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Tank 241-BY-111 Vapor Sampling and Analysis Tank Characterization Report (WHC-SD-WM-ER-440)		ECN No.

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7. Abstract

Tank 241-BY-111 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-111 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-111 Vapor Sampling and Analysis Tank Characterization Report

X.0 INTRODUCTION

Tank BY-111 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-111 was vapor sampled in accordance with *Data Quality Objectives for Generic In-Tank Health and Safety Issue Resolution* (Osborne et al. 1994).

Tank BY-111 was vapor sampled on May 11, 1994 using the *in situ* sampling (ISS) method (Pingel 1994), and again on November 16, 1994 using the more robust vapor sampling system (VSS) method (WHC 1995). There were problems with the May 1994 sampling event (i.e., some samples were radiolytically contaminated) and only the SUMMA™ canister samples were analyzed. 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-111 using the VSS on November 16, 1994 by WHC Sampling and Mobile Laboratories (WHC 1995). Sample collection and analysis were performed as directed by *Tank 241-BY-111 Tank Characterization Plan* (TCP), (Homi 1994). The tank headspace temperature was determined to be 27 °C. Air from the tank BY-111 headspace was withdrawn via a 7.3 m-long heated sampling probe mounted in riser 12A, and transferred via heated tubing to the VSS sampling manifold.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 13 trip blanks and 1 field blank that accompanied the samples.

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 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™,[1] canister tank air samples for selected inorganic gases and vapors are given in Table X-2 in parts per million by volume (ppmv). Carbon dioxide results are from SUMMA™ samples collected in November 1994 and analyzed by PNL (Lucke et al. 1995a); carbon monoxide, hydrogen, and nitrous oxide results are from SUMMA™ samples collected in May 1994 and analyzed by Oregon Graduate Institute of Science and Technology (OGIST), (Rasmussen 1994a). Inorganic analyte sorbent traps were prepared and analyzed by PNL (Lucke et al. 1995a).

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 0.6 % for nitrous oxide, to 28 % for carbon dioxide 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, 59 ppmv, is over twice the National Institute of Occupational Safety and Health (NIOSH) 8-hr recommended exposure limit (REL) of 25 ppmv (NIOSH 1995). Ammonia is thought to be a product of chemical and radiolytic waste degradation processes. It has been observed in virtually all of the waste tanks sampled to date, at concentrations ranging from about 3 ppmv in C-108 (Lucke et al. 1995b), to 1040 ppmv in tank BY-108 (McVeety et al. 1995a).

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 67 ppmv of hydrogen in tank BY-111, however, represents only about 0.2 % 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 BY-111, 98.9 ppmv, is about 4 times the NIOSH 8-hr REL of 25 ppmv (NIOSH 1995).

For comparison, the measured concentrations of ammonia, hydrogen, and nitrous oxide for the Ferrocyanide Watchlist tanks in 241-BY farm are given in Table X-3. Among these tanks, tank BY-111 has a moderately low level of ammonia, hydrogen, and nitrous oxide. 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 not linear.

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

X.2.2 Carbon Dioxide and Carbon Monoxide

The average measured headspace carbon dioxide concentration, 219 ppmv, is about one-half of the normal ambient air concentration of about 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 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. The 219 ppmv carbon dioxide concentration measured in tank BY-111 is typical of other tanks sampled to date.

Carbon monoxide in the tank BY-111 headspace, measured to be < 1 ppmv, is below the NIOSH 8-hr REL of 35 ppmv (NIOSH 1995). Elevated carbon monoxide concentrations have been observed in other waste tanks, and are thought to be due to the decomposition of organic waste in the tanks. The highest measured waste tank carbon monoxide concentration was 26.7 ppmv in tank C-103 (Huckaby and Story 1994).

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

Nitric oxide and nitrogen dioxide concentrations in the tank BY-111 headspace were determined to be ≤ 0.15 ppmv and ≤ 0.05 ppmv, respectively. These are both acid gases that would have very low equilibrium concentrations above the high pH waste in tank BY-111. Nitric oxide has been found at trace concentrations in other waste tanks, 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-111 was measured to be 6.9 mg/L, at the tank headspace temperature of 27 °C and pressure of 976 mbar (732 torr), (WHC 1995). This corresponds to a water vapor partial pressure of 9.6 mbar (7.2 torr), to a dew point of 6.4 °C, and to a relative humidity of 27 %. This is a very low water vapor concentration compared to other waste tanks. Hanlon (1995) reports tank BY-111 has essentially no aqueous supernate; the low water vapor concentration may be indicative of the lack of free water near the waste surface in tank BY-111.

A test of the efficiency of the silica gel traps used to collect water vapor was performed during the tank BY-111 sampling event (Lucke et al. 1995a). The test indicated that the normal sampling system trapped 96 % of the total water vapor. The water vapor concentrations in Table X-2 and discussed above have been corrected for the additional 4 %.

A silica gel sorbent trap was used to sample for tritium. 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 7 mg of water vapor, indicated the total activity of the sample to be below the method detection limit of 5 pCi (WHC 1995).

X.3 ORGANIC VAPORS

Organic vapors in the tank BY-111 headspace were sampled using SUMMA™ canisters, which were analyzed at 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. (1995a) and Lucke 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 OGIST on samples collected in May 1994 by the ISS method (Pingel 1994, Rasmussen 1994a).

SUMMA™ sample results should be considered to be the primary organic vapor data for tank BY-111. 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 15 of 27 target analytes selected by WHC. The detected analytes, and their average concentrations from the analysis of 3 TSTs, are given in Table X-4. The 27 TST target analytes for tank BY-111 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 et al. 1994). Acetone was measured to be above the method's upper calibration limit, and 10 of the other target analytes were positively identified by ORNL, but below the method's lower calibration limit. These are indicated in Table X-4.

Also given in Table X-4 are the organic compounds positively identified and quantitated in SUMMA™ canister samples by PNL. 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, Lucke et al. 1995a). Of the original 40 TO-14 analytes, only trichlorofluoromethane was detected above the 0.002 ppmv quantitation limit, and only 4 of the 15 additional target analytes were above the 0.005 ppmv method quantitation limit. Averages reported are from analyses of 3 SUMMA™ canister samples.

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

1) 2 of the analytes, vinylidene chloride and dichloromethane, were not detected in either sample type;

2) TST samples had 0.050 ppmv of acetonitrile, but SUMMA™ canister samples were found to have < 0.005 ppmv;

3) propanenitrile, butanenitrile, and pentanenitrile were found to be < 0.005 ppmv in both TST and SUMMA™ samples;

4) the 2 methods disagree on the concentrations acetone, n-hexane, benzene, n-heptane, and toluene.

Though the discrepancies between the TST and SUMMA™ sample analyses are currently not understood, and do exceed the accuracy requirements of the TCP, the reported concentrations are not above action limits. None of the analytes in Table X-4 is above NIOSH recommended work-place guidelines. The 0.050 ppmv acetonitrile concentration measured in TST samples, for example, is well below its NIOSH 8-hr REL of 20 ppmv. Similarly, the 1.55 ppmv of acetone measured in the SUMMA™ samples is well below its NIOSH 8-hr REL of 250 ppmv (NIOSH 1995). Furthermore, at the reported concentrations, the Table X-4 analytes do not individually or cumulatively represent a flammability hazard.

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 1.01 bar.

Both ORNL and PNL tentatively identify analytes by comparing the mass spectrometer (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 Tables X-5 and X-6, particularly near the bottom of the tables where the analytes have higher molecular weights, illustrate this.

The ORNL and PNL methods used to tentatively identify and estimate concentrations are described by Jenkins et al. (1995a) and Lucke et al.

(1995a), respectively, and should be reviewed before this data is used for decision making. 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 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.

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 (e.g., Cmpd # 15 and 16 in Table X-6). In these instances, the estimated concentration of a compound appearing as a doublet or triplet is simply the sum of the individual peak estimates.

X.3.3 Total Nonmethane Organic Compounds

OGIST measured the total nonmethane organic compound (TNMOC) concentration in 3 SUMMA™ canister samples collected on May 11, 1994 (Pingel 1994) using the EPA TO-12 method (Rasmussen 1994a). The sample mean was 9.6 mg/m^3, with a standard deviation of 0.2 mg/m^3. MS analyses indicated only 2.2 mg/m^3 of organic vapors in TST samples (Jenkins et al. 1995a). These values are in general agreement, with the difference probably due to the fact that the MS analysis of TST samples (unlike the EPA TO-12 method) did not include certain volatile compounds (e.g., propane, propene), or any compounds below specified laboratory criteria.

TNMOC measurements of other waste tanks have ranged from as high as 5,000 mg/m^3 in tank C-103 (Rasmussen and Einfeld 1994), to as low as 0.18 mg/m^3 in tank C-111 (Rasmussen 1994b), while the TNMOC concentration of clean ambient air ranges from about 0.03 to 0.1 mg/m^3. For comparison, the TNMOC concentrations of the Ferrocyanide Watchlist tanks in 241-BY farm are listed in Table X-3.

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 0.13 ppmv of trichlorofluoromethane measured in tank BY-111, its presence has

been noted in many of the tanks sampled to date. 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 been placed into 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.

Most 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 SUMMA™ 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-111. 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.

In general, the tank BY-111 organic vapor signature appears to be very similar to other NPH-rich waste tanks in 241-C and 241-BY farms.

Table X-1
Tank BY-111 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	2.0	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-111 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	59	2	3
Carbon Dioxide, CO_2	124-38-9	SUMMA™	3	219	61	28
Carbon Monoxide[3], CO	630-08-0	SUMMA™	3	< 1	--	--
Hydrogen[3], H_2	1333-74-0	SUMMA™	3	67	2	3
Nitric Oxide, NO	10102-43-9	Sorbent Trap	6	≤ 0.15	--	--
Nitrogen Dioxide, NO_2	10102-44-0	Sorbent Trap	6	≤ 0.05	--	--
Nitrous Oxide[3], N_2O	10024-97-2	SUMMA™	3	98.9	0.6	0.6
Water Vapor, H_2O	7732-18-5	Sorbent Trap	6	9,830 (6.9 mg/L)	950 (0.7 mg/L)	9.7

1. CAS = Chemical Abstracts Service.

2. RSD = relative standard deviation.

3. Rasmussen 1994a.

Table X-3
Comparison of Selected Analytes in
241-BY Farm Ferrocyanide Watchlist 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-110[8]	401	< 160	103	29
BY-111[9]	59.2	67	98.9	9.6
BY-112[10]	63	< 94	40	5.8

1. TNMOC = total nonmethane organic compounds.

2. Ammonia, hydrogen, and nitrous oxide results are from McVeety et al. 1995b; TNMOC results are from Rasmussen 1994a.

3. Ammonia result is from Clauss et al. 1994; hydrogen, nitrous oxide, and TNMOC results are from Rasmussen 1994c.

4. Ammonia result is from Pool et al. 1995; hydrogen, nitrous oxide, and TNMOC results are from Rasmussen 1994d.

5. Ammonia result is from Lucke et al. 1995c; hydrogen, nitrous oxide, and TNMOC results are from Rasmussen 1994e.

6. Ammonia, hydrogen, and nitrous oxide results are from Clauss et al. 1995a; TNMOC result is from Rasmussen 1994f.

7. Ammonia, hydrogen, and nitrous oxide results are from McVeety et al. 1995a; TNMOC result is from Rasmussen 1994f.

8. Ammonia, hydrogen, and nitrous oxide results are from Clauss et al. 1995b; TNMOC is estimated from mass spectra data by Jenkins et al. 1995b.

9. Ammonia results are from Lucke et al. 1995a; hydrogen, nitrous oxide, and TNMOC results are from Rasmussen 1994a.

10. Ammonia, hydrogen, and nitrous oxide results are from Clauss et al. 1995c; TNMOC was estimated from mass spectral data by Jenkins et al. 1995c.

Table X-4
Tank BY-111 Positively Identified Organic Compound Average Concentrations

Compound	CAS[1] Number	Sample Type	Average (ppmv)	Standard Deviation (ppmv)	RSD[2] (%)
Trichlorofluoromethane	75-69-4	SUMMA™,[3]	0.129	0.007	6
Ethanenitrile (acetonitrile)	75-05-8	TST[4]	0.050	0.003	5
		SUMMA™	< 0.005	--	--
Propanone (acetone)[5]	67-64-1	TST	0.48	0.02	3
		SUMMA™	1.55	0.10	6
Propanenitrile[5]	107-12-0	TST	0.0021	0.0002	8
		SUMMA™	< 0.005	--	--
Butanal[5]	123-72-8	TST	0.0026	0.0005	20
2-Butanone	78-93-3	SUMMA™	0.106	0.003	3
n-Hexane	110-54-3	TST	0.011	0.002	20
		SUMMA™	< 0.005	--	--
Benzene	71-43-2	TST	0.011	0.003	31
		SUMMA™	< 0.005	--	--
Butanenitrile[5]	109-74-0	TST	0.0024	0.0004	18
		SUMMA™	< 0.005	--	--
n-Heptane[5]	142-82-5	TST	0.0017	0.0004	26
		SUMMA™	0.040	0.001	15
Toluene[5]	108-88-3	TST	0.0031	0.0011	35
		SUMMA™	0.044	0.003	6
Pentanenitrile[5]	110-59-8	TST	< 0.00042	0.00014	33
		SUMMA™	< 0.005	--	--
n-Octane[5]	111-65-9	TST	< 0.0002	--	--
n-Nonane[5]	111-84-2	TST	0.00017	0.00001	7
n-Undecane[5]	1120-21-4	TST	< 0.00032	--	--
n-Dodecane[5]	112-40-3	TST	< 0.00046	--	--
n-Tridecane	629-50-5	TST	0.0015	0.0015	18

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 samples fell outside of the calibration range.

Table X-5
Tank BY-111 Tentatively Identified Organic Compounds in SUMMA™ Samples

Cmpd #	Compound	CAS[1] Number	Average (mg/m^3)	Standard Deviation (mg/m^3)
1	Propene	115-07-1	0.23	0.04
2	Propane	74-98-6	0.19	0.05
3	Cyclopropane	75-19-4	0.12	0.01
4	Isobutane	75-28-5	0.18	0.01
5	1-Butene	106-98-9	0.07	0.00
6	Butane	106-97-8	0.18	0.02
7	2-Methyl-1-propene[2]	115-11-7	0.06	--
8	Ethanol	64-17-5	0.07	0.00
9	Pentane	109-66-0	0.28	0.03
10	2-Methyl-2-propanol	75-65-0	0.15	0.01
11	2-Methyl-pentane	107-83-5	0.11	0.01
12	Butanal[3]	123-72-8	0.06	0.01
13	1-Butanol	71-36-3	0.17	0.00
14	2-Pentanone[3]	107-87-9	0.16	< 0.01
15	Cyclopentanol	96-41-3	0.06	< 0.01
16	Cyclopentanol	96-41-3	0.06	< 0.01
17	2-Hexanone	591-78-6	0.08	< 0.01
18	Octane	111-65-9	0.06	< 0.01
19	3-Heptanone	106-35-4	0.18	0.01
21	2-Heptanone[3]	110-43-0	0.07	< 0.01
22	Unknown Ketone[2]		0.07	--
24	Undecane	1120-21-4	0.07	0.00
25	Dodecane	112-40-3	0.09	0.00
26	Tridecane	629-50-5	0.07	0.01
Sum of tentatively identified compounds:			2.84	

1. CAS = Chemical Abstract Service.

2. Detected in only 1 sample.

3. Detected in only 2 samples.

Table X-6
Tank BY-111 Tentatively Identified Organic Compounds in TST Samples

Compound	CAS[1] Number	Average (mg/m^3)	Standard Deviation (mg/m^3)
Cyclopropane	75-19-4	0.0120	0.00163
Isobutane	75-28-5	0.0158	0.00337
1-Propene, 2-methyl-	115-11-7	0.0804	0.00591
Butane	106-97-8	0.1851	0.03169
1-Butene	106-98-9	0.0229	0.00217
Cyclobutane	287-23-0	0.0165	0.00202
Butane, 2-methyl- & Ethanol		0.0555	0.00860
Trichloromonofluoromethane	75-69-4	0.1117	0.00342
1-Pentene	109-67-1	0.0125	0.00195
1,3-Butadiene, 2-methyl	78-79-5	0.0089	0.00225
Isopropyl alcohol	67-63-0	0.0087	0.00798
2-Butene, 2-methyl	513-35-9	0.0019	0.00326
1-Pentene	109-67-1	0.0056	0.00485
Butane, 2,2-dimethyl-	75-83-2	0.0077	0.00095
Pentane, 2-methyl-	107-83-5	0.0308	0.00484
2-Propenal, 2-methyl	78-85-3	0.0024	0.00409
1-Propanol	71-23-8	0.0024	0.00409
Pentane, 3-methyl-	96-14-0	0.0082	0.00082
1-Hexene	592-41-6	0.0054	0.00472
3-Buten-2-one	78-94-4	0.0061	0.00568
Propanal, 2-methyl	78-84-2	0.0019	0.00322
Furan, tetrahydro-	109-99-9	0.0075	0.00111
Hexane, 3-methyl	589-34-4	0.0054	0.00475
2-Butanone, 3,3-dimethyl	75-97-8	0.0189	0.00102
2-Pentanone, 4,4-dimethyl	590-50-1	0.0076	0.00161
Cyclohexane, 1,1,3-trimethyl	3073-66-3	0.0014	0.00237
Cyclotetrasiloxane, octmethyl	556-67-2	0.0031	0.00281

Compound	CAS[1] Number	Average (mg/m^3)	Standard Deviation (mg/m^3)
Naphthalene, decahydro-2-methyl	2958-76-1	0.0014	0.00244
Cyclohexane, 2-butyl-1,1,3-trimethyl-	54676-39-0	0.0108	0.00221
Methenamine	100-97-0	0.0316	0.01372
Cyclohexane, 1,3,5-trimethyl-2-octdecyl	55282-34-3	0.0026	0.00231
2(3H)-Benzofuranone, 3a,4,5,6-tetra	16778-26-0	0.0034	0.00291
Cyclohexane, 1-(cyclohexylmethyl)2-ethyl	54934-93-9	0.0056	0.00171
Benzenesulfonamide, N-butyl	3622-84-2	0.0161	0.00967
Eicosane	112-95-8	0.0226	0.02784
Isopropyl Palmitate	142-91-6	0.0017	0.00303
Hexadecanal	629-80-1	0.0016	0.00271
Sum of tentatively identified compounds:		0.74	

1. CAS = Chemical Abstract Service.

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