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Title/Desc:

TANK 241TX105 HEADSPACE GAS & VAPOR
CHARACTERIZATION RESULTS FOR SAMPLES COLLECTED IN
12/1994

COMPLETE

ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 626290

Proj.
ECN

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12. Description of Change Title change and complete rewrite.			
13a. Justification (mark one) Criteria Change ☒ Design Improvement ☐ Environmental ☐ Facility Deactivation ☐ As-Found ☐ Facilitate Const ☐ Const. Error/Omission ☐ Design Error/Omission ☐			
13b. Justification Details Complete rewrite which includes all vapor sampling events to date and data qualification.			
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ENGINEERING CHANGE NOTICE

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1. ECN (use no. from pg. 1)

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15. Design
Verification
Required
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16. Cost Impact

ENGINEERING

CONSTRUCTION

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 Additional ☐ \$
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18. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 12. Enter the affected document number in Block 19.

SDD/DD	☐	Seismic/Stress Analysis	☐	Tank Calibration Manual	☐
Functional Design Criteria	☐	Stress/Design Report	☐	Health Physics Procedure	☐
Operating Specification	☐	Interface Control Drawing	☐	Spares Multiple Unit Listing	☐
Criticality Specification	☐	Calibration Procedure	☐	Test Procedures/Specification	☐
Conceptual Design Report	☐	Installation Procedure	☐	Component Index	☐
Equipment Spec.	☐	Maintenance Procedure	☐	ASME Coded Item	☐
Const. Spec.	☐	Engineering Procedure	☐	Human Factor Consideration	☐
Procurement Spec.	☐	Operating Instruction	☐	Computer Software	☐
Vendor Information	☐	Operating Procedure	☐	Electric Circuit Schedule	☐
OM Manual	☐	Operational Safety Requirement	☐	ICRS Procedure	☐
FSAR/SAR	☐	IEFD Drawing	☐	Process Control Manual/Plan	☐
Safety Equipment List	☐	Cell Arrangement Drawing	☐	Process Flow Chart	☐
Radiation Work Permit	☐	Essential Material Specification	☐	Purchase Requisition	☐
Environmental Impact Statement	☐	Fac. Proc. Samp. Schedule	☐	Tickler File	☐
Environmental Report	☐	Inspection Plan	☐		☐
Environmental Permit	☐	Inventory Adjustment Request	☐		☐

19. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision

Document Number/Revision

Document Number Revision

20. Approvals

Signature	Date	Signature	Date
<u>OPERATIONS AND ENGINEERING</u>		<u>ARCHITECT-ENGINEER</u>	
Cog. Eng. D. R. Bratzel <i>DR Bratzel</i>	9/25/95	PE	_____
Cog. Mgr. T. J. Kelley <i>TJ Kelley</i>	9/25/95	QA	_____
QA	_____	Safety	_____
Safety	_____	Design	_____
Environ.	_____	Environ.	_____
Other	_____	Other	_____
Proj.	_____		_____
Proj.	_____		_____
Proj.	_____	<u>DEPARTMENT OF ENERGY</u>	
Proj.	_____	Signature or a Control Number that tracks the Approval Signature	

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RELEASE AUTHORIZATION

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Characterization Results for Samples Collected in
December 1995

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

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

Kara Broz

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SUPPORTING DOCUMENT

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7. Abstract

Significant changes have been made to all of the original vapor characterization reports. This report documents specific headspace gas and vapor characterization results for all vapor sampling events to date. In addition, changes have been made to the original vapor reports to qualify the data based on quality assurance issues associated with the performing laboratories.

8. RELEASE STAMP

OFFICIAL RELEASE
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Tank 241-TX-105 Headspace Gas and Vapor Characterization Results for Samples Collected in December 1994

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Date Published
September 1995

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**Tank 241-TX-105 Headspace Gas and Vapor Characterization Results
for Samples Collected in December 1994**

September 18, 1995

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Acronyms and Abbreviations

CES	consensus exposure standard
EPA	Environmental Protection Agency
GC	gas chromatograph
GC/MS	gas chromatograph/mass spectrometer
LFL	lower flammability limit
MS	mass spectrometer
NFPA	National Fire Protection Association
NPH	normal paraffinic hydrocarbon
ORNL	Oak Ridge National Laboratory
PNL	Pacific Northwest Laboratory
ppmv	parts per million by volume, 1 ppmv = 10 ⁻⁴ vol%
TNMOC	total nonmethane organic carbon
TST	triple sorbent trap
vol%	percent by volume, 1 vol% = 10,000 ppmv
VSS	vapor sampling system
WHC	Westinghouse Hanford Company

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Tank 241-TX-105 Headspace Gas and Vapor Characterization Results
for Samples Collected in December 1994

1.0 INTRODUCTION

1.1 Characterization Objectives

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).

1.2 Characterization Data Criteria

Data Quality Objectives for Generic In-Tank Health and Safety Issue Resolution describes parameters for data collection to ensure appropriate conclusions can be drawn from the data. Tank headspace characterization data were collected to help in the evaluation of 1) headspace flammability, and 2) identification and quantification of compounds of toxicological concern.

Single Shell Tank Interim Operational Safety Requirements (Dougherty 1995) specifies that combustible constituents in tank headspaces be maintained below 25 % of the lower flammability limit (LFL). This essentially agrees with National Fire Protection Association requirements that combustible concentrations be maintained at or below 25 % of the LFL (NFPA 1992). However, current governing operating specifications for single shell waste tanks, such as tank TX-105 specify that combustible constituents be maintained at or below 20 % of the LFL (WHC 1995a).

Headspace characterization data are used by Westinghouse Hanford Company (WHC) Tank Waste Remediation Systems Industrial Hygiene as source term data in the industrial hygiene strategy to protect workers from tank fugitive emissions. Because selection of worker protective equipment must be based on industrial hygiene monitoring of the work place and not on source term data (29 CFR 1910.120), tank headspace characterization data can not be used for this purpose. Furthermore, because there are mechanisms by which headspace constituents can be either diluted or concentrated as they are released to the atmosphere, the headspace characterization data should not be considered to be representative of emissions at the point of emission.

These statements notwithstanding, the data quality objectives document specifies that the industrial hygiene group be advised if constituents with toxicological properties exceed 50 % of the appropriate consensus exposure standard (CES) for non-carcinogens, or 10 % of the appropriate CES for carcinogens. A CES is defined as the most stringent of known regulatory or recommended toxicological values for the workplace (Osborne et al. 1994).

1.3 Sampling Overview

Tank TX-105 headspace characterization data presented here are from a single sampling event. Samples collected are thought to have been representative of the tank headspace when the tank was sampled (Meacham et al. 1995), and sample analyses were designed to provide a reasonably accurate and complete characterization of the significant headspace constituents. No assessment has been made of how the tank TX-105 headspace composition changes with time, though studies of tank C-103 suggest that composition changes probably occur very slowly in passively ventilated tanks, such as tank TX-105 (Huckaby et al 1994).

1.4 Tank Headspace Dynamics

Tank TX-105 is the second tank in a 3-tank cascade with tanks TX-104 and TX-106. It is connected to tanks TX-104 and TX-106 via a 7.4-cm (2.9-in.) inside diameter, 7.6-m (25-ft) long underground cascade lines. Since these cascade lines connect the headspaces of these tanks, gases and vapors originating from the wastes in tank TX-104 or tank TX-106 may be transferred to tank TX-105 (unless the cascade lines are obstructed). At this time there are no comparable headspace characterization data for either tanks TX-104 or TX-106 with which to determine their potential effect on tank TX-105.

The cascade of tanks TX-104, TX-105, and TX-106 is passively ventilated, which means that the tanks are allowed to exhale air, waste gases, and vapors as the barometric pressure falls, and inhale ambient air as the barometric pressure rises. Each of these tanks has its own filtered breather riser. Barometric pressure typically rises and falls on a diurnal cycle, producing an average daily exchange of air equal to about 0.46 % of each tank headspace (Huckaby 1994). Changes in the concentrations of tank headspace constituents due to barometric pressure changes are consequently very slow.

2.0 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 1995b). Sample collection and analysis were performed as directed by *Tank 241-TX-105 Tank Characterization Plan*, (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 2-1 by analytical laboratory. Table 2-1 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 et al. (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 (1995b).

3.0 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 3-1 in parts per million by volume (ppmv) in dry air. The concentration of water vapor given in Table 3-1 has been adjusted to tank conditions as are given in Section 3.3. Inorganic analyte sorbent traps and SUMMATM canisters were prepared and analyzed by PNL (Klinger et al. 1995). PNL analyses of SUMMATM canisters and sorbent traps for inorganic compounds were performed 50 and 23 days, respectively, after sample collection (Ligotke 1995), which was within the 60-day holding time requirement of the WHC quality assurance project plan (Keller 1994). All sample preparation and analyses were performed at PNL quality assurance impact level 2.

3.1 Ammonia, Hydrogen, and Nitrous Oxide

Ammonia concentration in the headspace of tank TX-105 was measured at 20 ppmv. Ammonia has been observed in virtually all of the passively ventilated 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. Given the LFL of ammonia in air is about 15 % by volume (vol%), the measured 20 ppmv corresponds to about 0.01% of the LFL, and does not contribute appreciably to the flammability of the headspace.

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 LFL for hydrogen in air is about 4 vol%, the 99 ppmv detection limit for hydrogen corresponds to about 0.25 % of its LFL, and at this level hydrogen is not a flammability concern in tank TX-105.

Nitrous oxide was detected in only 1 SUMMATM canister sample at a concentration of 12.8 ppmv. Nitrous oxide is usually present at higher concentrations in the waste tanks, and has been observed to be as high as about 868 ppmv in tank U-103 (Ligotke et al. 1995). Under the proper conditions, nitrous oxide can serve as an oxidizer to support combustion. However, Cashdollar et al. (1992) found that nitrous oxide had no significant effect on the flammability of hydrogen and air mixtures for hydrogen concentrations less than 20 vol%, and that "small amounts of nitrous oxide (relative to air) do not appear to have much effect on the flammability". Their results suggest the measured nitrous oxide concentration is much too low to have a significant effect on the flammability of the tank TX-105 headspace.

3.2 Carbon Dioxide and Carbon Monoxide

The average measured headspace carbon dioxide concentration, 156 ppmv, is well below the normal ambient air concentration of about 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 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 was measured to be < 12 ppmv. Elevated carbon monoxide concentrations have been observed in other waste tanks, and are thought to be due to the

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

decomposition of organic waste in the tanks. The highest waste tank carbon monoxide concentration measured to date was [26.7 ppmv] in tank C-103² (Huckaby et al 1994).

3.3 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 detected in other waste tanks at comparable concentrations, presumably due to its formation from oxygen and nitrogen in the radiation field of the headspace. These constituents could potentially serve as oxidizers to support combustion, but at the measured concentrations would have a negligible effect on the flammability of the tank TX-105 headspace.

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 1995b). 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 %.

Silica gel sorbent traps were used to test for tritium. It is assumed that tritium produced by the waste combines with hydroxide ions to form tritium-substituted water. Evaporation of the tritium-substituted water would then result in airborne radioactive contamination. Silica gel sorbent traps adsorb virtually all (normal and tritium-substituted) water vapor from the sampled tank air, and are analyzed at the WHC 222-S laboratory. Radiochemical analysis of the silica gel trap indicated the total activity of the headspace to be less than 50 pCi/L (WHC 1995b).

² The carbon monoxide measurement in tank C-103 was made by Oregon Graduate Institute of Science and Technology, and placed in brackets to emphasize it should be considered secondary data.

4.0 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 a gas chromatograph (GC) equipped with a mass spectrometer (MS) to separate, identify, and quantitate the analytes. Descriptions of sample device cleaning, sample preparations, and analyses are given by Jenkins et al. (1995a) and Klinger et al. (1995).

SUMMA™ sample results should be considered to be the primary organic vapor data for tank TX-105. PNL results were produced at PNL quality assurance impact level 2. All PNL analyses were completed 59 days after sample collection, which was within the maximum 60-day holding time allowed by WHC quality assurance project plan (Keller 1994). The 60-day holding time was administratively chosen, because no holding time study has been performed to determine the stability of organic analytes in SUMMA™ canisters in the chemical matrix of the tank samples.

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.

All TSTs prepared by ORNL had 3 surrogate compounds added to evaluate sample matrix effects, potential handling, storage, and shipment problems, and analytical instrumentation performance (Jenkins et al. 1995a). ORNL evaluated the surrogate recoveries using a statistical approach similar to that prescribed by *SW 846 Method 8260A Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS) Capillary Column Technique* (EPA 1992). Using this approach, ORNL reported that all surrogates had standard deviation values within the 95 % confidence interval for variance, indicating that no bias was introduced in the measurement of analyte quantities (Jenkins 1995a).

4.1 Positively Identified Organic Analytes

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

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

Table 4-1 are the organic compounds positively identified and quantitated in SUMMA™ 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™

canister samples. At the reported concentrations, the Table 4-1 analytes do not individually or cumulatively represent a flammability hazard.

Jenkins et al (1995a) positively identified 25 of 27 target analytes selected by WHC. The 2 positively identified quantified analytes, and their average concentrations from the analysis of 3 TSTs, are given in Table 4-2. Despite calibration of the instrument over about a 20-fold concentration range, 20 of the compounds listed in Table 4-3 were outside of the calibration range in at least 1 of the TST samples.

Jenkins et al. (1995a) report the positive identification of 25 of 27 target analytes in TST samples. Dibutyl butylphosphonate and tributyl phosphate were the only TST target analytes not detected. The average concentrations of the positively identified compounds reported by ORNL are given in Tables 4-2, 4-3, and 4-4. The ORNL report gives only upper bounds for some of the average values, even though all analytes listed were positively identified. Despite calibration of the instrument over about a 20-fold concentration range, only 5 of the target analytes were quantitated in all 3 TSTs. These are listed in Tables 4-2 and 4-4; those in Table 4-4 are segregated because analyses were performed after the analyte-specific ORNL practical holding times had been exceeded for these analytes. Table 4-3 lists the 20 compounds for which the measurement was outside the instrumental calibration range in at least 1 TST sample, and were consequently not quantitated. Tables 4-2, 4-3, and 4-4 are mutually exclusive, so that no analyte appears in more than 1 of these tables.

The ORNL practical holding time is defined as the holding time for which there is a 15 % risk that the concentration of an analyte in the sample will be below its initial concentration. As indicated in Table 4-4, of butanal, 1-butanol, and 2-pentanone exceeded their practical holding times, and may have been affected by the 37 day period between sample collection and analysis (Jenkins 1995b). Jenkins et al (1995b) describe the ORNL practical holding time study, and report practical holding times of butanal, 1-butanol, and 2-pentanone are 1, 17, and 34 days, respectively. It should be noted that the contractual holding time for the TST samples was 60 days.

ORNL also detected 2 of the target analytes, n-dodecane and n-tridecane, in the trip and field blanks at levels comparable to those measured in tank air samples. Though ORNL identified a potential source of contamination, the possibility that the tank air samples may also have been contaminated could not be excluded (Jenkins et al, 1995a).

Eleven target analytes were common to both the ORNL and PNL analyses. These are listed with their TST and SUMMA™ average concentrations in Table 4-5. The TST and SUMMA™ sample analyses agree well for these compounds, except for propanone. Both laboratories indicate propanone to be at very low levels compared to its LFL (the propanone LFL is about 26,000 ppmv in air).

4.2 Tentatively Identified Organic Analytes

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. Using these methods, many analytes can be tentatively identified with reasonable confidence without having to inject each into the GC/MS to determine their GC retention times or specific MS patterns.

By the nature of the sampling devices, virtually all organic vapors present in the tank headspace are collected by both TST and SUMMA™ samples. Analyses of the samples are designed to recover,

separate, and identify the organic vapors in the samples. TSTs are not good for collecting highly volatile compounds (i.e., molecules more volatile than propane), but are quite good for most others. In contrast, the recovery of very low volatility compounds (e.g., molecules with more than about 15 carbon atoms) and some polar compounds with moderate volatility (e.g., butanal) from SUMMA™ samples has been problematic.

Only 2 tentatively identified compounds recovered from SUMMA™ samples. These are given with estimated concentrations in Table 4-6. The tentatively identified compounds detected in TST samples, and their estimated concentrations, are listed in Table 4-7. Compounds are listed in Table 4-7 according to the order by which the eluted chromatographically. The averages reported by ORNL in Table 4-7 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/m³, based on dry air at 0 °C and 1.01 bar.

Because the list of tentatively identified organic compounds in TST samples is particularly long and locating any given compound may be difficult, the list has been sorted alphanumerically by compound name in Table 4-8. Table 4-9 gives the same list, sorted in order of decreasing estimated concentration. Numbers in the first columns of Tables 4-8 and 4-9 (Cmpd #) identify the location of the compound in Table 4-7.

The ORNL and PNL methods used to tentatively identify and estimate concentrations are described by Jenkins et al. (1995a) and Klinger et al. (1995), respectively, and should be reviewed before this data is used for decision making. Concentrations given in Tables 4-6 through 4-9 should be considered rough estimates. Results in these tables are presented in terms of observed peaks, and are not adjusted for the assignment of the same identity to different peaks (e.g., Cmpd # 33 and 42 in Table 4-7). In these instances, the estimated concentration of a compound appearing as a doublet or triplet is simply the sum of the individual peak estimates.

One TST sample was analyzed using a gas chromatograph with flame ionization detection (GC/FID), (Jenkins et al. 1995a). This analysis indicated the total organic vapor concentration in the TST sample to be about 2.5 mg/m³. This analysis is similar to the EPA task order 12 (TO-12) method that has been performed on SUMMA™ samples from many of the waste tanks (EPA 1988). The TO-12 method is an accepted method for establishing the total nonmethane organic carbon (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.

4.3 Discussion of Organic Analytes

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 1994). 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, 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.

The absence of tributyl phosphate in the tank TX-105 samples may be due to a sampling difficulty. 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 concentration of tributyl phosphate in the tank TX-105 headspace should be considered to be unknown.

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 unusual 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 other 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.

5.0 SUMMARY

The tank B-103 headspace was sampled in February 1995 for gases and vapors to address flammability and industrial hygiene concerns. Collection and analysis of samples has been reported. It was determined that no headspace constituents exceeded the flammability or industrial hygiene notification limits specified in the current *Vapor Sampling and Analysis Plan* (Horn 1995).

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Table 2-1
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	Organic vapors	4 tank air samples
		1.0	Organic vapors	4 tank air samples
		4.0	Organic vapors	4 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
				6 tank air samples + 3 trip blanks
	Triethanolamine Sorbent Trap	3.0	Nitrogen Dioxide	6 tank air samples + 3 trip blanks
				6 tank air samples + 3 trip blanks
	Oxidation bed + Triethanolamine Sorbent Trap	3.0	Nitric Oxide	6 tank air samples + 3 trip blanks
				6 tank air samples + 3 trip blanks
WHC 222-S Laboratory	Silica Gel Sorbent Trap	3.0	Water vapor	3 tank air samples + 2 ambient air samples
	SUMMA™ canister	6.0	Organic vapors	3 tank air samples + 2 ambient air samples
	Silica Gel Sorbent Trap	1.0	Tritium-Substituted Water Vapor	1 tank air sample

Table 3-1
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 ₂ O	10024-97-2	SUMMA™	3	12.8	—	—
Water Vapor, H ₂ O	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. Burnum (1995) specifies the RSD should be less than 25 %.

3 Detected in only 1 sample.

Table 4-1
Tank TX-105 Quantitatively Measured Organic Compounds in SUMMA™ Samples --
Analyses by Pacific Northwest Laboratory

Cmpd #	Compound	CAS ¹ Number	Average ² (ppmv)	Standard Deviation (ppmv)	RSD ³ (%)
1	Chloromethane	74-87-3	0.007	0.001	9
2	Trichlorofluoromethane	75-69-4	0.063	0.003	4
3	Trichloromethane (chloroform)	67-66-3	0.015	0.0001	1
4	Tetrachloromethane (carbon tetrachloride)	56-23-5	0.317	0.007	2
5	Propanone (acetone)	67-64-1	0.884	0.030	3
6	2-Butanone	78-93-3	0.046	0.001	2
7	Methane	74-82-8	< 61	—	—

1 CAS = Chemical Abstract Service.

2 Average of 3 samples.

3 RSD = relative standard deviation. Burnum (1995) specifies the RSD should be less than 25 %.

Table 4-2
Tank TX-105 Quantitatively Measured Organic Compound Average Concentrations --
Analyses by Oak Ridge National Laboratory¹

Cmpd #	Compound	CAS ² Number	Average ³ (ppmv)	Standard Deviation (ppmv)	RSD ⁴ (%)
1	Ethanenitrile (acetonitrile)	75-05-8	0.0056	0.0010	17
2	n-Tridecane	629-50-5	0.0010	0.0001	9

1 Results in this table are quantitative (as defined in Section 4.1).

2 CAS = Chemical Abstract Service.

3 Average of 3, 4-L TST samples.

4 RSD = relative standard deviation. Burnum (1995) specifies the RSD should be less than 25 %.

Table 4-3
Tank TX-105 Positively Identified Organic Compounds in TST Samples --
Analyses by Oak Ridge National Laboratory¹

Cmpd #	Compound	CAS ² Number	Average ³ (ppmv)	Standard Deviation (ppmv)	RSD ⁴ (%)
1	Propanone (acetone)	67-64-1	0.21	0.09	42
2	Vinylidene Chloride	75-35-4	< 0.00058	—	—
3	Dichloromethane (methylene chloride)	75-09-2	< 0.0013	—	—
4	Propanenitrile	107-12-0	0.00084	0.00006	7
5	n-Hexane	110-54-3	< 0.00065	—	—
6	Benzene	71-43-2	< 0.00043	—	—
7	n-Butanenitrile	109-74-0	0.0016	0.0003	16
8	n-Heptane	142-82-5	0.00035	0.00004	12
9	Toluene	108-88-3	0.00082	0.00011	13
10	n-Pentanenitrile	110-59-8	0.00029	0.00002	7
11	2-Hexanone	591-78-6	0.0011	0.00004	3
12	n-Octane	111-65-9	0.00039	0.00012	31
13	n-Hexanenitrile	628-73-9	0.00021	0.00001	2
14	2-Heptanone	110-43-0	0.00084	0.00002	3
15	n-Nonane	111-84-2	0.00031	0.00003	10
16	n-Heptanenitrile	629-08-3	< 0.00020	—	—
17	2-Octanone	111-13-7	0.00019	0.00001	5
18	n-Decane	124-18-5	< 0.00012	—	—
19	n-Undecane	1120-21-4	< 0.00014	—	—
20	n-Dodecane	112-40-3	0.00070	0.00004	6

1 Results in this table are not quantitative (as defined in Section 4.1) because measured values in at least 1 of the samples are outside instrument calibration limits.

2 CAS = Chemical Abstract Service.

3 Average of 3, 4-L TST samples.

4 RSD = relative standard deviation. Burnum (1995) specifies the RSD should be less than 25 %.

Table 4-4
Tank TX-105 Positively Identified Organic Compounds in TST Samples
for which Practical Holding Times were Exceeded --
Analyses by Oak Ridge National Laboratory¹

Cmpd #	Compound	CAS ² Number	Average ³ (ppmv)	Standard Deviation (ppmv)	RSD ⁴ (%)
1	Butanal ⁵	123-72-8	0.0080	0.0003	4
2	1-Butanol ⁵	71-36-3	0.0097	0.0005	5
3	2-Pentanone ⁵	107-87-9	0.0033	0.0005	14

1 Practical holding times are defined and discussed in Section 4.1.

2 CAS = Chemical Abstract Service.

3 Average of 3, 4-L TST samples.

4 RSD = relative standard deviation. Burnum (1995) specifies the RSD should be less than 25 %.

5 The concentration of this analyte is quantitatively measured (as defined in Section 4.1).

Table 4-5
Tank TX-105 Comparison of Organic Compounds in TST and SUMMA™ Samples --
Analyses by Pacific Northwest Laboratory
and Oak Ridge National Laboratory

Compound	CAS ¹ Number	TST Average ² (ppmv)	SUMMA™ Average ³ (ppmv)	PRD ⁴ (%)
Ethanenitrile (acetonitrile)	75-05-8	0.0056	< 0.005	> 11
Propanone (acetone)	67-64-1	0.21	0.884	123
Vinylidene Chloride	75-35-4	< 0.00058	< 0.002	—
Dichloromethane (methylene chloride)	75-09-2	< 0.0013	< 0.002	—
Propanenitrile	107-12-0	0.00084	< 0.005	—
n-Hexane	110-54-3	< 0.00065	< 0.005	—
Benzene	71-43-2	< 0.00043	< 0.005	—
n-Butanenitrile	109-74-0	0.0016	< 0.005	—
n-Heptane	142-82-5	0.00035	< 0.005	—
Toluene	108-88-3	0.00082	< 0.005	—
n-Decane	124-18-5	< 0.00012	< 0.005	—

1 CAS = Chemical Abstract Service.

2 Average of 3, 4-L TST samples.

3 Average of 3 samples by PNL.

4 PRD = percent relative difference. Keller (1994) requires the PRD to be less than 20 %.

Table 4-6
Tank TX-105 Tentatively Identified Organic Compounds in SUMMA™ Samples --
Analyses Conducted by Pacific Northwest Laboratory

Cmpd #	Compound	CAS ¹ Number	Average ³ (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.

3 Average of 3 samples by PNL, presented values are estimated.

Table 4-7
Tank TX-105 Tentatively Identified Organic Compounds in TST Samples
in Order of Chromatographic Elution –
Analyses Conducted by Oak Ridge National Laboratory

Cmpd #	Compound	CAS ¹ Number	Average ² (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

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Cmpd #	Compound	CAS ¹ Number	Average ² (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-ethylidihydro-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 ester	2432-55-5	0.003	0.0004
53	Diethyl Phthalate	84-66-2	0.019	0.002
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

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
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.

2 Average of 3, 4-L TST samples, presented values are estimates.

Table 4-8
 Tank TX-105 Tentatively Identified Organic Compounds in TST Samples
 Sorted Alphanumerically –
 Analyses Conducted by Oak Ridge National Laboratory

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
12	1-Propanol	71-23-8	0.029	0.003
2	1-Propene, 2-methyl-	115-11-7	0.020	0.007
21	1-Pentanol	71-41-0	0.003	0.003
57	1,1'-Biphenyl, 2,3,4',6-tetrachloro-	52663-58-8	0.002	0.0003
55	1,1'-Biphenyl, 2,2'-diethyl-	13049-35-9	0.001	0.002
22	2-Pentanone, 4,4-dimethyl-	590-50-1	0.008	0.001
17	2-Butanone, 3,3-dimethyl-	75-97-8	0.011	0.001
16	2-Butanone, 3-methyl-	563-80-4	0.004	0.0001
13	2-Butanone	78-93-3	0.015	0.008
10	2-Propanol, 2-methyl-	75-65-0	0.015	0.022
35	2-Heptanone, 6-methyl-	928-68-7	0.003	0.0002
40	2(3H)-Furanone, 5-ethylidihydro-5-methyl-	2865-82-9	0.008	0.002
32	3-Octanone	106-68-3	0.003	0.0002
28	3-Heptanone	106-35-4	0.019	0.0004
29	3-Heptanol	589-82-2	0.003	0.0003
51	5-Tridecanone	30692-16-1	0.001	0.001
3	Acetaldehyde	75-07-0	0.012	0.018
43	Acetophenone	98-86-2	0.002	0.0000
48	Alkane		0.001	0.001
36	Benzaldehyde	100-52-7	0.004	0.0003
56	Benzene, 1,1'-(1,4-butanediyl)bis-	1083-56-3	0.009	0.014
54	Benzenesulfonamide, N-butyl-	3622-84-2	0.017	0.017
46	Benzoic acid, 2-[trimethylsilyl]oxy]trimethyl-	3789-85-3	0.001	0.002
41	Benzyl Alcohol	100-51-6	0.003	0.000
52	Butyric acid, thio-, S-decyl ester	2432-55-5	0.003	0.0004
14	Chloroform	67-66-3	0.017	0.003
25	Cyclotrisiloxane, hexamethyl-	541-05-9	0.006	0.001

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
47	Decanal	112-31-2	0.002	0.001
53	Diethyl Phthalate	84-66-2	0.019	0.002
6	Ethanol	64-17-5	0.030	0.004
30	Heptanal	111-71-7	0.001	0.002
23	Hexanal	66-25-1	0.001	0.001
31	Hexanal, 3-methyl-	19269-28-4	0.001	0.001
34	Hexanoic acid, anhydride	2051-49-2	0.001	0.002
5	Hydrazine, 1,1-dimethyl-	57-14-7	0.005	0.002
9	Hydrazine, 1,1-dimethyl-	57-14-7	0.003	0.002
8	Isopropyl Alcohol	67-63-0	0.005	0.001
1	Methane, chloro-	74-87-3	0.008	0.003
4	Methyl Alcohol	67-56-1	0.081	0.014
11	Nitric acid, methyl ester	598-58-3	0.005	0.002
15	Nitric acid, ethyl ester	625-58-1	0.006	0.002
18	Nitric acid, propyl ester	627-13-4	0.009	0.001
26	Nitric acid, butyl ester	928-45-0	0.003	0.0003
33	Nitric acid, pentyl ester	1002-16-0	0.003	0.0004
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
42	Nitric acid, pentyl ester	1002-16-0	0.008	0.001
45	Nitric acid, heptyl ester	20633-12-9	0.001	0.001
44	Nonanal	124-19-6	0.004	0.0002
37	Octanal	124-13-0	0.001	0.001
27	p-Xylene	106-42-3	0.004	0.0001
19	Propane, 2-methyl-2-nitro-	594-70-7	0.015	0.002
49	Propanoic acid, 2-methyl- 3-hydroxyl-2,4,4-trimethyl-	74367-34-3	0.001	0.001
20	Propylene Glycol	57-55-6	0.006	0.008
24	Tetrachloroethylene	127-18-4	0.003	0.0002

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
50	Tetradecane	629-59-4	0.001	0.001
7	Trichloromonofluoromethane	75-69-4	0.058	0.012
Sum of tentatively identified compounds:			0.51	

1 CAS = Chemical Abstract Service.

2 Average of 3, 4-L TST samples, presented values are estimates.

Table 4-9
 Tank TX-105 Tentatively Identified Organic Compounds in TST Samples
 Sorted by Estimated Concentration –
 Analyses Conducted by Oak Ridge National Laboratory

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
4	Methyl Alcohol	67-56-1	0.081	0.014
7	Trichloromonofluoromethane	75-69-4	0.058	0.012
6	Ethanol	64-17-5	0.030	0.004
12	1-Propanol	71-23-8	0.029	0.003
2	1-Propene, 2-methyl-	115-11-7	0.020	0.007
28	3-Heptanone	106-35-4	0.019	0.0004
53	Diethyl Phthalate	84-66-2	0.019	0.002
54	Benzenesulfonamide, N-butyl-	3622-84-2	0.017	0.017
14	Chloroform	67-66-3	0.017	0.003
10	2-Propanol, 2-methyl-	75-65-0	0.015	0.022
19	Propane, 2-methyl-2-nitro-	594-70-7	0.015	0.002
13	2-Butanone	78-93-3	0.015	0.008
3	Acetaldehyde	75-07-0	0.012	0.018
17	2-Butanone, 3,3-dimethyl-	75-97-8	0.011	0.001
56	Benzene, 1,1'-(1,4-butanediyl)bis-	1083-56-3	0.009	0.014
18	Nitric acid, propyl ester	627-13-4	0.009	0.001
1	Methane, chloro-	74-87-3	0.008	0.003
40	2(3H)-Furanone, 5-ethyldihydro-5-methyl-	2865-82-9	0.008	0.002
22	2-Pentanone, 4,4-dimethyl-	590-50-1	0.008	0.001
42	Nitric acid, pentyl ester	1002-16-0	0.008	0.001
20	Propylene Glycol	57-55-6	0.006	0.008
15	Nitric acid, ethyl ester	625-58-1	0.006	0.002
25	Cyclotrisiloxane, hexamethyl-	541-05-9	0.006	0.001
5	Hydrazine, 1,1-dimethyl-	57-14-7	0.005	0.002
8	Isopropyl Alcohol	67-63-0	0.005	0.001
11	Nitric acid, methyl ester	598-58-3	0.005	0.002
27	p-Xylene	106-42-3	0.004	0.0001

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
16	2-Butanone, 3-methyl-	563-80-4	0.004	0.0001
36	Benzaldehyde	100-52-7	0.004	0.0003
44	Nonanal	124-19-6	0.004	0.0002
29	3-Heptanol	589-82-2	0.003	0.0003
32	3-Octanone	106-68-3	0.003	0.0002
33	Nitric acid, pentyl ester	1002-16-0	0.003	0.0004
41	Benzyl Alcohol	100-51-6	0.003	0.000
35	2-Heptanone, 6-methyl-	928-68-7	0.003	0.0002
21	1-Pentanol	71-41-0	0.003	0.003
9	Hydrazine, 1,1-dimethyl-	57-14-7	0.003	0.002
52	Butyric acid, thio-, S-decyl ester	2432-55-5	0.003	0.0004
24	Tetrachloroethylene	127-18-4	0.003	0.0002
26	Nitric acid, butyl ester	928-45-0	0.003	0.0003
57	1,1'-Biphenyl, 2,3,4',6-tetrachloro-	52663-58-8	0.002	0.0003
47	Decanal	112-31-2	0.002	0.001
43	Acetophenone	98-86-2	0.002	0.0000
30	Heptanal	111-71-7	0.001	0.002
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
39	Nitric acid, 2-methyl propyl ester	543-29-3	0.001	0.002
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
38	Nitric acid, hexyl ester	20633-11-8	0.001	0.001
37	Octanal	124-13-0	0.001	0.001
23	Hexanal	66-25-1	0.001	0.001
55	1,1'-Biphenyl, 2,2'-diethyl-	13049-35-9	0.001	0.002

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
31	Hexanal, 3-methyl-	19269-28-4	0.001	0.001
34	Hexanoic acid, anhydride	2051-49-2	0.001	0.002
Sum of tentatively identified compounds:			0.51	

1 CAS = Chemical Abstract Service.

2 Average of 3, 4-L TST samples, presented values are estimates.

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