pristan)		0.013	0.0223
88	tetradecane, 4,11-dimethyl-	55045-12-0	0.008	0.0010
89	pentadecane, 2-methyl-	1560-93-6	0.026	0.0229
90	dodecane, 2-methyl-8-propyl-	55045-07-3	0.013	0.0230
91	hexadecane	544-76-3	0.017	0.0020
92	alkane		0.007	0.0060
93	c16-alkane		0.004	0.0062
94	5-undecanone, 2-methyl-	50639-02-6	0.019	0.0017
95	alkanone		0.005	0.0090
96	tridecane, 2,5-dimethyl-	56292-66-1	0.006	0.0050
97	dodecane, 4,9-dipropyl-	3054-63-5	0.003	0.0052
98	alkanal		0.003	0.0044
99	hexadecane	544-76-3	0.113	0.0040
100	1,1'-biphenyl, 2-chloro-	2051-60-7	0.006	0.0052
101	cyclohexadecane	295-65-8	0.003	0.0050
102	phthalate		0.020	0.0026
103	dodecane, 2,6,10-trimethyl-	3891-98-3	0.010	0.0174
104	pentadecane, 2,6,10-trimethyl- (non-pristan)		0.009	0.0149
105	dodecane, 4,9-dipropyl-		0.013	0.0230
106	benzenamine, n-phenyl-	122-39-4	0.005	0.0045
107	5-tridecanone		0.005	0.0085
108	heptadecane	629-78-7	0.018	0.0065
109	pentadecane, 2,6,10,14-tetramethyl-	1921-70-6	0.018	0.0078
110	alkene		0.005	0.0089
111	alkane		0.003	0.0058
112	tetradecanoic acid	544-63-8	0.058	0.0210

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113	eicosane	112-95-8	0.013	0.0219
114	benzenesulfonamide, n-butyl-	3622-84-2	0.055	0.0197
115	tetradecanoic acid	544-63-8	0.002	0.0033
116	pentadecanoic acid	1002-84-2	0.027	0.0123
117	1-hexadecanol	36653-82-4	0.006	0.0050
118	2-octadecenal	56554-96-2	0.008	0.0140
119	9-hexadecenoic acid	2091-29-4	0.050	0.0436
120	hexadecanoic acid	57-10-3	0.113	0.0893
121	eicosane	112-95-8	0.016	0.0283
122	hexadecanoic acid, 1-methylethyl ester	142-91-6	0.017	0.0180
123	hexadecanoic acid	57-10-3	0.003	0.0057
124	1-hexadecene	629-73-2	0.016	0.0141
125	1-hexadecanol	36653-82-4	0.004	0.0073
126	eicosane	112-95-8	0.003	0.0052
Sum of tentatively identified compounds:			4.15	

1. CAS = Chemical Abstract Service.
2. Average includes samples where concentration was zero.

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