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7. Abstract

Tank 241-TX-105 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-TX-105 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-TX-105 Vapor Sampling and Analysis Tank Characterization Report

X.0 INTRODUCTION

Tank TX-105 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 TX-105 was vapor sampled in accordance with *Data Quality Objectives for Generic In-Tank Health and Safety Issue Resolution* (Osborne et al. 1994).

X.1 SAMPLING EVENT

Headspace gas and vapor samples were collected from tank TX-105 using the vapor sampling system (VSS) on December 20, 1994 by WHC Sampling and Mobile Laboratories (WHC 1995). Sample collection and analysis were performed as directed by *Tank 241-TX-105 Tank Characterization Plan* (TCP), (Carpenter 1994). The tank headspace temperature was determined to be 24.8 °C. Air from the tank TX-105 headspace was withdrawn via a 6.1 m-long heated sampling probe mounted in riser 11A, and transferred via heated tubing to the VSS sampling manifold.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 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 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). Inorganic analyte sorbent traps and SUMMA™ canisters were prepared and analyzed by PNL (Klinger et al. 1995).

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

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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 5 % for ammonia, to 16 % 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, 20 ppmv, is less than 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. 1995), to 1040 ppmv in BY-108 (McVeety et al. 1995). The 20 ppmv of ammonia in tank TX-105 is among the lowest reported for waste 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, they appear ubiquitously with the high-level waste. Neither gas is highly soluble in the aqueous wastes of the tanks, so except for situations where bubbles are trapped within the waste and released episodically, the gases are released as they are generated. The concentration of these gases in the tank headspaces is therefore a function of their overall generation rate and the rate at which they are vented to the atmosphere.

The concentration of hydrogen in tank TX-105 was determined to be less than the method detection limit of 99 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, the 99 ppmv detection limit for hydrogen corresponds to about 0.25 % of its LFL, and indicates hydrogen is not a flammability concern in tank TX-105.

The nitrous oxide concentration in tank TX-105, 12.8 ppmv detected in only 1 of the 3 SUMMA^{TM} samples analyzed, is about half of the NIOSH 8-hr REL of 25 ppmv (NIOSH 1995). Nitrous oxide, also known as laughing gas, is usually present at higher concentrations in the waste tanks, and has been observed to be as high as about 800 ppmv in tank C-103 (Huckaby and Story 1994).

X.2.2 Carbon Dioxide and Carbon Monoxide

The average measured headspace carbon dioxide concentration, 156 ppmv, is well below 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 156 ppmv carbon dioxide concentration measured in tank TX-105 is typical of other tanks sampled to date.

Carbon monoxide in the tank TX-105 headspace, measured to be < 12 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 waste tank carbon monoxide concentration measured to date 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 TX-105 headspace were determined to be 1.04 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 TX-105. Nitric oxide has been found at similar 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 TX-105 was measured to be 13.2 mg/L, at the tank headspace temperature of 24.8 °C and pressure of 986 mbar (740 torr), (WHC 1995). This corresponds to a water vapor partial pressure of 18.1 mbar (13.6 torr), to a dew point of 15.9 °C, and to a relative humidity of 58 %.

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 15 mg of water vapor, indicated the total activity of the sample to be below the method detection limit of 50 pCi in the sample (WHC 1995).

X.3 ORGANIC VAPORS

Organic vapors in the tank TX-105 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. (1995) and Klinger et al. (1995).

SUMMA™ sample results should be considered to be the primary organic vapor data for tank TX-105. ORNL analyses of TST samples from this and other waste tanks generally agree with, support, and augment the SUMMA^{TM} 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 25 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-3. The 27 TST target analytes for tank TX-105 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 18 of the other target analytes were positively identified by ORNL, but were below the method's lower calibration limit in at least 2 of the TST samples. These are indicated in Table X-3.

Also given in Table X-3 are the organic compounds positively identified and quantitated in SUMMA^{TM} canister samples by PNL. PNL performed analyses according to the Environmental Protection Agency (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, Klinger et al. 1995). Only 4 of the original 40 TO-14 analytes were detected above their 0.002 ppmv quantitation limit, and only 2 of the 14 additional target analytes were above their 0.005 ppmv method quantitation limit. Averages reported are from analyses of 3 SUMMA^{TM} canister samples. None of the analytes in Table X-3 is above NIOSH recommended work-place guidelines. Furthermore, at the reported concentrations, the Table X-3 analytes do not individually or cumulatively represent a flammability hazard.

Eleven target analytes were common to both the ORNL and PNL analyses. Except for acetone, the TST and SUMMA^{TM} sample analyses agree to within the accuracy specified in the TCP. Acetone was determined to be 0.88 ppmv in the SUMMA^{TM} samples, and 0.21 ppmv in the TST samples. Though this discrepancy between the TST and SUMMA^{TM} sample analyses is currently not understood, and do exceed the accuracy requirements of the TCP, the reported concentrations are not above action limits. The 0.88 ppmv of acetone measured in the SUMMA^{TM} samples is well below its NIOSH 8-hr REL of 250 ppmv (NIOSH 1995).

X.3.2 Tentatively Identified Organic Analytes

In addition to targeted analytes, both ORNL and PNL analytical procedures allow the tentative identification of other organic vapors. By the nature of the samples and their analysis, virtually all 3- to 15-carbon organic compounds present in the tank headspace above analytical detection limits are observable. The PNL list of tentatively identified compounds, with estimated concentrations, is given in Table X-4, and the ORNL list of tentatively identified compounds, and their estimated concentrations, is given in Table X-

5. Estimated concentrations are in mg/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 may also determine its molecular weight. The method usually does not, however, allow the unambiguous identification of structural isomers, and uncertainties increase with analyte molecular weight. Entries in Tables X-4 and X-5, 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. (1995) and Klinger et al. (1995), respectively, and should be reviewed before this data is used for decision making. Concentrations given in Tables X-4 and X-5 should be considered rough estimates. The proper quantitation of all observed analytes is outside the scope and budget of these analyses, and the estimation of concentrations involves several important assumptions. The validity of each assumption depends on the analyte, and such factors as the specific configuration of the analytical instrumentation.

Results in Tables X-4 and X-5 are presented in terms of observed peaks, and are not adjusted for the occurrence of split chromatographic peaks or the assignment of the same identity to 2 peaks (e.g., Cmpd # 33 and 42 in Table X-5). In these instances, the estimated concentration of the compound is simply the sum of the individual peak estimates.

X.3.3 Total Nonmethane Organic Compounds

One TST sample was analyzed using a gas chromatograph with flame ionization detection (GC/FID), (Jenkins et al. 1995). This analysis indicated the total organic vapor concentration in the TST sample to be about 2.5 mg/m^3. This analysis is similar to the EPA task order 12 (TO-12) method that has been performed on SUMMA^{TM} samples from many of the waste tanks. The TO-12 method is an accepted method for establishing the total nonmethane organic compound (TNMOC) concentration of an air sample using GC/FID. The analysis performed on the TST is analogous to the TO-12 method, yet differs in several ways, such as the calibration method, and that it does not include compounds more volatile than propane.

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 1994a), while the TNMOC concentration of clean ambient air ranges from about 0.03 to 0.1 mg/m^3.

X.3.4 Discussion of Organic Analytes

There are 3 general reasons that any given organic compound is present in the headspace of a waste tank: First, the organic compound may have been pumped into the tank with other waste and is simply evaporating; second, the organic compound may be a reaction product of other organic waste stored in the tank; and third, the organic vapor may have been introduced to the headspace by the exchange of air with another waste tank.

There is some evidence that tank TX-105 has trace amounts of the semivolatile normal paraffinic hydrocarbon (NPH) process diluent. A mixture of NPHs (i.e., n-undecane, n-dodecane, n-tridecane, and n-tetradecane) was used as a diluent for tributyl phosphate in several Hanford processes. NPHs have been found in all of the waste tank headspaces sampled to date in the 241-BY and 241-C tank farms, and in the only other 241-TX farm tank sampled to date, tank TX-118 (Rasmussen 1994b). TST samples from tank TX-105 were found to have trace amounts of the NPHs, however, it was also noted that comparable levels of the n-dodecane and n-tridecane were found in the TST trip and field blanks, suggesting laboratory contamination may be the real source of the NPHs in the TSTs.

The presence of trace quantities of several volatile compounds in TST samples (Table X-5), particularly the straight-chain aldehydes and ketones, also suggest that trace quantities of the NPHs exist in tank TX-105. This is based on their occurrence in tanks that have strong NPH signatures and the theory that they are radiolytic and oxidative degradation products of the NPHs, but there may be other reasons for their existence in the waste tanks. Furthermore, tanks having clear NPH signatures have also had relatively high concentrations of 1-butanol, a known degradation product of tributyl phosphate. This is consistent with the process association of NPHs with tributyl phosphate. The tank TX-105 1-butanol concentration, however, is comparable with the concentrations of other alcohols, such as methanol, ethanol, and 1-propanol, and does not provide the same strong indication that tributyl phosphate is present. Tributyl phosphate itself was not detected in either TST nor SUMMA™ samples.

Tank TX-105 has a larger variety of halogenated hydrocarbons than other tanks sampled to date. Chloromethane (methyl chloride), dichloromethane (methylene chloride), trichloromethane (chloroform), tetrachloromethane (carbon tetrachloride), trichlorofluoromethane (Freon-11), and 1,1-dichloroethene (vinylidene chloride) were all positively identified in the tank TX-105 samples. The presence and relatively high concentrations of these highly volatile compounds in the headspace suggests that they are also present as a liquid. A solution of these compounds would be expected to be quite dense (carbon tetrachloride, for example, has a specific gravity of 1.6 at 25 °C), and might reside below any aqueous waste. The evaporation of these halogenated compounds would consequently be reduced to the rate at which they diffused through the aqueous waste.

Among tanks sampled to date, tank TX-105 samples are unique in having a homologous series of (tentatively identified) nitric acid esters. TST samples were found to have small quantities of the methyl, ethyl, propyl, butyl, pentyl, hexyl, and heptyl nitric acid esters. Several alkyl acid esters were also tentatively identified in TST samples.

In general, the tank TX-105 organic vapor signature is very different from the 241-BY and 241-C farm tanks sampled to date, but that is in keeping with their different waste histories. Though there are a few volatile compounds common to both tank TX-105 and the NPH-rich tanks of 241-BY and 241-C farms, the latter tend to have more volatile alkanes, alkenes, and nitriles.

Table X-1
Tank TX-105 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	0.2, 1.0, and 4.0	Organic vapors	12 tank air samples + 2 trip blank + 2 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$^{\text{TM}}$ 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 TX-105 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	20	1	5
Carbon Dioxide, CO_2	124-38-9	SUMMA™	3	156	25	16
Carbon Monoxide, CO	630-08-0	SUMMA™	3	< 12	--	--
Hydrogen, H_2	1333-74-0	SUMMA™	3	< 99	--	--
Nitric Oxide, NO	10102-43-9	Sorbent Trap	6	1.04	0.10	10
Nitrogen Dioxide, NO_2	10102-44-0	Sorbent Trap	6	≤ 0.02	--	--
Nitrous Oxide[3], N_2O	10024-97-2	SUMMA™	3	12.8	--	--
Water Vapor, H_2O	7732-18-5	Sorbent Trap	6	18,300 (13.2 mg/L)	1,100 (0.8 mg/L)	6

1. CAS = Chemical Abstracts Service.

2. RSD = relative standard deviation.

3. Detected in only 1 sample.

Table X-3
Tank TX-105 Positively Identified Organic Compound Average Concentrations

Compound	CAS[1] Number	Sample Type	Average (ppmv)	Standard Deviation (ppmv)	RSD[2] (%)
Chloromethane	74-87-3	SUMMA™,[3]	0.007	0.001	9
Trichlorofluoromethane	75-69-4	SUMMA™	0.063	0.003	4
Trichloromethane (chloroform)	67-66-3	SUMMA™	0.015	0.0001	1
Tetrachloromethane (carbon tetrachloride)	56-23-5	SUMMA™	0.317	0.007	2
Ethanenitrile (acetonitrile)	75-05-8	TST[4]	0.0056	0.0010	17
		SUMMA™	< 0.005	--	--
Propanone (acetone)[5]	67-64-1	TST	0.21	0.09	42
		SUMMA™	0.884	0.030	3
Vinylidene Chloride[5,6]	75-35-4	TST	< 0.00058	--	--
		SUMMA™	<0.002	--	--
Dichloromethane (methylene chloride)[5,6]	75-09-2	TST	< 0.0013	--	--
		SUMMA™	< 0.002	--	--
Propanenitrile[5]	107-12-0	TST	0.00084	0.00006	7
		SUMMA™	< 0.005	--	--
Butanal	123-72-8	TST	0.0080	0.0003	4
2-Butanone	78-93-3	SUMMA™	0.046	0.001	2
n-Hexane[5,6]	110-54-3	TST	< 0.00065	--	--
		SUMMA™	< 0.005	--	--
Benzene[5,6]	71-43-2	TST	< 0.00043	--	--
		SUMMA™	< 0.005	--	--
1-Butanol	71-36-3	TST	0.0097	0.0005	5
Butanenitrile[5]	109-74-0	TST	0.0016	0.0003	16
		SUMMA™	< 0.005	--	--
2-Pentanone	107-87-9	TST	0.0033	0.0005	14
n-Heptane[5]	142-82-5	TST	0.00035	0.00004	12
		SUMMA™	< 0.005	--	--
Toluene[5]	108-88-3	TST	0.00082	0.00011	13
		SUMMA™	< 0.005	--	--
Pentanenitrile[5]	110-59-8	TST	0.00029	0.00002	7

Compound	CAS[1] Number	Sample Type	Average (ppmv)	Standard Deviation (ppmv)	RSD[2] (%)
2-Hexanone[5]	591-78-6	TST	0.0011	0.00004	3
n-Octane[5]	111-65-9	TST	0.00039	0.00012	31
Hexanenitrile[5]	628-73-9	TST	0.00021	0.00001	2
2-Heptanone[5]	110-43-0	TST	0.00084	0.00002	3
n-Nonane[5]	111-84-2	TST	0.00031	0.00003	10
Heptanenitrile[5,6]	629-08-3	TST	< 0.00020	--	--
2-Octanone[5]	111-13-7	TST	0.00019	0.00001	5
n-Decane[5,6]	124-18-5	TST SUMMA™	< 0.00012 < 0.005	-- --	-- --
n-Undecane[5,6]	1120-21-4	TST	< 0.00014	--	
n-Dodecane	112-70-3	TST	0.00070	0.00004	6
n-Tridecane	629-50-5	TST	0.0010	0.0001	9

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 the calibration range.

6. Positively identified in TST samples, but below quantitation limit.

Table X-4
Tank TX-105 Tentatively Identified Organic Compounds in SUMMA™ Samples

Cmpd #	Compound	CAS[1] Number	Average (mg/m^3)	Standard Deviation (mg/m^3)
1	Acetaldehyde[2]	75-07-0	0.06	--
2	Unknown C5 ether		0.05	0.02
Sum of tentatively identified compounds:			0.11	

1. CAS = Chemical Abstract Number.

2. Detected in only 1 sample.

Table X-5
Tank TX-105 Tentatively Identified Organic Compounds in TST Samples

Cmpd #	Compound	CAS[1] Number	Average (mg/m^3)	Standard Deviation (mg/m^3)
1	Methane, chloro-	74-87-3	0.008	0.003
2	1-Propene, 2-methyl-	115-11-7	0.020	0.007
3	Acetaldehyde	75-07-0	0.012	0.018
4	Methyl Alcohol	67-56-1	0.081	0.014
5	Hydrazine, 1,1-dimethyl-	57-14-7	0.005	0.002
6	Ethanol	64-17-5	0.030	0.004
7	Trichloromonofluoromethane	75-69-4	0.058	0.012
8	Isopropyl Alcohol	67-63-0	0.005	0.001
9	Hydrazine, 1,1-dimethyl	57-14-7	0.003	0.002
10	2-Propanol, 2-methyl	75-65-0	0.015	0.022
11	Nitric acid, methyl ester	598-58-3	0.005	0.002
12	1-Propanol	71-23-8	0.029	0.003
13	2-Butanone	78-93-3	0.015	0.008
14	Chloroform	67-66-3	0.017	0.003
15	Nitric acid, ethyl ester	625-58-1	0.006	0.002
16	2-Butanone, 3-methyl	563-80-4	0.004	0.0001
17	2-Butanone, 3,3-dimethyl	75-97-8	0.011	0.001
18	Nitric acid, propyl ester	627-13-4	0.009	0.001
19	Propane, 2-methyl-2-nitro-	594-70-7	0.015	0.002
20	Propylene Glycol	57-55-6	0.006	0.008
21	1-Pentanol	71-41-0	0.003	0.003
22	2-Pentanone, 4,4-dimethyl	590-50-1	0.008	0.001
23	Hexanal	66-25-1	0.001	0.001
24	Tetrachloroethylene	127-18-4	0.003	0.0002
25	Cyclotrisiloxane, hexamethyl	541-05-9	0.006	0.001
26	Nitric acid, butyl ester	928-45-0	0.003	0.0003
27	p-Xylene	106-42-3	0.004	0.0001

Cmpd #	Compound	CAS[1] Number	Average (mg/m^3)	Standard Deviation (mg/m^3)
28	3-Heptanone	106-35-4	0.019	0.0004
29	3-Heptanol	589-82-2	0.003	0.0003
30	Heptanal	111-71-7	0.001	0.002
31	Hexanal, 3-methyl-	19269-28-4	0.001	0.001
32	3-Octanone	106-68-3	0.003	0.0002
33	Nitric acid, pentyl ester	1002-16-0	0.003	0.0004
34	Hexanoic acid, anhydride	2051-49-2	0.001	0.002
35	2-Heptanone, 6-methyl	928-68-7	0.003	0.0002
36	Benzaldehyde	100-52-7	0.004	0.0003
37	Octanal	124-13-0	0.001	0.001
38	Nitric acid, hexyl ester	20633-11-8	0.001	0.001
39	Nitric acid, 2-methyl propyl ester	543-29-3	0.001	0.002
40	2(3H)-Furanone, 5-ethyldihydro-5-methyl	2865-82-9	0.008	0.002
41	Benzyl Alcohol	100-51-6	0.003	0.000
42	Nitric acid, pentyl ester	1002-16-0	0.008	0.001
43	Acetophenone	98-86-2	0.002	0.0000
44	Nonanal	124-19-6	0.004	0.0002
45	Nitric acid, heptyl ester	20633-12-9	0.001	0.001
46	Benzoic acid, 2-[trimethylsilyl)oxy]trimethyl-	3789-85-3	0.001	0.002
47	Decanal	112-31-2	0.002	0.001
48	Alkane		0.001	0.001
49	Propanoic acid, 2-methyl-3-hydroxyl-2,4,4-trimethyl	74367-34-3	0.001	0.001
50	Tetradecane	629-59-4	0.001	0.001
51	5-Tridecanone	30692-16-1	0.001	0.001
52	Butyric acid, thio-, S-decyl	2432-55-5	0.003	0.0004
53	Diethyl Phthalate	84-66-2	0.019	0.002

Cmpd #	Compound	CAS[1] Number	Average (mg/m^3)	Standard Deviation (mg/m^3)
54	Benzenesulfonamide, N-butyl	3622-84-2	0.017	0.017
55	1,1'-Biphenyl, 2,2'-diethyl-	13049-35-9	0.001	0.002
56	Benzene, 1,1'-(1,4-butanediyl)bis-	1083-56-3	0.009	0.014
57	1,1'-Biphenyl, 2,3,4',6-tetrachloro-	52663-58-8	0.002	0.0003
Sum of tentatively identified compounds:			0.51	

[1] CAS = Chemical Abstract Service.

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