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Tank 241-TY-104 Vapor Sampling and Analysis Tank Characterization Report (WHC-SD-WM-ER-463)		ECN No.

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7. Abstract

Tank 241-TY-104 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-TY-104 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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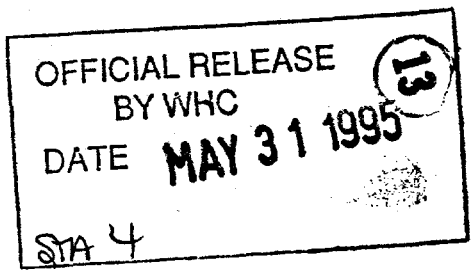

Tank 241-TY-104 Vapor Sampling and Analysis Tank Characterization Report

X.0 INTRODUCTION

Tank TY-104 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). The tank TY-104 headspace was 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 TY-104 using the vapor sampling system (VSS) on April 27, 1995 by WHC Sampling and Mobile Laboratories (WHC 1995). Sample collection and analysis were performed as directed by *Tank 241-TY-104 Tank Characterization Plan* (Homi 1995). The tank headspace temperature was determined to be 15.6 °C. Air from the tank TY-104 headspace was withdrawn from a single elevation via the temperature/vapor probe mounted in riser 3, and transferred via heated tubing to the VSS sampling manifold. All heated zones of the VSS were maintained at approximately 40 °C. All tank air samples were collected between 10:29 a.m. and 3:53 p.m., with no sampling 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 14 field blanks provided by the laboratories.

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

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

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

X.2.1 Ammonia, Hydrogen, and Nitrous Oxide

The reported ammonia concentration, 61 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 TY-104 was determined to be < 49 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, a 49 ppmv hydrogen concentration in tank TY-104 would correspond to about 0.12 % of its LFL. At this level, hydrogen is not a flammability concern in tank TY-104.

The reported nitrous oxide concentration in tank TY-104, 98 ppmv, is typical of other waste tanks sampled to date. This concentration is about 4 times the NIOSH 8-hr REL of 25 ppmv for nitrous oxide (NIOSH 1995). Nitrous oxide has been detected in other passively ventilated waste tanks at average concentrations as low as about 12 ppmv in tank TX-105 (Klinger 1995b), and as high as 763 ppmv in tank C-103 (Huckaby and Story 1994).

X.2.2 Carbon Monoxide and Carbon Dioxide

Carbon monoxide in the tank TY-104 headspace, characterized as < 23 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 carbon dioxide concentration in the tank TY-104 headspace, measured to be < 23 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. The 2 ambient air samples collected at the start of the tank TY-104 gas and vapor sampling event, for example, were measured to have an average 371 ppmv of carbon dioxide.

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 < 23 ppmv of carbon dioxide in the tank TY-104 headspace is perhaps lower than the average in other waste

tanks that have been sampled, but poses no worker safety or flammability hazard.

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

Nitric oxide and nitrogen dioxide concentrations in the tank TY-104 headspace were determined to be 0.18 ppmv and ≤ 0.02 ppmv, respectively. These are acid gases that would have very low equilibrium concentrations above the high pH sludge in tank TY-104. The measurable presence of nitric oxide is not uncommon in the waste tank headspaces, and 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 TY-104 was determined to be about 12.8 mg/L, at the measured tank headspace temperature of 15.6 °C and pressure of 982.3 mbar (736.9 torr), (WHC 1995). This corresponds to a water vapor partial pressure of 15.7 mbar (11.8 torr), to a dew point of 13.7 °C, and to a relative humidity of 88 %.

Silica gel sorbent traps were used to sample for tritium. It is assumed that tritium produced by the waste combines with hydroxide ions to form tritium-substituted water. Evaporation of the tritium-substituted water would then result in airborne radioactive contamination. Silica gel sorbent traps adsorb virtually all (normal and tritium-substituted) water vapor from the sampled tank air, and are analyzed at the WHC 222-S laboratory. 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 vapor, the most abundant waste constituents in the tank TY-104 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 concentrations of ammonia and nitrous oxide are typical of other waste tanks that have been sampled.

The relative standard deviations of the inorganic gas and vapor results given in the last column in Table X-2 are satisfactory for the methods used. Relative standard deviations range from 1.2 % for water vapor to about 11 % for nitric oxide results. The relatively poor precision of the nitric oxide results is probably due to the variable levels of background contamination in the sorbent traps. 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.), small relative standard deviations suggest proper control was maintained both in the field and in the laboratories.

X.3 ORGANIC VAPORS

Organic vapors in the tank TY-104 headspace were sampled using SUMMA™ canisters, which were analyzed by PNL, and triple sorbent traps (TSTs), which were analyzed by ORNL. PNL and ORNL both used gas chromatographs (GCs) equipped with mass spectrometer (MS) detectors 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. (1995a).

SUMMA™ sample results should be considered to be the primary organic vapor data for tank TY-104. 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 by analysis of standards. 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 39 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-3 lists the organic compounds positively identified and quantitated in SUMMA™ samples. SUMMA™ analyses were performed according to the TO-14 methodology, except for methane analysis, which was analyzed with the inorganic gases (Klinger et al. 1995a). Only 3 of the 39 TO-14 target analytes (trichlorofluoromethane, 1,1,2-trichloro-1,2,2-trifluoroethane, and tetrachloromethane) and only 5 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. Dichloromethane, dibutyl butylphosphonate, and tributyl phosphate were the only TST target analytes not detected. The

average concentrations of the detected target analytes, from the analysis of 3 TSTs, are given in Table X-4. Despite calibration of the instrument over about a 20-fold concentration range, 17 of the 24 compounds listed in Table X-4 were outside of the calibration range in at least 2 of the TST samples.

Both PNL and ORNL report target analyte concentrations in ppmv of analyte in dry air. To correct for the measured water vapor content of tank TY-104 and obtain concentration in ppmv of analyte in moist tank air, multiply the dry-air ppmv concentrations by 0.984.

Eleven target analytes were common to both TST and SUMMA™ analyses. Table X-5 lists these, and their reported average concentrations in TST and SUMMA™ samples. Results from these 2 sampling and analytical methods are in fairly good agreement. As indicated in Table X-5, the reported concentrations of acetone, acetonitrile, and propanenitrile are quite similar in SUMMA™ and TST samples. Other target analytes are generally only present at very low concentrations, however, and none are near levels of concern. Benzene, propanenitrile, and acetonitrile have the lowest NIOSH RELs of the 11 compounds in Table X-5, being 0.1, 6, and 20 ppmv, respectively.

Acetone and n-tridecane are the only organic target analytes measured 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 standards of 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, identify, and quantify 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 tentatively identified compounds recovered from SUMMA™ samples, in the order by which the eluted chromatographically, are given in Table X-6 with

estimated concentrations. 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-7. Compounds are listed in Table X-7 according to the order by which the eluted chromatographically. The averages reported by ORNL in Table X-7 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/m^3, 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 Klinger et al. (1995a), respectively, and should be reviewed before this data is used for decision making. Concentrations given in Tables X-6 and X-7 should be considered rough estimates.

X.3.4 Discussion of Organic Compounds

The organic compounds listed in Tables X-3 through X-7 may be classified as either 1) organic compounds added to tank TY-104 as waste that are still evaporating, or 2) organic compounds that have been generated by reactions of the original waste.

The first class encompasses all organic compounds that were placed into the tank as waste. It includes the semivolatile straight-chain alkanes, which were used as diluents of tributyl phosphate in various plutonium extraction processes. These 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). About 15 % of the total estimated organic vapor in tank TY-104 TST samples is due to n-dodecane, n-tridecane, and n-tetradecane.

The tentatively identified cyclosiloxanes (i.e., Cmpd # 48 and 77 in Table X-7) may also have been sent to tank TY-104 with other wastes. Small quantities of organo-silicon compounds may have been introduced to the waste tank through their use as defoaming agents, but they may also be present in the headspace due to their use in liquid traps at the tank's breather riser. These have been observed in TST blanks, however, and they may be present as artifacts of the gas chromatography process.

The absence of tributyl phosphate in the tank TY-104 samples does not necessarily indicate it is not present in the headspace or the waste. The relatively high concentrations of the tributyl phosphate diluents (i.e., n-dodecane, n-tridecane, and n-tetradecane) and their degradation products is reason to expect tributyl phosphate may be present in the tank waste. 1-Butanol, which is one of the most abundant organic compounds identified in tank TY-104 TST samples, is known to be a product of the hydrolysis of tributyl phosphate. Furthermore, informal tests by ORNL indicate that tributyl phosphate is adsorbed by the glass fiber filters used during sampling to protect the samples from radiolytic particulate contamination. Based on these considerations, the lack of tributyl phosphate in the tank TY-104

headspace samples should not be taken as proof it is not present in the headspace or the waste.

A relatively large number of halogenated organic compounds were detected in samples from tank TY-104, including dichlorofluoromethane, trichlorofluoromethane (which is frequently detected in the waste tanks), trichloromethane, tetrachloromethane, 1,1,1-trichloroethane, 1,1,2-trichloro-1,2,2-trifluoroethane, and tetrachloroethene. These compounds are frequently used as cleaning solvents and may have been sent to the waste tanks when they became radiologically contaminated.

Also present in the TST samples from tank TY-104 are several chlorinated and polychlorinated biphenyls (PCBs), (e.g., Cmpd # 160, 166, 168, 171-175, 178, 180-184, and 186 in Table X-7). PCBs were used for various industrial purposes, and small quantities may have been sent to the waste tanks when contaminated. PCBs are considered potential carcinogens by NIOSH, and the 8-hr NIOSH REL for PCBs in general is 0.001 mg/m^3 (NIOSH 1995). As indicated in Table X-7, 8 of the 15 chlorinated biphenyls had average estimated concentrations above 0.001 mg/m^3 in TST samples.

The second class includes all organic compounds that have been generated via radiolytic and chemical reactions of the waste. The majority of compounds listed in Tables X-3 through X-7 fall into this category, including the alcohols, aldehydes, alkenes, alkyl nitrates, alkyl nitrites, ketones, nitriles, and volatile alkanes, all of which have been associated with the degradation of the NPHs. In particular, alcohols and ketones are prominent in Table X-7.

The total organic vapor concentration of tank TY-104 was estimated by Jenkins et al. to be about 3 mg/m^3 from the analysis of 3 TST samples by GC/MS. A similar summation of organic compounds measured in SUMMA™ samples from tank TY-104 provides an estimated total organic vapor concentration of 1.5 mg/m^3.

Though these estimated total organic vapor concentrations are 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 about 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 1994), while the TNMOC concentration of clean ambient air ranges from about 0.03 to 0.1 mg/m^3. Compared to other waste tanks that have been sampled, tank TY-104 has a relatively low concentration of organic vapors.

Table X-1
Tank TY-104 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	4.0 and 6.0	Organic vapors	12 tank air samples, + 2 trip blanks + 2 field blanks
Pacific Northwest Laboratories	Acidified Carbon Sorbent Trap	3.0	Ammonia	6 tank air samples + 3 trip blank + 3 field blanks
	Triethanolamine Sorbent Trap	3.0	Nitrogen Dioxide	6 tank air samples + 3 trip blank + 3 field blanks
	Oxidation Bed + Triethanolamine Sorbent Trap	3.0	Nitric Oxide	6 tank air samples + 3 trip blank + 3 field blanks
	Silica Gel Sorbent Trap	3.0	Water vapor	6 tank air samples + 3 trip blanks + 3 field blanks
	SUMMA™ canister	6.0	Carbon Dioxide, Carbon Monoxide, Hydrogen, Methane, Nitrous Oxide, 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 TY-104 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	61	2	3
Carbon Dioxide, CO_2	124-38-9	SUMMA™	3	< 23	--	--
Carbon Monoxide, CO	630-08-0	SUMMA™	3	< 23	--	--
Hydrogen, H_2	1333-74-0	SUMMA™	3	< 49	--	--
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_2O	10024-97-2	SUMMA™	3	98	2.3	2
Water Vapor, H_2O	7732-18-5	Sorbent Trap	6	15,900 (11.8 mg/L)	200 (0.1 mg/L)	1.2

1. CAS = Chemical Abstracts Service.

2. RSD = relative standard deviation.

Table X-3
Tank TY-104 Positively Identified Organic Compounds in SUMMA™ Samples

Cmpd #	Compound	CAS[1] Number	Average (ppmv)	Standard Deviation (ppmv)	RSD[2] (%)
1	Ethanenitrile (acetonitrile)	75-05-8	0.069	0.009	13
2	Propanone (acetone)	67-64-1	0.11	0.01	11
3	Trichlorofluoromethane	75-69-4	0.032	0.003	10
4	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	0.022	0.002	10
5	Propanenitrile	107-12-0	0.017	0.010	56
6	1-Propanol	71-23-8	0.009	0.005	51
7	2-Butanone	78-93-3	0.007	0.0004	6
8	Tetrachloromethane (carbon tetrachloride)	56-23-5	0.009	0.0004	4
9	Methane	74-82-8	< 23	--	--
Sum of positively identified compounds:			0.95	mg/m^3	

1. CAS = Chemical Abstract Service.

2. RSD = relative standard deviation.

Table X-4
Tank TY-104 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	0.043	0.006	13
2	Propanone[3] (acetone)	67-64-1	0.097	0.009	9
3	1,1-Dichloroethene[3] (vinylidine chloride)	75-35-4	0.00016	0.00001	8
4	Propanenitrile	107-12-0	0.010	0.001	6
5	Butanal[3]	123-72-8	0.036	0.002	5
6	n-Hexane[3]	110-54-3	0.00069	0.00006	9
7	Benzene[3]	71-43-2	0.00037	0.00001	3
8	1-Butanol[3]	71-36-3	0.042	0.003	6
9	Butanenitrile	109-74-0	0.0061	0.0005	8
10	2-Pentanone	107-87-9	0.0024	0.0001	3
11	n-Heptane[3]	142-82-5	0.00042	0.00003	6
12	Toluene[3]	108-88-3	0.00058	0.00003	5
13	Pentanenitrile	110-59-8	0.0014	0.00002	1
14	2-Hexanone	591-78-6	0.00081	0.00006	8
15	n-Octane[3]	111-65-9	0.00019	0.00001	7
16	Hexanenitrile[3]	628-73-9	0.00074	0.00003	4
17	2-Heptanone[3]	110-43-0	0.00074	0.00002	3
18	n-Nonane[3]	111-84-2	0.00021	0.00002	8
19	Heptanenitrile[3]	629-08-3	0.00052	0.00003	5
20	2-Octanone[3]	111-13-7	0.00041	0.00002	6
21	n-Decane[3]	124-18-5	0.00029	0.00003	9
22	n-Undecane	1120-21-4	0.0012	0.0001	9
23	n-Dodecane[3]	112-40-3	0.016	0.001	7
24	n-Tridecane[3]	629-50-5	0.12	0.002	2
Sum of positively identified compounds:			1.8	mg/m^3	

1. CAS = Chemical Abstract Service.

2. RSD = relative standard deviation.

3. Two or more samples were outside the calibration range.

Table X-5
Tank TY-104 Comparison of 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	0.00016	< 0.005
Dichloromethane (methylene chloride)	75-09-2	< 0.00089	< 0.005
Propanone (acetone)	67-64-1	0.097	0.11
Ethanenitrile (acetonitrile)	75-05-8	0.043	0.069
Propanenitrile	107-12-0	0.010	0.017
Butanenitrile	109-74-0	0.0061	< 0.005
Benzene	71-43-2	0.00037	< 0.005
Toluene	108-88-3	0.00058	< 0.005
n-Hexane	110-54-3	0.00069	< 0.005
n-Heptane	142-82-5	0.00042	< 0.005
n-Decane	124-18-5	0.00029	< 0.005

1. CAS = Chemical Abstract Service.

Table X-6
Tank TY-104 Tentatively Identified Organic Compounds in SUMMA™ Samples

Cmpd #	Compound	CAS[1] Number	Average (mg/m^3)	Standard Deviation (mg/m^3)
1	Methyl nitrite	624-91-9	0.21	0.06
2	Methanol (methyl alcohol)	67-56-1	0.14	0.02
3	Unknown alkyl nitrate		0.06	0.01
4	1-Butanol	71-36-3	0.10	0.01
5	n-Tridecane	629-50-5	0.06	< 0.01
Sum of tentatively identified compounds:			0.57	

1. CAS = Chemical Abstract Service.

Table X-7
Tank TY-104 Tentatively Identified Organic Compounds in TST Samples

Cmpd #	Compounds	CAS[1] Number	Average (mg/m^3)	Standard Deviation (mg/m^3)
1	1-Propene, 2-methyl-	115-11-7	0.0040	0.0015
2	Methyl alcohol and others		0.036	0.032
3	Ethylene Oxide	75-21-8	0.017	0.030
4	1-Propene, 2-methyl-	115-11-7	0.0042	0.0005
5	Hydrazine, 1,1-dimethyl	57-14-7	0.0031	0.0006
6	Methane, dichlorofluoro-	75-43-4	0.0017	0.0002
7	Ethanol	64-17-5	0.026	0.003
8	Trichlorofluoromethane	75-69-4	0.038	0.006
9	Silane, chlorotrimethyl	75-77-4	0.00095	0.00165
10	Isopropyl Alcohol	67-63-0	0.0071	0.0011
11	Cyclopropane, ethyl	1191-96-4	0.00042	0.00072
12	Ethane, 1,1,2-trichloro-1,2,2-trifluoro-	76-13-1	0.11	0.01
13	Methyl nitrate	598-58-3	0.031	0.002
14	2-Propen-1-ol	107-18-6	0.00059	0.00051
15	Pentane, 2-methyl-	107-83-5	0.0012	0.0001
16	1-Propanol	71-23-8	0.026	0.002
17	3-Buten-2-one	78-94-4	0.0024	0.0004
18	2-Butanone	78-93-3	0.018	0.002
19	Chloroform	67-66-3	0.0045	0.0007
20	Nitric acid, ethyl ester	625-58-1	0.031	0.002
21	Furan, tetrahydro-	109-99-9	0.0029	0.0008
22	1-Propanol, 2-methyl-	78-83-1	0.0013	0.0001
23	Acetic acid	64-19-7	0.00061	0.00106
24	Ethane, 1,1,1-trichloro	71-55-6	0.00067	0.00058
25	3-Pentanol, 2-methyl-	565-67-3	0.00066	0.00059
26	Propanenitrile, 2,2-dimethyl	630-18-2	0.0022	0.0013

Cmpd #	Compounds	CAS[1] Number	Average (mg/m^3)	Standard Deviation (mg/m^3)
27	2-Butenal	4170-30-3	0.0022	0.0015
28	2-Butanone, 3-methyl	563-80-4	0.0015	0.0017
29	1,4-Butanediamine	110-60-1	0.00080	0.00076
30	Nitric acid, 1-methylethyl ester	1712-64-7	0.0046	0.0002
31	Pentanal	110-62-3	0.011	0.001
32	Isopropyl Alcohol	67-63-0	0.0010	0.0009
33	2-Heptene, (E)-	14686-13-6	0.00046	0.00080
34	1H-Imidazole, 2-methyl-	693-98-1	0.0016	0.0002
35	Nitric acid, propyl ester	627-13-4	0.027	0.001
36	3-Buten-2-one, 3-methyl-	814-78-8	0.0014	0.0002
37	Pyrazine	290-37-9	0.0025	0.0002
38	Propane, 2-methyl-2-nitro-	594-70-7	0.0060	0.0002
39	3-Pentanone, 2-methyl-	565-69-5	0.00076	0.00018
40	1-Pentanol	71-41-0	0.0023	0.0041
41	2-Pentanone, 3-methyl-	565-61-7	0.00037	0.00032
42	2-Pentanone, 4,4-dimethyl-	590-50-1	0.0019	0.0001
43	3-Hexanone	589-38-8	0.00070	0.00003
44	cis-1-nitro-1-propene	27675-36-1	0.0080	0.0006
45	1-butanamine, N-ethylidene	6898-74-4	0.0030	0.0004
46	Hexanal	66-25-1	0.0092	0.0006
47	Tetrachloroethylene	127-18-4	0.024	0.001
48	Cyclotrisiloxane, hexamethyl-	541-05-9	0.0023	0.0011
49	Nitric acid, butyl ester	928-45-0	0.011	0.0003
50	Pyridine, 3-methyl-	108-99-6	0.0023	0.0004
51	1-Hexene, 4,5-dimethyl-	16106-59-5	0.00020	0.00034
52	Acetamide, N-methyl-	79-16-3	0.00040	0.00070
53	4-Heptanone	123-19-3	0.00022	0.00039
54	2-Hexenal, (E)-	6728-26-3	0.0013	0.0005

Cmpd #	Compounds	CAS[1] Number	Average (mg/m^3)	Standard Deviation (mg/m^3)
55	Nitric acid, propyl ester and ethylbenzene		0.0014	0.0003
56	1-Hexanol	111-27-3	0.0055	0.0004
57	p-Xylene	106-42-3	0.00046	0.00043
58	Propane, 2-[(1,1-dimethylethyl) sulfonyl]-2-methyl-	1886-75-5	0.0023	0.0007
59	3-Heptanone	106-35-4	0.0067	0.0003
60	2-Nonene, (E)-	6434-78-2	0.00043	0.00039
61	3-Heptanol	589-82-2	0.0036	0.0003
62	Heptanal	111-71-7	0.0088	0.0005
63	Acetonitrile, hydroxy-	107-16-4	0.00096	0.00166
64	Pyridine, 2-ethyl-	100-71-0	0.00022	0.00039
65	trans-3,4-Dimethyl-cyclopentanone	19550-73-3	0.00021	0.00037
66	Pentanol, 5-amino	2508-29-4	0.0020	0.0017
67	Nitric acid, pentyl ester	1002-16-0	0.0054	0.0003
68	Propane, 2-ethoxy-2-methyl-	637-92-3	0.00036	0.00062
69	2,3-Dimethyl-2-hexanol	1955-03-9	0.00022	0.00038
70	2-Pentene, 2,4-dimethyl-	625-65-0	0.0010	0.0002
71	2-Pentanol, 2,3-dimethyl-	4911-70-0	0.00087	0.00011
72	2-Heptanone, 6-methyl-	928-68-7	0.0068	0.0003
73	3-Tetradecene, (E)-	41446-68-8	0.00093	0.00010
74	2(3H)-Furanone, dihydro-5-methyl-	108-29-2	0.0013	0.0001
75	1-Hexene, 5,5-dimethyl-	7116-86-1	0.0023	0.0003
76	1-Heptanol	111-70-6	0.0053	0.0005
77	Cyclotetrasiloxane, octamethyl	556-67-2	0.0013	0.0013
78	Octanal	124-13-0	0.0068	0.0007
79	5-Decene (E)	7433-56-9	0.0011	0.0001
80	Decane, 4-methyl-	2847-72-5	0.00071	0.000003

Cmpd #	Compounds	CAS[1] Number	Average (mg/m^3)	Standard Deviation (mg/m^3)
81	Nitric acid, hexyl ester	20633-11-8	0.0040	0.0003
82	Hexane, 2,5-dimethyl-	592-13-2	0.0021	0.0002
83	Cyclopentane, 1-ethyl-3-methyl-	2613-66-3	0.00039	0.00034
84	Nitric acid, pentyl ester	1002-16-0	0.00031	0.00054
85	Cyclohexanone, 2,2,6-trimethyl	2408-37-9	0.00035	0.00031
86	1-Propanol, 2,2-dimethyl nitrate	926-42-1	0.0036	0.0004
87	5-Undecene	4941-53-1	0.0010	0.0001
88	1-Decanol, 2-ethyl	21078-65-9	0.00095	0.00009
89	2(3H)-Furanone, 5-ethyldihydro-	695-06-7	0.0022	0.0001
90	1-Octanol	111-87-5	0.0029	0.0001
91	Acetophenone	98-86-2	0.0028	0.00003
92	Octanenitrile	124-12-9	0.0024	0.0001
93	1-Decene, 5-methyl-	54244-79-0	0.0019	0.0001
94	2-Nonanone	821-55-6	0.0022	0.0002
95	Benzene, nitro-	98-95-3	0.0037	0.0002
96	Nonanal	124-19-6	0.0056	0.0008
97	2-Undecene, (Z)-	821-96-5	0.00060	0.00008
98	Nonane, 3-methyl-5-propyl-	31081-18-2	0.00092	0.00015
99	Nitric acid, hexyl ester	20633-11-8	0.0029	0.0004
100	2-Hexanone, 6-methoxy-	29006-00-6	0.00044	0.00039
101	Benzoic acid, 2-[(trimethylsilyl)oxy]-trimethyl	3789-85-3	0.00028	0.00048
102	n-Amylcyclohexane	29949-27-7	0.0011	0.0002
103	Heptane, 3-ethyl-2-methyl-	14676-29-0	0.0014	0.0006
104	Undecane, 2-methyl-	7045-71-8	0.00075	0.00008
105	2(3H)-Furanone, dihydro-5-propyl-	105-21-5	0.0034	0.0005
106	1-Nonanol	143-08-8	0.0019	0.0004
107	3-Dodecene, (E)-	7206-14-6	0.0069	0.0005
108	2-Decanone	693-54-9	0.0032	0.0001

Cmpd #	Compounds	CAS[1] Number	Average (mg/m^3)	Standard Deviation (mg/m^3)
109	1-Decene	872-05-9	0.0013	0.0001
110	Undecane, 2,6-dimethyl-	17301-23-4	0.0025	0.0002
111	Benzene, 1-methyl-3-nitro-	99-08-1	0.0012	0.0001
112	Nitric acid, nonyl ester	20633-13-0	0.0014	0.0003
113	Cyclohexane, 2-butyl-1,1,3-trimethyl-	54676-39-0	0.0010	0.00003
114	Nonadecane, 9-methyl-	13287-24-6	0.00019	0.00032
115	Cyclohexane, hexyl	4292-75-5	0.0019	0.0001
116	Dodecane, 4-methyl-	6117-97-1	0.00087	0.00001
117	Undecane, 2,10-dimethyl-	17301-27-8	0.0015	0.0001
118	Tridecane, 7-methyl-	26730-14-3	0.0046	0.0001
119	2(3H)-Furanone, 5-butyldihydro-	104-50-7	0.0041	0.0005
120	Furan, tetrahydro-2, 5-dipropyl-	4457-62-9	0.0020	0.0003
121	4-Nonene, 5-butyl- and others		0.0017	0.0003
122	7-Tetradecene, (Z)-	41446-60-0	0.0025	0.0002
123	Undecanenitrile	2244-07-7	0.0015	0.0013
124	2-Pyrrolidionone	616-45-5	0.00053	0.00091
125	6-Tridecene	24949-38-0	0.0012	0.0003
126	1-Ethylpropyl octanoate and others		0.00023	0.00041
127	Pyridine, 2,3,6-trimethyl	1462-84-6	0.00043	0.00037
128	1-Methyl-2-(4-methylpentyl)-cyclopentane		0.00018	0.00032
129	Cyclohexanol, 4-methyl-1-(1-methylethyl)-	470-65-5	0.00018	0.00032
130	5-Decanone	820-29-1	0.00098	0.00005
131	Undecane, 3-ethyl-	17312-58-2	0.0016	0.0014
132	n-Amylcyclohexane	29949-27-7	0.00072	0.00124
133	Nonane, 4,5-dimethyl-	17302-23-7	0.0016	0.00001
134	1-Pyrrolidinecarboxaldehyde	3760-54-1	0.00040	0.00035

Cmpd #	Compounds	CAS[1] Number	Average (mg/m^3)	Standard Deviation (mg/m^3)
135	3-Cyclohexene-1-carboxaldehyde, 1,3,4-trimethyl	40702-26-9	0.0050	0.0003
136	6-Dodecanone	6064-27-3	0.023	0.005
137	2(3H)-Furanone, 5-heptyldihydro- and others		0.0057	0.0015
138	Furan, tetrahydro-2, 5-dipropyl-	4457-62-9	0.0048	0.0011
139	2,2'-Bioxepane	74793-02-5	0.0069	0.0002
140	3-Dodecanone	1534-27-6	0.019	0.004
141	Tetradecane	629-59-4	0.30	0.01
142	Decanamide, N-(2-hydroxyethyl)-	7726-08-1	0.0036	0.0032
143	Dodecanamide, N-(2-hydroxyethyl)-	142-78-9	0.0026	0.0045
144	1-Methylcycloheptanol	3761-94-2	0.0010	0.0008
145	Tridecane, 5-methyl-	25117-31-1	0.00070	0.00004
146	Hexadecane	544-76-3	0.0034	0.0002
147	3-Hexyne-2,5-diol, 2,5-dimethyl-	142-30-3	0.0023	0.0008
148	6-Tridecanone	22026-12-6	0.019	0.001
149	4-Dodecanone, 11-methyl	29366-35-6	0.0084	0.0146
150	Cyclohexene, 1-methyl-3-(1-methylethyl)-	13828-31-4	0.0018	0.0031
151	Cyclohexanol, 4-methyl-1-(1-methylethyl)-	470-65-5	0.0011	0.0010
152	3-Tridecanone	1534-26-5	0.038	0.006
153	Pentadecane	629-62-9	0.013	0.003
154	2-Tridecanone	593-08-8	0.011	0.003
155	3-Dodecanol	10203-30-2	0.0028	0.0049
156	2-Decanol	1120-06-5	0.0048	0.0014
157	2-Undecanol	1653-30-1	0.0012	0.0020
158	(S)-(-)-1-Amino-2-(methoxymethyl)-pyrrolidine	59983-39-0	0.00060	0.00104
159	Alkyl cyclohexane		0.00092	0.00025

Cmpd #	Compounds	CAS[1] Number	Average (mg/m^3)	Standard Deviation (mg/m^3)
160	1,1'-Biphenyl, 4-chloro	2051-62-9	0.0023	0.0001
161	4-Decanone	624-16-8	0.013	0.001
162	4-Tetradecanone	26496-20-8	0.013	0.0003
163	3-Dodecanone	1534-27-6	0.0055	0.0096
164	3-Tetradecanone	629-23-2	0.012	0.010
165	2-Tetradecanone	2345-27-9	0.0057	0.0003
166	1,1'-Biphenyl, 4-chloro	2051-62-9	0.00049	0.00044
167	Diethyl Phthalate	84-66-2	0.00061	0.00053
168	1,1'-Biphenyl, 2,2'-dichloro-	13029-08-8	0.0012	0.0001
169	Pentadecane	629-62-9	0.00022	0.00038
170	2-Heptadecanone	2922-51-2	0.00018	0.00031
171	1,1'-Biphenyl, 2,5-dichloro-	34883-39-1	0.00099	0.00006
172	1,1'-Biphenyl, 4,4'-dichloro-	2050-68-2	0.0020	0.0002
173	1,1'-Biphenyl, 4,4'-dichloro-	2050-68-2	0.0014	0.0002
174	1,1'-Biphenyl, 2,3-dichloro-	16605-91-7	0.0011	0.0003
175	1,1'-Biphenyl, 4,4'-dichloro-	2050-68-2	0.00066	0.00114
176	Isopropyl Myristate	110-27-0	0.00043	0.00075
177	Benzenesulfonamide, N-butyl	3622-84-2	0.0023	0.0023
178	1,1'-Biphenyl, 2,4',5-trichloro-	16606-02-3	0.0038	0.0009
179	Hexadecane, 7,9-dimethyl-	21164-95-4	0.00071	0.00020
180	1,1'-Biphenyl, 2,4,4'-trichloro-	7012-37-5	0.0026	0.0006
181	1,1'-Biphenyl, 2,3,4-trichloro-	55702-46-0	0.00091	0.00030
182	1,1'-Biphenyl, 2,3,4-trichloro-	55702-46-0	0.00094	0.00012
183	1,1'-Biphenyl, 2,3,3',5'-tetrachloro-	41464-49-7	0.0028	0.0002
184	1,1'-Biphenyl, 2,3,4',6-tetrachloro-	52663-58-8	0.00020	0.00034
185	Isopropyl Palmitate	142-91-6	0.00067	0.00065
186	Tetrachlorobiphenyl and others		0.00018	0.00031

Cmpd #	Compounds	CAS[1] Number	Average (mg/m^3)	Standard Deviation (mg/m^3)
Sum of tentatively identified compounds:			1.23	

1. CAS = Chemical Abstract Service.

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