RMIS View/Print Document Cover Sheet

This document was retrieved from the Boeing ISEARCH System.

Accession #: D196054881

Document #: SD-WM-ER-464

Title/Desc:

TANK 241C110 HEADSPACE GAS & VAPOR
CHARACTERIZATION RESULTS FOR SAMPLES COLLECTED IN
8/1994

COMPLETE

ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 626284

Proj.
ECN

2. ECN Category (mark one) Supplemental ☐ Direct Revision ☒ Change ECN ☐ Temporary ☐ Standby ☐ Supersedeure ☐ Cancel/Void ☐	3. Originator's Name, Organization, MSIN, and Telephone No. D. R. BRATZEL, 75640, S7-21, 373-3579	3a. USQ Required? ☐ Yes ☒ No	4. Date 09/27/95
	5. Project Title/No./Work Order No. TANK 241-C-110 HEADSPACE GAS AND VAPOR CHARACTERIZATION RESULTS FOR SAMPLES COLLECTED IN AUGUST 1994	6. Bldg./Sys./Fac. No. 2704HV/200E	7. Approval Designator N/A
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-ER-464 REV ^{KMS} 10 7/27/95	9. Related ECN No(s). N/A	10. Related PO No. N/A
11a. Modification Work ☐ Yes (fill out Blk. 11b) ☒ No (NA Blks. 11b, 11c, 11d)	11b. Work Package No. N/A	11c. Modification Work Complete N/A Cog. Engineer Signature & Date	11d. Restored to Original Condition (Temp. or Standby ECN only) N/A Cog. Engineer Signature & Date
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.			
14. Distribution (include name, MSIN, and no. of copies) See attached Distribution Sheet		RELEASE STAMP OFFICIAL RELEASE BY WHC DATE SEP 27 1995 Stu. 4	

ENGINEERING CHANGE NOTICE

Page 2 of 2

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

626284

15. Design Verification Required

☐ Yes

☒ No

16. Cost Impact

ENGINEERING

CONSTRUCTION

Additional ☐ \$

Savings ☐ \$

Additional ☐ \$

Savings ☐ \$

17. Schedule Impact (days)

Improvement ☐

Delay ☐

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>DRB</i>	<u>9/25/95</u>	PE	
Cog. Mgr. T. J. Kelley <i>TJK</i>	<u>9/25/95</u>	QA	
QA		Safety	
Safety		Design	
Environ.		Environ.	
Other		Other	
Proj.			
Proj.			
Proj.			
Proj.			
		<u>DEPARTMENT OF ENERGY</u>	
		Signature or a Control Number that tracks the Approval Signature	
		<u>ADDITIONAL</u>	

RELEASE AUTHORIZATION

Document Number: WHC-SD-WM-ER-464, REV 1

Document Title: Tank 241-C-110 Headspace Gas and Vapor
Characterization Results for Samples Collected in
August 1994

Release Date: 9/27/95

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

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

Kara Broz

9/27/95

TRADEMARK DISCLAIMER. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy. Available in paper copy. Printed in the United States of America. To obtain copies of this report, contact:

Westinghouse Hanford Company - Document Control Services
P.O. Box 1970, Mailstop H6-08, Richland, WA 99352
Telephone: (509) 372-2420; Fax: (509) 376-4989

THIS PAGE INTENTIONALLY
LEFT BLANK

SUPPORTING DOCUMENT

1. Total Pages 51

2. Title

TANK 241-C-110 HEADSPACE GAS AND VAPOR
CHARACTERIZATION RESULTS FOR SAMPLES COLLECTED IN
AUGUST 1994

3. Number

WHC-SD-WM-ER-464

4. Rev No.

1

5. Key Words

CHARACTERIZATION OBJECTIVES, TANK HEADSPACE,
SAMPLING EVENT, INORGANIC GASES, ORGANIC VAPORS

6. Author

Name: D. R. BRATZEL

Signature DRB [Signature] 9/25/95

Organization/Charge Code 75640/N4ABI

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
BY WHC
DATE SEP 27 1995

Sta. 4

THIS PAGE INTENTIONALLY
LEFT BLANK

THIS PAGE INTENTIONALLY
LEFT BLANK

Tank 241-C-110 Headspace Gas and Vapor Characterization Results for Samples Collected in August 1994

J. L. Huckaby
Pacific Northwest Laboratories

D. R. Bratzel
Westinghouse Hanford Company

Date Published
September 1995

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Westinghouse
Hanford Company

P.O. Box 1970
Richland, Washington

Management and Operations Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

THIS PAGE INTENTIONALLY
LEFT BLANK

Contents

1.0 INTRODUCTION	1
1.1 Characterization Objectives	1
1.2 Characterization Data Criteria	1
1.3 Sampling Overview	2
1.4 Tank Headspace Dynamics	2
2.0 SAMPLING EVENT	3
3.0 INORGANIC GASES AND VAPORS	4
3.1 Ammonia, Hydrogen, and Nitrous Oxide	4
3.2 Carbon Monoxide and Carbon Dioxide	5
3.3 Nitric Oxide, Nitrogen Dioxide, Water, and Tritium	5
3.4 Discussion of Inorganic Gases and Vapors	6
4.0 ORGANIC VAPORS	7
4.1 Positively Identified Organic Compounds	7
4.2 Tentatively Identified Organic Compounds	9
4.3 Total Nonmethane Organic Compounds	9
4.4 Discussion of Organic Compounds	10
5.0 SUMMARY	11
6.0 REFERENCES	12

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
OGIST	Oregon Graduate Institute of Science and Technology
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

Acknowledgements

The author wishes to thank Chris Simonen for her work verifying data and generating tables, and Shas Mattigod for his help with the construction and reviews of this document.

THIS PAGE INTENTIONALLY
LEFT BLANK

Tank 241-C-110 Headspace Gas and Vapor Characterization Results
for Samples Collected in August 1994

1.0 INTRODUCTION

1.1 Characterization Objectives

Tank C-110 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 C-110 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 C-110, specify that combustible constituents be maintained at or below 20 % of the LFL (Boyles 1994).

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 C-110 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 C-110 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 C-110 (Huckaby and Story 1994).

1.4 Tank Headspace Dynamics

Tank C-110 is the first tank in a 3-tank cascade with tanks C-111 and C-112, and is connected to tank C-111 via a 7.4-cm (2.9-in.) inside diameter, 7.6-m (25-ft) long cascade line. Tanks C-111 and C-112 are connected by a similar cascade line. Since these cascade lines connect the headspaces of these tanks, gases and vapors originating from the wastes in tank C-111 or tank C-112 may be transferred to tank C-110 (unless the cascade lines are obstructed). However, headspace data, as discussed in Sections 3.4 and 4.4, indicate that the inter-tank exchange of gases and vapors has little effect on the headspace composition of tank C-110.

The cascade of tanks C-110, C-111, and C-112 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 C-110 using the vapor sampling system (VSS) on August 18, 1994 by WHC Sampling and Mobile Laboratories (WHC 1995). Sample collection and analysis were performed as directed by the sample and analysis plan¹ (WHC 1995, Appendix A). The tank headspace temperature was determined to be 21.9 °C. Air from the tank C-110 headspace was withdrawn via a 7.3 m-long heated sampling probe mounted in riser 1, and transferred via heated tubing to the VSS sampling manifold. All heated zones of the VSS were maintained at approximately 50 °C. All samples were collected between 11:50 a.m. and 3:35 p.m.

Sampling media were prepared and analyzed by WHC, Oak Ridge National Laboratories (ORNL), Pacific Northwest Laboratories (PNL), and Oregon Graduate Institute of Science and Technology (OGIST) through a contract with Sandia National Laboratories. The 39 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 provided by the laboratories.

A general description of vapor sampling and sample analysis methods is given by Huckaby and Babad (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.

¹ The current requirement that sampling and analysis parameters be specified by a tank characterization plan was not in effect for gas and vapor sampling until October 1, 1994.

3.0 INORGANIC GASES AND VAPORS

Analytical results of sorbent trap and SUMMA^{TM,2} 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. Inorganic analyte sorbent traps were prepared and analyzed by PNL, with analyses performed within 27 days of sample collection. PNL analyses of SUMMATM canisters for inorganic compounds were performed 193 days after sample collection (Ligothke 1995), greatly exceeding the 60-day holding time requirement of the WHC quality assurance project plan (Keller 1994). However, it should be noted that these inorganic compounds (i.e., the permanent gases) would be expected to be very stable in the SUMMATM canisters, and the results may not have been affected by the long holding time. PNL results were produced at PNL quality assurance impact level 3.

SUMMATM were also prepared and analyzed by OGIST. OGIST SUMMATM data have been placed in square brackets both in Table 3-1 and elsewhere in this report to indicate they represent secondary results. Furthermore, OGIST was not operating under a WHC-approved quality assurance plan when samples were analyzed. Reports by PNL (Ligothke et al. 1995a) and OGIST (Rasmussen 1994a) describe sample preparation and analyses.

3.1 Ammonia, Hydrogen, and Nitrous Oxide

Based on analyses of 6 ammonia sorbent trap samples, the average ammonia concentration in the headspace of tank C-110 was determined to be 124 ppmv. This is a typical ammonia concentration for the waste tanks that have been sampled. 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. 1995a), to 1040 ppmv in BY-108 (McVeety et al. 1995). Given the LFL of ammonia in air is about 15 % by volume (vol%), the measured 124 ppmv corresponds to less than 0.1 % of the LFL, and does not contribute appreciably to the flammability of the headspace.

The concentration of hydrogen in tank C-110 was determined by PNL to be < 94 ppmv, and by OGIST to be 12 ppmv. At 12 ppmv, tank C-110 would have one of the lowest measured hydrogen concentrations of the passively ventilated waste tanks. Hydrogen in the waste tanks is of concern as a fuel. Given that the LFL for hydrogen in air is about 4 vol%, the < 94 ppmv hydrogen concentration in tank C-110 corresponds to less than 0.24 % of its LFL. At this level, hydrogen is not a flammability concern in tank C-110.

The nitrous oxide concentration in tank C-110, at an average of 21 ppmv in 2 PNL SUMMATM samples and [9.4 ppmv] in 3 OGIST SUMMATM samples, is also relatively low compared to other waste tanks that have been sampled. The PNL and OGIST SUMMATM canister samples were collected at about the same time, and in principle should have provided identical results. The difference should apparently be attributed to analytical inaccuracies. Nitrous oxide has been detected in other passively ventilated waste tanks at average concentrations as high as 878 ppmv in tank U-103 (Ligothke et al. 1995b). 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 C-110 headspace.

² SUMMA is a trademark of Molectrics, Inc., Cleveland, Ohio.

3.2 Carbon Monoxide and Carbon Dioxide

Carbon monoxide was determined to be < 12 ppmv in the 3 PNL SUMMATM samples from tank C-110. The average carbon monoxide concentration measured by OGIST in 3 SUMMATM canister samples from tank C-110 was [0.7 ppmv]. 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, in the waste tank headspaces elevated 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-103³ (Huckaby and Story 1994).

The carbon dioxide concentration in the tank C-110 headspace, measured to be an average 94 ppmv by PNL and [42 ppmv] by OGIST, is significantly lower than it is in ambient air. 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. 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 C-110 gas and vapor sampling event, for example, were measured to have an average 402 ppmv of carbon dioxide (Ligotke et al. 1995a).

There is no apparent reason for the discrepancy in reported carbon dioxide concentrations by PNL and OGIST other than analytical inaccuracies. The carbon dioxide concentrations reported by PNL and OGIST are both within the typical range of other waste tanks sampled to date, and the discrepancy between the 2 laboratories analyses is not significant in terms of worker health or safety.

3.3 Nitric Oxide, Nitrogen Dioxide, Water, and Tritium

Nitric oxide and nitrogen dioxide concentrations in the tank C-110 headspace were determined to be 0.08 and $\leq$ 0.06 ppmv, respectively. These are acid gases that would have very low equilibrium concentrations above the high pH sludge in tank C-110. 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. 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 C-110 headspace.

The relative standard deviation of nitric oxide measurements is 38 %, which exceeds the 25 % precision limit specified by Burnum (1995). The poor precision of these analyses is a consequence of the measured nitric oxide concentration being very near the normal background contamination of the sorbent traps.

The water vapor concentration of tank C-110 was determined to be about 12.4 mg/L, at the measured tank headspace temperature of 21.9 °C and pressure of 990.8 mbar (743.3 torr), (WHC 1995). This equates to a water vapor partial pressure of 16.9 mbar (12.6 torr), to a dew point of 14.8 °C, and to a relative humidity of 64 %.

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

³ The carbon monoxide measurement in tank C-103 was made by OGIST, and should be considered secondary data.

laboratory. Radiochemical analysis of the silica gel trap indicated the total activity of the headspace to be less than 50 pCi/L (WHC 1995).

3.4 Discussion of Inorganic Gases and Vapors

Aside from water vapor, the most abundant waste constituents in the tank C-110 headspace are ammonia, hydrogen, and nitrous oxide. These have been detected in most tank headspaces sampled to date, and are usually the dominant species. Compared to other passively ventilated waste tanks that have been sampled, tank C-110 has low concentrations of both hydrogen and nitrous oxide.

The relative standard deviations of the inorganic gas and vapor results given in the last column in Table 3-1 are good for the methods used at the concentrations reported. Relative standard deviations range from less than 1 % for the OGIST measurement of hydrogen, to about 38 % for the PNL measurement of nitric oxide. The poor precision of the nitric oxide results is due to the fact that the sample results were very near the background contamination level 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.

As discussed briefly in Section 1.3, it is possible that gases and vapors generated by the waste in tanks C-111 and C-112 could be transferred to tank C-110 via the cascade lines. Table 3-2 lists the measured concentrations of selected inorganic gases and vapors in tanks C-110, C-111, and C-112. If a significant exchange of gases and vapors were taking place between adjacent tanks, either their headspace compositions would be very similar, or all constituents detected in one tank would be at equal or higher concentration in the other tank. Consideration of the data in Table 3-2 indicates that any transfer of gases and vapors between these tanks is probably negligible. Specifically, ammonia and carbon monoxide are at much higher concentrations in tank C-110 than in tank C-111, while nitric oxide and nitrous oxide are at much lower concentrations in tank C-110 than in tank C-111.

4.0 ORGANIC VAPORS

Organic vapors in the tank C-110 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) detector to separate, identify, and quantitate the analytes. Descriptions of sample device cleaning, sample preparations, and analyses are given by Jenkins et al. (1995a) and Ligothke et al. (1995a). Quantitative measurements of methane and the total organic vapor concentration by the U.S. Environmental Protection Agency (EPA) task order 12 (TO-12) method was also performed by OGIST (EPA 1988, Rasmussen 1994a). As elsewhere, OGIST data should be considered secondary results, and are provided within brackets.

PNL SUMMA™ sample results should be considered to be the primary organic vapor data for tank C-110. PNL results were produced at PNL quality assurance impact level 3. Because tank C-110 analyses were initially assigned low priority by WHC, PNL SUMMA™ canister analyses for organic vapors were not performed until 231 days after sample collection (Ligothke 1995), greatly exceeding the specified 60-day holding time (Keller 1994). The 60-day holding time was administratively chosen, because no holding time study has been performed to address the stability of organic compounds in SUMMA™ canisters in the likely chemical matrix of the waste tanks.

ORNL analyses of TST samples from this and other waste tanks generally agree with, support, and augment the SUMMA™ sample results. However, because analyses at OGIST and ORNL were not performed under a WHC approved quality assurance plan, documentation of the quality assurance measures is less rigorous. Results of a quality assurance assessment of ORNL by Hendrickson (1995) should be reviewed before results unique to the TST samples are used for decision making.

ORNL analyzed 5 of the 8 TST tank samples, 1 of the 2 TST field blanks, and both of the 2 TST trip blanks. ORNL analyzed a single 0.5-L TST tank sample to estimate the concentration of organic vapors sampled. Because the measured organic vapor concentrations were relatively low, the 4 collected 2.0-L TST tank samples were analyzed for analyte identification and quantification. Poor recovery of chemical surrogates from the first TST trip blank analyzed prompted ORNL to analyze the second TST trip blank. Recoveries of surrogates from the second trip blank were normal, and ORNL could find no simple explanation for the poor recoveries of the first TST trip blank.

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 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 from the 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 vapor data from tank C-103.

Table 4-1 lists the organic compounds positively identified and quantitated in SUMMA™ samples. Analysis for methane was performed by OGIST and should be considered secondary data (Rasmussen 1994a), and other SUMMA™ analyses were performed according to the EPA TO-14 methodology by PNL (EPA 1988, Ligotke et al. 1995a). Of the 39 TO-14 target analytes, only trichlorofluoromethane was measured to be above the 0.005 ppmv quantitation limit of the analyses. Averages reported are from analyses of 3 SUMMA™ canister samples.

Jenkins et al. (1995a) report the positive identification of 25 of 27 target analytes in TST samples. 1,1-Dichloroethene and dibutyl butylphosphonate were the only TST target analytes not detected in the TST samples. The positively identified analytes, and their average concentrations from the analysis of 4 TSTs, are given in Tables 4-2 and 4-3. Two compounds, butanal and 1-butanol, have been listed in Table 4-3 to indicate their measurements were not performed within their practical holding times (Jenkins 1995b). Data in Tables 4-3 and 4-4 should not be considered quantitative and may not be accurate to within $\pm 30\%$ as specified by Burnum (1995).

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 4-3, the analyses of butanal and 1-butanol exceeded their practical holding times, and may have been affected by the 25 day period between sample collection and analysis. Jenkins et al. (1995b) describe the ORNL practical holding time study, and report the 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 (Keller 1994).

The concentration of tributyl phosphate reported in Table 4-2 probably underestimates the actual concentrations in the tank headspace. The volatility of this compound is very low, and it is thought to be adsorbed by glass fiber filters used during sampling to protect samples from radiolytic particulates.

Both PNL and ORNL report target analyte concentrations in ppmv of analyte in dry air. The results given may be corrected for the measured water vapor content of tank C-110 to obtain concentration in ppmv of analyte in moist tank air by multiplying the dry-air ppmv concentrations by 0.983.

Ten target analytes were common to both TST and SUMMA™ analyses. Table 4-5 lists these, and their reported average concentrations in TST and SUMMA™ samples. Results from these 2 sampling and analytical methods are in good agreement for acetone, acetonitrile, propanenitrile, and butanenitrile. The 6 remaining compounds listed in Table 4-5 were reported as being below 0.005 ppmv in SUMMA™ samples. Three of these compounds were determined to be above 0.005 ppmv in TST samples, though none are at levels of concern.

The most abundant analytes in Tables 4-1 through 4-4 are methane, 1-butanol, butanal, acetonitrile, acetone, and n-tridecane, each of which was measured to be above 0.1 ppmv. At the reported concentrations, the target analytes do not individually or collectively represent a flammability hazard.

4.2 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 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 SUMMATM 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 (i.e., molecules with more than about 15 carbon atoms) and some polar compounds with moderate volatility (i.e., butanal) from SUMMATM samples has been problematic.

The list of tentatively identified compounds recovered from SUMMATM samples, with estimated concentrations, is given in Table 4-6. Compounds are listed in Table 4-6 in the order by which they eluted chromatographically, and 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 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 4-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 difficult to analyze, 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 Ligotke et al. (1995a), respectively, and should be reviewed before this data are used for decision making. Concentrations given in Tables 4-6 through 4-9 should be considered rough estimates. Results in Tables 4-6 through 4-9 are presented in terms of observed chromatographic peaks, and are not adjusted for the occurrence of split peaks or the assignment of the same identity to different peaks (e.g., Cmpd # 155, 164, and 172 in Table 4-7). In these instances, the estimated concentration of a compound appearing in more than 1 peak is simply the sum of the individual peak estimates.

4.3 Total Nonmethane Organic Carbon

OGIST measured the TNMOC concentration in 3 SUMMATM canister samples using the EPA TO-12 method (Rasmussen 1994a). The sample mean was [22.3 mg/m³], with a standard deviation of [0.4 mg/m³]. Summation of the positively and tentatively identified organic compounds observed in TST samples gives an estimate of 22.6 mg/m³, in very good agreement with the TO-12 measurement (Jenkins et al. 1995a).

As indicated in Table 3-2, tank C-110 has a much higher measured TNMOC concentration than either tanks C-111 or C-112. The TO-12 method TNMOC measurements by OGIST of other waste tanks have

ranged from as high as [5,000 mg/m³] in tank C-103 (Rasmussen and Einfeld 1994), to as low as [0.18 mg/m³] in tank C-111 (Rasmussen 1994b), while the TNMOC concentration of clean ambient air ranges from about 0.03 to 0.1 mg/m³.

4.4 Discussion of Organic Compounds

The organic compounds listed in Tables 4-1 through 4-9 may be classified as either 1) organic compounds added to tank C-110 as waste that are still evaporating, or 2) organic compounds that have been generated by reactions of the original waste.

The first category encompasses all organic compounds that were placed into the tank as waste. It includes the tentatively identified alkyl-substituted cyclic, semivolatile branched, and semivolatile straight-chain alkanes. These were used as diluents of tributyl phosphate in various plutonium extraction processes. The semivolatile straight-chain 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).

Many of the semivolatile alkanes found in tank C-110 are cyclic or branched. Examination of Table 4-7 indicates many alkyl-substituted cyclopentanes, cyclohexanes, decahydronaphthalenes, and branched alkanes. These are also prominent in Table 4-9, where the tentatively identified organic compounds in TST samples have been ranked by their estimated concentrations. By contrast, there are other 241-C farm tanks, notably tank C-102 (Huckaby 1995a), in which the semivolatile alkane character is heavily dominated by the NPHs.

Halogenated compounds, such as trichlorofluoromethane, may also have been placed into the waste tanks as waste. The origin of these is unknown, but they are commonly detected as headspace constituents by both TST and SUMMATM sample analyses.

The tentatively identified cyclosiloxanes (i.e., Cmpd # 19 and 51 in Table 4-4) may also be in this category. Small quantities of siloxanes may have been introduced to the waste tank through their use as process surfactants or the disposal of contaminated hydraulic fluids. They may also be present in the headspace due to their use in liquid traps at the tank's breather riser. These compounds are frequently detected at very low levels in blanks, so it is also possible these are laboratory contaminants.

The second category includes all organic compounds that have been generated via radiolytic and chemical reactions of the waste. The majority of volatile compounds listed in Tables 4-1 through 4-9 fall into this category, including the alcohols, aldehydes, ketones, nitriles, alkenes, and volatile alkanes, all of which have been associated with the degradation of the semivolatile alkanes. While both larger and smaller molecules are generated from the waste, the most abundant of these in the headspace are the smaller, short-chain volatile compounds.

Ambient air SUMMATM samples collected at the start of the tank C-110 sampling event indicate both acetonitrile and n-tridecane were present at trace levels in the atmosphere upwind of tank C-110. Because these compounds were at much higher concentrations in the tank headspace than in the ambient air, their presence in the ambient air is thought to have a negligible effect on tank C-110.

The organic vapors in tank C-110 clearly indicate the presence of semivolatile alkanes associated with tributyl phosphate and their degradation products. Comparisons of data for tanks C-110 and C-111 suggest that the organic vapor in tank C-110 comes primarily from the waste in tank C-110, and could not be transferred from tank C-111 via the cascade line between these tanks (see Table 3-2 and Huckaby 1995b). The organic vapor concentrations in tank C-110 are typical for a tank containing semivolatile alkanes and tributyl phosphate.

5.0 SUMMARY

The tank C-110 headspace was sampled in August 1994 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* (Homi 1995).

THIS PAGE INTENTIONALLY
LEFT BLANK.

5.0 REFERENCES

- 29 CFR 1910.120, 1993, "Hazardous Waste Operations and Emergency Response", *Code of Federal Regulations*.
- Boyles, V. C., 1994, *Operating Specifications for Single Shell Waste Storage Tanks*, OSD-T-151-00013 Rev. D-4, Westinghouse Hanford Company, Richland, Washington.
- Burnum, S. T., 1995, *Qualification of Reported WHC Vapor Program Data*, (letter 95-CHD-065 to president, Westinghouse Hanford Company, August 18), Department of Energy, Richland Operations Office, Richland, Washington.
- Cashdollar, K. L., M. Hertzberg, I. A. Zlochower, C. E. Lucci, G. M. Green, and R. A. Thomas, 1992, *Laboratory Flammability Studies of Mixtures of Hydrogen, Nitrous Oxide, and Air*, WHC-SD-WM-ES-219 Rev. 0, Westinghouse Hanford Company, Richland, Washington.
- Dougherty, L. F., 1995, *Single Shell Tank Interim Operational Safety Requirements*, WHC-SD-WM-OSR-005 Rev. 0, Westinghouse Hanford Company, Richland, Washington.
- EPA 1988, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*, PB90-127374, U.S. Environmental Protection Agency, Washington, D.C.
- EPA 1992, *Test Methods for Evaluating Solid Waste*, SW-846 Rev. 1, U.S. Environmental Protection Agency, Washington, D.C.
- Hendrickson, R. W., 1995, *Tank Vapor Characterization Oak Ridge National Laboratories Quality Assurance Assessment*, TWRSQA-95-0012, Westinghouse Hanford Company, Richland, Washington.
- Huckaby, J. L., 1994, *Tank 241-C-103 Headspace Flammability*, WHC-EP-0734 Rev. 1, Westinghouse Hanford Company, Richland, Washington.
- Huckaby, J. L., H. Babad, and D. R. Bratzel, 1995, *Headspace Gas and Vapor Characterization Summary for the 43 Vapor Program Suspect Tanks*, WHC-SD-WM-ER-514, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
- Huckaby, J. L., 1995a, *Tank 241-C-102 Headspace Gas and vapor Characterization Results for Samples Collected in August 1994*, WHC-SD-WM-ER-459 Rev. 1, Westinghouse Hanford Company, Richland, Washington.
- Huckaby, J. L., and D. R. Bratzel, 1995b, *Tank 241-C-111 Headspace Gas and vapor Characterization Results for Samples Collected in August 1993 and September 1994*, WHC-SD-WM-ER-425 Rev. 2, Westinghouse Hanford Company, Richland, Washington.
- Huckaby, J. L., 1995c, *Tank 241-C-112 Headspace Gas and vapor Characterization Results for Samples Collected in June 1994 and August 1994*, WHC-SD-WM-ER-426, Rev. 2, Westinghouse Hanford Company, Richland, Washington.
- Huckaby, J. L., and M. S. Story, 1994, *Vapor Characterization of Tank 241-C-103*, WHC-EP-0780 Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-ER-464 Rev. 1

- Jenkins, R. A., 1995, (letter to J. W. Osborne, Westinghouse Hanford Company, June 7), Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- Jenkins, R. A., A. B. Dindal, C. E. Higgins, C. Y. Ma, M. A. Palausky, J. T. Skeen, and C. K. Bayne, 1995a, *Analysis of Tank 241-C-110 Headspace Components*, CASD-ORNL-FR-241-C110.95 Rev 1, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- Jenkins, R. A., A. B. Dindal, C. E. Higgins, C. Y. Ma, M. A. Palausky, J. T. Skeen, and C. K. Bayne, 1995b, *Analysis of Tank 241-TY-104 Headspace Components*, ORNL-CASD-FR-241TY104.95 Rev 1, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- Keller, K. K., 1994, *Quality Assurance Project Plan for Tank Vapor Characterization*, WHC-SD-WM-QAPP-013 Rev. 2, Westinghouse Hanford Company, Richland, Washington.
- Ligotke, M. W., 1995, *PNL Vapor Project Analytical Holding Times*, (Letter to D. R. Bratzel, September 23, 1995) Pacific Northwest Laboratory, Richland, Washington.
- Ligotke, M. W., T. W. Clauss, K. H. Pool, R. B. Lucke, B. D. McVeety, G. S. Klinger, K. B. Olsen, M. McCulloch, J. S. Fruchter, and S. C. Goheen, 1995, *Vapor Space Characterization of Waste Tank 241-C-110: Results from Samples Collected on 8/18/94*, PNL-10645 UC-606, Pacific Northwest Laboratory, Richland, Washington.
- Lucke, R. B., M. W. Ligotke, K. H. Pool, T. W. Clauss, A. K. Sharma, B. D. McVeety, M. McCulloch, J. S. Fruchter, and S. C. Goheen, 1995, *Vapor Space Characterization of Waste Tank 241-C-108: Results from Samples Collected Through the Vapor Sampling System on 8/5/94*, PNL-10351 UC-606, Pacific Northwest Laboratory, Richland, Washington.
- Mahlum, D. D., J. Y. Young, and R. E. Weller, 1994, *Toxicologic Evaluation of Analytes from Tank 231-C-103*, PNL-10189, Pacific Northwest Laboratory, Richland, Washington.
- Meacham, J. E., H. Babad, R. J. Cash, G. T. Dukelow, S. J. Eberlein, D. W. Hamilton, G. D. Johnson, J. W. Osborne, M. A. Payne, D. J. Sherwood, D. A. Turner, and J. L. Huckaby, 1995, *Approach for Tank Safety Characterization of Hanford Site Waste*, WHC-EP-0843 Rev. 0, UC-2070, Westinghouse Hanford Company, Richland, Washington.
- NFPA 1992, *Standard on Explosion Prevention Systems*, NFPA 69, National Fire Protection Association, Quincy, Massachusetts.
- Osborne, J. W., and J. L. Huckaby, 1994, *Program Plan for the Resolution of Tank Vapor Issues*, WHC-EP-0562 Rev. 1, Westinghouse Hanford Company, Richland, Washington.
- Osborne, J. W., J. L. Huckaby, T. P. Rudolph, E. R. Hewitt, D. D. Mahlum, J. Y. Young, C. M. Anderson, 1994, *Data Quality Objectives for Generic In-Tank Health and Safety Issue Resolution*, WHC-SD-WM-DQO-002, Westinghouse Hanford Company, Richland, Washington.
- Rasmussen, R. A., 1994a, *Air Samples Collected at Waste Tank 241-C-110 on August 18, 1994 by Westinghouse Hanford in 6-L SS SUMMA® Canisters*, Oregon Graduate Institute of Science and Technology, Beaverton, Oregon.

WHC-SD-WM-ER-464 Rev. 1

Rasmussen, R. A., 1994b, *Air Samples Collected at Waste Tank 241-C-111 on September 13, 1994 by Westinghouse Hanford in 6-L SS SUMMA® Canisters*, Oregon Graduate Institute of Science and Technology, Beaverton, Oregon.

Rasmussen, R. A., and W. Einfeld, 1994, *Hanford Tank 103-C Analyses and Method Validation Development Phase*, SAND94-1807, Sandia National Laboratories, Albuquerque, New Mexico.

WHC 1995, *Vapor and Gas Sampling of Single-Shell Tank 241-C-110 Using the Vapor Sampling System*, WHC-SD-WM-RPT-126, Westinghouse Hanford Company, Richland, Washington.

THIS PAGE INTENTIONALLY
LEFT BLANK

Table 2-1
Tank C-110 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	0.5	Organic vapors	4 tank air samples
		2.0	Organic vapors	4 tank air samples + 2 trip blanks
Oregon Graduate Institute of Science and Technology	SUMMA™ canister	6.0	Hydrogen, Methane, Nitrous Oxide, Carbon Dioxide, Carbon Monoxide, Organic vapors	3 tank air samples
Pacific Northwest Laboratories	Acidified Carbon Sorbent Trap	3.0	Ammonia	6 tank air samples + 3 trip blanks
	Triethanolamine Sorbent Trap	3.0	Nitrogen Dioxide	6 tank air samples + 3 trip blanks
	Oxidation bed + Triethanolamine Sorbent Trap	3.0	Nitric Oxide	6 tank air samples + 3 trip blanks
	Silica Gel Sorbent Trap	3.0	Water vapor	6 tank air samples + 3 trip blanks
	SUMMA™ canister	6.0	Organic vapors	3 tank air samples + 2 ambient air samples
WHC 222-S Laboratory	Silica Gel Sorbent Trap	1.0	Tritium-Substituted Water Vapor	1 tank air sample

Table 3-1
 Tank C-110 Inorganic Gas and Vapor Concentrations --
 Analyses by Oregon Graduate Institute of Science and Technology and by Pacific Northwest Laboratory

Compound	CAS ¹ Number	Sample Type	Number of Samples	Average ² (ppmv)	Standard Deviation ² (ppmv)	RSD ^{3,4} (%)
Ammonia, NH ₃	7664-41-7	Sorbent Trap	6	124	3	2.4
Carbon Dioxide, CO ₂	124-38-9	SUMMA TM	3	94 [42]	4 [0.3]	4 [0.6]
Carbon Monoxide, CO	630-08-0	SUMMA TM	3	< 12 [0.7]	-- [0.1]	-- [14]
Hydrogen, H ₂	1333-74-0	SUMMA TM	3	< 94 [12]	-- [0.1]	-- [1]
Nitric Oxide, NO	10102-43-9	Sorbent Trap	6	0.08	0.03	38
Nitrogen Dioxide, NO ₂	10102-44-0	Sorbent Trap	6	≤ 0.06	--	--
Nitrous Oxide ⁴ , N ₂ O	10024-97-2	SUMMA TM	3	21 [9.4]	1.4 [2.4]	7 [26]
Water Vapor, H ₂ O	7732-18-5	Sorbent Trap	6	12.4 mg/L	0.7 mg/L	6

¹ CAS = Chemical Abstracts Service.

² Bracketed values are from OGIST and should be considered secondary results, non-bracketed values are from PNL and should be considered primary results.

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

⁴ Nitrous oxide was detected in only 2 PNL SUMMATM samples. Relative difference and percent relative difference are given in place of standard deviation and relative standard deviation.

Table 3-2
Comparison of Tank C-110, C-111, and C-112 Headspace Constituents –
Inorganic Analyses by Oregon Graduate Institute of Science and Technology,
and Organic Analyses by Oak Ridge National Laboratory¹

Tank:	C-110	C-111 ²	C-112 ³
Date sampled, (mo/day/yr)	8/8/94	9/13/94	8/11/94
Headspace temperature, (°C)	21.9	27	28
Sampling Temperature, (°C)	50	50	50
Ammonia, (ppmv)	124	5.6	22.7
Hydrogen, (ppmv)	[12]	[12.4]	[204]
Carbon dioxide, (ppmv)	[42]	[198]	[102]
Carbon monoxide, (ppmv)	[0.7]	[0.10]	[0.92]
Nitric oxide, (ppmv)	0.08	0.62	0.62
Nitrogen dioxide, (ppmv)	≤ 0.06	≤ 0.08	≤ 0.02
Nitrous oxide, (ppmv)	[9.4]	[99.3]	[544]
Water vapor, (mg/m ³)	12.4	22.2	22.3
Water vapor, (% relative humidity)	64	86	82
Ethanenitrile (acetonitrile), (ppmv)	(0.17)	0.0093	(3.0)
Propanone (acetone), (ppmv)	(0.21)	0.0080	(0.078)
1-Butanol, (ppmv)	(0.73)	(0.0016)	0.0044
n-Dodecane, (ppmv)	(0.084)	(0.00054)	(0.00043)
n-Tridecane, (ppmv)	(0.15)	(0.0012)	(0.00060)
Total nonmethane organic compounds by EPA TO-12 method, (mg/m ³)	[22.2]	[0.18]	[3.4]

1 Where PNL inorganic gas or vapor data was unavailable for tanks C-111 and C-112, OGIST results are given in brackets to indicate the data should be considered secondary results. Organic vapor results are from ORNL, with semiquantitative values in parentheses and quantitative values not in parentheses.

2 Data are from Huckaby 1995b.

3 Data are from Huckaby 1995c.

Table 4-1
Tank C-110 Positively Identified Organic Compounds in SUMMA™ Samples --
Analyses by Pacific Northwest Laboratory

Cmpd #	Compound	CAS ¹ Number	Average ² (ppmv)	Standard Deviation (ppmv)	RSD ³ (%)
1	Ethanenitrile (acetonitrile)	75-05-8	0.24	0.01	3
2	Propanone (acetone)	67-64-1	0.22	0.01	3
3	Trichlorofluoromethane	75-69-4	0.024	0.0004	2
4	Propanenitrile	107-12-0	0.030	0.001	3
5	1-Propanol	71-23-8	0.020	0.002	8
6	2-Butanone	78-93-3	0.047	0.002	5
7	Tetrahydrofuran	109-99-9	0.013	0.0004	3
8	n-Butanenitrile	109-74-0	0.019	0.002	9
9	Cyclohexane	110-82-7	0.011	0.0003	3
10	n-Decane	124-18-5	0.008	0.001	8
11	Methane ⁴	74-82-8	[1.9]	[< 0.005]	—

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 %.

4 Methane analyses were performed by OGIST and should be considered a secondary result (Ramussen 1994a).

Table 4-2
Tank C-110 Quantitatively Measured 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	Propanenitrile	107-12-0	0.034	0.001	3
2	n-Butanenitrile	109-74-0	0.012	0.002	12
3	n-Pentanenitrile	110-59-8	0.0064	0.0006	15
4	2-Hexanone	591-78-6	0.0060	0.0008	12
5	n-Hexanenitrile	628-73-9	0.0055	0.0003	11
6	n-Heptanenitrile	629-08-3	0.0059	0.0007	10
7	2-Heptanone	110-43-0	0.010	0.003	28
8	n-Octanenitrile	124-12-9	0.0040	0.0007	16
9	n-Nonanenitrile	2243-27-8	0.0050	0.0012	25
10	Tributyl phosphate	126-73-8	0.0022	0.0022	100

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

2 CAS = Chemical Abstract Service.

3 Average of 4, 2-L TST samples.

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

Table 4-3
Tank C-110 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	Ethanenitrile (acetonitrile)	75-05-8	0.17	0.02	14
2	Propanone (acetone)	67-64-1	0.21	0.02	9
3	Dichloromethane (methylene chloride)	75-09-2	0.015	0.015	100
4	n-Hexane	110-54-3	0.0026	0.0007	31
5	Benzene	71-43-2	0.016	0.026	185
6	n-Heptane	142-82-5	0.0030	0.0013	43
7	Toluene	108-88-3	0.010	0.017	177
8	n-Octane	111-65-9	0.0018	0.0007	46
9	n-Nonane	111-84-2	0.0024	0.0004	25
10	2-Octanone	111-13-7	0.0036	0.0014	33
11	n-Dodecane	112-40-3	0.084	0.041	45
12	n-Tridecane	629-50-5	0.15	0.07	46

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 4, 2-L TST samples.

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

Table 4-4
Tank C-110 Positively Identified 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	0.65	0.50	65
2	1-Butanol ⁵	71-36-3	0.73	0.07	10
3	2-Pentanone ⁶	107-87-9	0.018	0.004	23

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

2 CAS = Chemical Abstract Service.

3 Average of 4, 2-L TST samples.

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

5 The concentration of this analyte was not quantitatively measured (as defined in Section 4.1), because the measured concentration was outside of the instrumental calibration limits.

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

Table 4-5
Tank C-110 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 (%)
1,1-Dichloroethene (vinylidene chloride)	75-35-4	< 0.00092	< 0.005	—
Dichloromethane (methylene chloride)	75-09-2	0.0137	< 0.005	> 93
Propanone (acetone)	67-64-1	0.21	0.22	5
Ethanenitrile (acetonitrile)	75-05-8	0.17	0.24	34
Propanenitrile	107-12-0	0.034	0.030	13
n-Butanenitrile	109-74-0	0.012	0.019	45
Benzene	71-43-2	0.016	< 0.005	> 105
Toluene	108-88-3	0.010	< 0.005	> 67
n-Hexane	110-54-3	0.0026	< 0.005	—
n-Heptane	142-82-5	0.0030	< 0.005	—

1 CAS = Chemical Abstract Service.

2 Average of 4, 2-L TST sample analyses.

3 Average of 3 sample analyses.

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

Table 4-6
Tank C-110 Tentatively Identified Organic Compounds in SUMMA™ Samples --
Analyses by Pacific Northwest Laboratory

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard ³ Deviation (mg/m ³)
1	Ethanal ⁴ (acetaldehyde)	75-07-0	0.50	0.06
2	Propane ⁵	74-98-6	0.39	—
3	Butanal	123-72-8	0.21	0.02
4	2-Pentanone	107-87-9	0.080	0.001
5	2-Heptanone, 6-methyl- ³	928-68-7	0.070	< 0.01
6	Unknown C11 Alkane ³		0.072	0.002
7	n-Undecane	1120-21-4	0.28	0.09
8	Unknown Alkane ³		0.068	< 0.01
9	Unknown Methyl Decahydronaphthalene		0.085	0.021
10	Unknown C11 Alkene/Cycloalkane ³		0.092	< 0.01
11	Unknown Methyl Decahydronaphthalene		0.10	0.03
12	n-Dodecane	112-40-3	0.59	0.13
13	Unknown C13 Alkane		0.22	0.05
14	Unknown C13 Alkene/Cycloalkane ³		0.094	0.005
15	Unknown Alkane		0.17	0.04
16	n-Tridecane	629-50-5	0.55	0.15
17	Unknown Alkane		0.079	0.023
18	n-Tetradecane	629-59-4	0.30	0.11
19	Unknown Alkane		0.075	0.020
Sum of tentatively identified compounds:			3.65	

1 CAS = Chemical Abstract Service.

2 Based on analyses of 3 samples, values listed are estimates.

3 When the analyte was detected in only 2 samples, the entry is the relative difference (i.e., their difference divided by 2).

4 Detected in only 2 samples.

5 Detected in only 1 sample.

Table 4-7
Tank C-110 Tentatively Identified Organic Compounds in TST Samples
in Order of Chromatographic Elution --
Analyses by Oak Ridge National Laboratory

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
1	methane, trichlorofluoro-	75-69-4	0.17	0.15
2	3-buten-2-one	78-94-4	0.015	0.031
3	2-butanone	78-93-3	0.26	0.13
4	pentane and others		0.13	0.12
5	2,3-dihydrofuran	1191-99-7	0.025	0.028
6	furan, tetrahydro-	109-99-9	0.037	0.074
7	unknown		0.057	0.114
8	2-butenenitrile	4786-20-3	0.0044	0.0087
9	acetic acid and others		0.0059	0.0118
10	butanal, 3-methyl-	590-86-3	0.013	0.015
11	propane, 2-methyl-2-nitro-	594-70-7	0.021	0.014
12	cyclopentane	287-92-3	0.024	0.021
13	propane, 2-isocyanato-	1795-48-8	0.011	0.022
14	methylamine, n-(1-methy-butylidene)-	22431-09-0	0.0046	0.0091
15	2h-pyran-2-one, tetrahydro-5, 6-dimethyl-, trans-	24405-16-1	0.016	0.019
16	hexanal	66-25-1	0.038	0.023
17	cyclobutane, 1,2-diethyl-, trans-	19341-98-1	0.022	0.044
18	acetic acid, butyl ester	123-86-4	0.0049	0.0097
19	cyclotrisiloxane, hexamethyl-	541-05-9	0.0096	0.0192
20	hexamethylcyclotrisiloxane	541-05-9	0.023	0.046
21	nitric acid, butyl ester	928-45-0	0.0048	0.0096
22	cyclopentanone, 3-methyl-	1757-42-2	0.0060	0.0120
23	cyclobutanone, 2-ethyl-	10374-14-8	0.0054	0.0108
24	mixture		0.0060	0.0119
25	benzene, ethyl-	100-41-4	0.015	0.031
26	benzene, 1,2-dimethyl-	95-47-6	0.046	0.087

WHC-SD-WM-ER-464 Rev. 1

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
27	1-hexene, 5-methyl-	3524-73-0	0.015	0.018
28	heptane, 2,5-dimethyl-	2216-30-0	0.0047	0.0093
29	3-heptanone	106-35-4	0.021	0.016
30	styrene	100-42-5	0.016	0.033
31	benzene, 1,3-dimethyl-	108-38-3	0.019	0.037
32	heptanal	111-71-7	0.023	0.019
33	cyclopentanone, 2,4-dimethyl-	1121-33-1	0.0065	0.0129
34	bicyclo[4.1.0]heptane	286-08-8	0.0056	0.0112
35	bicyclo[2.2.1]heptane	279-23-2	0.010	0.012
36	heptane, 3-ethyl-2-methyl-	14676-29-0	0.015	0.010
37	1-pentyn-3-ol, 4-methyl- and others		0.011	0.022
38	bicyclo[2.2.1]heptane and others		0.0098	0.0116
39	c8-alkanone		0.21	0.06
40	nonane, 4-methyl-	17301-94-9	0.010	0.012
41	benzene, propyl-	103-65-1	0.0070	0.0140
42	1,1,2,3-tetramethylcyclohexane	6783-92-2	0.038	0.045
43	1,1,2,3-tetramethylcyclohexane	6783-92-2	0.034	0.040
44	2-octanol	123-96-6	0.026	0.030
45	benzene, 1-ethyl-2-methyl	611-14-3	0.011	0.022
46	3-buten-2-ol	598-32-3	0.17	0.06
47	cyclopropane, pentyl-	2511-91-3	0.022	0.026
48	cyclohexanal, 4-(1-methylethyl)-		0.016	0.011
49	cyclopentane, 1,2-dimethyl-3-(1-methylethyl)-	489-20-3	0.024	0.018
50	benzene, (1-methylethyl)-	98-82-8	0.0086	0.0173
51	cyclotetrasiloxane, octamethyl-	556-67-2	0.12	0.14
52	(Z)-2,3,4,5-tetramethyl-3-hexane		0.020	0.040
53	benzonitrile	100-47-0	0.019	0.037
54	cyclopentane, 1-butyl-2-ethyl-	72993-32-9	0.019	0.013

WHC-SD-WM-ER-464 Rev. 1

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
55	decane	124-18-5	0.27	0.03
56	cyclopentane, 2-isopropyl-1, 3,-dimethyl-	32281-85-9	0.0071	0.0083
57	benzene, 1-propenyl-	637-50-3	0.022	0.043
58	hexanal	66-25-1	0.0032	0.0063
59	cyclopentane, 1-methyl-3-(2-methylpropyl)-	29053-04-1	0.0027	0.0055
60	cyclohexane, diethyl-	1331-43-7	0.0048	0.0096
61	c10-alkane and others		0.0081	0.0099
62	c6-cyclopentane		0.041	0.033
63	1-hexene, 5,5,-dimethyl-	7116-86-1	0.0045	0.0091
64	nonane, 2,6-dimethyl-	17302-28-2	0.23	0.04
65	heptane, 3,3-dimethyl-	4032-86-4	0.0046	0.0093
66	1-hexanol, 2-ethyl- and others		0.011	0.013
67	octane, 6-ethyl-2-methyl-	62016-19-7	0.030	0.025
68	benzene, (1,1-dimethylethyl)-	98-06-6	0.013	0.027
69	alkane and others		0.019	0.038
70	cyclohexane, (1-methylpropyl)-	7058-01-7	0.13	0.02
71	cyclopentane, 1-methyl-3-(2-methylpropyl)-	29053-04-1	0.065	0.007
72	cyclohexane, (1-methylpropyl)-	7058-01-7	0.036	0.024
73	cyclohexane, cyclopropyl-	32669-86-6	0.067	0.009
74	1,1-dimethyl-2-propylcyclohexane		0.071	0.006
75	decane, 5-methyl-	13151-35-4	0.070	0.050
76	decane, 4-methyl-	2847-72-5	0.090	0.014
77	decane, 2-methyl-	6975-98-0	0.24	0.03
78	decane, 3-methyl-	13151-34-3	0.054	0.108
79	naphthalene, decahydro-, trans-	493-02-7	0.019	0.037
80	nonane, 3,7-dimethyl-	17302-32-8	0.15	0.11
81	cyclohexane, 1,2-diethyl-1-methyl-	61141-79-5	0.013	0.026

WHC-SD-WM-ER-464 Rev. 1

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
82	ethanone, 1-phenyl and cyclohexane, 1,2-diethyl-1-methyl-		0.045	0.054
83	bicyclo[2.2.2]octane, 1,2,3,6-tetramethyl-	62338-45-8	0.015	0.030
84	cyclohexane, 1,2-diethyl-1-methyl- and ethanone, 1-phenyl-		0.018	0.036
85	formic acid, 2,6-dimethyl- 5-hepten-2-ol ester		0.044	0.029
86	cyclohexane, 1,1,3,5- tetramethyl-, trans-	50876-31-8	0.0053	0.0105
87	5-undecene	4941-53-1	0.20	0.08
88	2-nonanone	821-55-6	0.083	0.057
89	mixture		0.019	0.038
90	cyclohexane, 1-ethyl-2-propyl-	62238-33-9	0.011	0.022
91	undecane	1120-21-4	0.95	0.25
92	c11-alkene		0.061	0.015
93	octane, 6-ethyl-2-methyl-	62016-19-7	0.019	0.038
94	cyclohexane, 2-butyl-1, 1,3-trimethyl-	54676-39-0	0.065	0.044
95	undecane, 5-methyl-	1632-70-8	0.27	0.02
96	cyclohexene, 1-pentyl-	15232-85-6	0.041	0.029
97	undecane, 4-methyl-	2980-69-0	0.055	0.066
98	undecane, 2-methyl-	7045-71-8	0.39	0.26
99	undecane, 3-methyl-	1002-43-3	0.070	0.049
100	2-undecene, 8-methyl-, (Z)-	74630-44-7	0.016	0.018
101	naphthalene, decahydro- 2-methyl-	2958-76-1	0.10	0.20
102	1-undecene, 7-methyl-	74630-42-5	0.080	0.012
103	cyclohexane, pentyl-	4292-92-6	0.055	0.110
104	methyl-decahydronaphthalene		0.60	0.03
105	1-undecene, 8-methyl-	74630-40-3	0.025	0.029
106	6-methylundecane	17302-33-9	0.50	0.06
107	undecane, 4-methyl-	2980-69-0	0.25	0.07
108	undecane, 2-methyl-	7045-71-8	0.48	0.12

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
109	undecane, 2,3-dimethyl-	17312-77-5	0.042	0.085
110	undecane, 3-methyl-	1002-43-3	0.26	0.06
111	c12-alkene		0.056	0.066
112	decane, 2,3,6-trimethyl-	62238-12-4	0.023	0.045
113	cyclododecane	294-62-2	0.13	0.02
114	cyclohexane, 1-methyl-3-pentyl-	54411-02-8	0.019	0.038
115	naphthalene and others		0.017	0.034
116	naphthalene, decahydro-2, 3-dimethyl-	1008-80-6	0.0057	0.0114
117	cyclohexane, 1-methyl-4-(1-methylbutyl)-	54411-00-6	0.012	0.025
118	undecane, 2,6-dimethyl-	17301-23-4	0.36	0.22
119	dodecane and acetophenone, 2'-hydroxy-5'-methoxy		0.095	0.016
120	undecane, 3,7-dimethyl-	17301-29-0	0.024	0.048
121	alkene and acetophenone, 2'-hydroxy-5'-methoxy-		0.033	0.066
122	cyclohexane, 2-butyl-1, 1,3-trimethyl-	54676-39-0	0.13	0.12
123	alkene		0.0071	0.0142
124	naphthalene, decahydro-1, 6-dimethyl-	1750-51-2	0.016	0.032
125	cyclohexane, (4-methylpentyl)-	61142-20-9	0.090	0.181
126	cyclopentane, 1-hexyl-3-methyl-	61142-68-5	0.13	0.15
127	undecane, 2,5-dimethyl	17301-22-3	0.025	0.049
128	undecane, 2,4-dimethyl	17312-80-0	0.019	0.038
129	cyclopentane, 1-hexyl-3-methyl-	61142-68-5	0.072	0.144
130	dodecane, 4-methyl-	6117-97-1	0.11	0.05
131	undecane, 2,10-dimethyl-	17301-27-8	0.22	0.11
132	tridecane, 4-methyl-	26730-12-1	0.26	0.16
133	dodecane, 4,6-dimethyl	61141-72-8	0.25	0.50
134	c6-cyclohexane		0.0063	0.0126
135	2-decyne and 6-methyl-8,9-(7H)-dihydro-1,2,4-triazolo [4,3-B]-1,2,4-Triazepin-8-one		0.031	0.063

WHC-SD-WM-ER-464 Rev. 1

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
136	1-tridecane	2437-56-1	0.025	0.050
137	3-tetradecene, (z)-	41446-67-7	0.062	0.124
138	c13-alkene		0.056	0.040
139	c9-cyclopentane		0.013	0.026
140	c13-alkane		0.012	0.025
141	tridecane, 5-,methyl-	25117-31-1	0.018	0.013
142	dodecane, 4,6-dimethyl-	61141-72-8	0.057	0.020
143	dodecane, 2,5-dimethyl-	56292-65-0	0.17	0.08
144	cyclohexane,1-(cyclohexylmethyl)-2-ethyl	54934-93-9	0.0083	0.0166
145	c8-cyclohexane		0.019	0.037
146	1-tetradecene	1120-36-1	0.046	0.025
147	tridecane, 6-methyl-	13287-21-3	0.085	0.051
148	c7-cyclohexane		0.15	0.09
149	tridecane, 4-methyl-	26730-12-1	0.14	0.06
150	tridecane, 2-methyl-	1560-06-9	0.19	0.08
151	tridecane, 3-methyl-	6418-41-3	0.17	0.08
152	dodecane, 2,6,10-trimethyl-	3891-98-3	0.39	0.42
153	bicyclohexyl, 2-methyl-,trans	50991-09-8	0.0054	0.0108
154	tetradecane	629-59-4	0.42	0.40
155	pentadecane	629-62-9	0.12	0.13
156	c7-cyclohexane		0.027	0.054
157	alkane		0.010	0.020
158	dodecane, 2,6,11-trimethyl	31295-56-4	0.034	0.067
159	c15-alkane		0.019	0.038
160	tridecane, 3-ethyl-	13286-73-2	0.066	0.102
161	c15-alkane		0.023	0.027
162	tridecane, 3-ethyl-	13286-73-2	0.070	0.047
163	dodecane, 2-methyl-8-propyl	55045-07-3	0.21	0.42
164	pentadecane	629-62-9	0.063	0.125

WHC-SD-WM-ER-464 Rev. 1

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
165	hexadecane	544-76-3	0.031	0.062
166	c15-alkane		0.060	0.041
167	c15-alkane		0.069	0.017
168	pentadecane, 3-methyl	2882-96-4	0.016	0.032
169	hexadecane	544-76-3	0.024	0.028
170	2-dodecene, 4-methyl-	56851-45-7	0.011	0.013
171	3-tridecanone	1534-26-5	0.058	0.015
172	pentadecane	629-62-9	0.33	0.31
173	c9-cyclohexane		0.015	0.030
174	c9-cyclohexane		0.045	0.089
175	dodecane, 2-methyl-6-propyl-	55045-08-4	0.011	0.007
176	alkane		0.0074	0.0148
177	tridecane, 5-propyl-	55045-11-9	0.078	0.020
178	dodecane, 2-methyl-8-propyl-	55045-07-3	0.042	0.028
179	docosane, 7-hexyl	55373-86-9	0.015	0.030
180	c17-alkane		0.064	0.004
181	dodecane, 5,8-diethyl-	24251-86-3	0.029	0.002
182	5-undecanone, 2-methyl-	50639-02-6	0.073	0.007
183	4-undecanone	14476-37-0	0.021	0.041
184	cyclohexane, 1,2,4,5-tetraethyl-	61142-24-3	0.025	0.029
185	3-dodecanone	1534-27-6	0.023	0.002
186	hexadecane	544-76-3	0.16	0.03
187	1-butanone, 4-(dimethylamine)-1-phenyl	3760-63-2	0.0039	0.0078
188	phthlate		0.072	0.032
189	heptadecane, 3-methyl-	6418-44-6	0.050	0.003
190	TBP and benzenamine, N-phenyl		0.013	0.026
191	decane 3-cyclohexyl-, 3-cyclohexyl-	13151-74-1	0.0018	0.0037
192	5-tridecanone	30692-16-1	0.020	0.002
193	mixture		0.0044	0.0088

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
194	1-tridecyn-4-ol	74646-37-0	0.0044	0.0033
195	heptadecane	629-78-7	0.035	0.005
196	c18-alkane		0.035	0.006
197	tetradecanoic acid	544-63-8	0.030	0.024
198	9H-fluoren-9-one	486-25-9	0.0042	0.0085
199	octadecane	593-45-3	0.0024	0.0048
200	alkane and benzaldehyde, 4-hydroxy-		0.0018	0.0037
201	siloxane		0.0035	0.0069
202	benzenesulfonamide, n-butyl-	3622-84-2	0.082	0.062
203	alkanoic acid		0.0010	0.0021
204	pentadecanoic acid	1002-84-2	0.018	0.012
205	1-hexadecanol	36653-82-4	0.0070	0.0112
206	heptadecane	629-78-7	0.00090	0.00180
207	9-hexadecenoic acid	2091-29-4	0.015	0.022
208	hexadecanoic acid	57-10-3	0.058	0.084
209	hexadecane, 2,6,10,14-tetramethyl-	638-36-8	0.0013	0.0025
210	1-hexadecanol	36653-82-4	0.0046	0.0092
211	hexadecanoic acid, 1-methylethyl ester	142-91-6	0.013	0.027
212	alkane		0.0037	0.0075
Sum of tentatively identified compounds:			14.83	

1 CAS = Chemical Abstract Service.

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

Table 4-8
Tank C-110 Tentatively Identified Organic Compounds in TST Samples
Sorted Alphanumerically --
Analyses by Oak Ridge National Laboratory

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
52	(Z)-2,3,4,5-tetramethyl-3-hexane		0.020	0.040
102	1-undecene, 7-methyl-	74630-42-5	0.080	0.012
105	1-undecene, 8-methyl-	74630-40-3	0.025	0.029
210	1-hexadecanol	36653-82-4	0.0046	0.0092
187	1-butanone, 4-(dimethylamine)-1-phenyl	3760-63-2	0.0039	0.0078
27	1-hexene, 5-methyl-	3524-73-0	0.015	0.018
63	1-hexene, 5,5-dimethyl-	7116-86-1	0.0045	0.0091
66	1-hexanol, 2-ethyl- and others		0.011	0.013
37	1-pentyn-3-ol, 4-methyl- and others		0.011	0.022
136	1-tridecane	2437-56-1	0.025	0.050
194	1-tridecyn-4-ol	74646-37-0	0.0044	0.0033
146	1-tetradecene	1120-36-1	0.046	0.025
205	1-hexadecanol	36653-82-4	0.0070	0.0112
74	1,1-dimethyl-2-propylcyclohexane		0.071	0.006
153	bicyclohexyl, 2-methyl-,trans	50991-09-8	0.0054	0.0108
43	1,1,2,3-tetramethylcyclohexane	6783-92-2	0.034	0.040
42	1,1,2,3-tetramethylcyclohexane	6783-92-2	0.038	0.045
100	2-undecene, 8-methyl-, (Z)-	74630-44-7	0.016	0.018
3	2-butanone	78-93-3	0.26	0.13
88	2-nonanone	821-55-6	0.083	0.057
170	2-dodecene, 4-methyl-	56851-45-7	0.011	0.013
8	2-butenenitrile	4786-20-3	0.0044	0.0087
44	2-octanol	123-96-6	0.026	0.030
135	2-decyne and 6-methyl-8,9-(7H)-dihydro-1,2,4-triazolo [4,3-B]-1,2,4-Triazepin-8-one		0.031	0.063
5	2,3-dihydrofuran	1191-99-7	0.025	0.028

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
15	2h-pyran-2-one, tetrahydro-5, 6-dimethyl-, trans-	24405-16-1	0.016	0.019
46	3-buten-2-ol	598-32-3	0.17	0.06
171	3-tridecanone	1534-26-5	0.058	0.015
2	3-buten-2-one	78-94-4	0.015	0.031
185	3-dodecanone	1534-27-6	0.023	0.002
29	3-heptanone	106-35-4	0.021	0.016
137	3-tetradecene, (z)-	41446-67-7	0.062	0.124
183	4-undecanone	14476-37-0	0.021	0.041
87	5-undecene	4941-53-1	0.20	0.08
192	5-tridecanone	30692-16-1	0.020	0.002
182	5-undecanone, 2-methyl-	50639-02-6	0.073	0.007
106	6-methylundecane	17302-33-9	0.50	0.06
207	9-hexadecenoic acid	2091-29-4	0.015	0.022
198	9H-fluoren-9-one	486-25-9	0.0042	0.0085
9	acetic acid and others		0.0059	0.0118
18	acetic acid, butyl ester	123-86-4	0.0049	0.0097
157	alkane		0.010	0.020
200	alkane and benzaldehyde, 4-hydroxy-		0.0018	0.0037
176	alkane		0.0074	0.0148
69	alkane and others		0.019	0.038
212	alkane		0.0037	0.0075
203	alkanoic acid		0.0010	0.0021
123	alkene		0.0071	0.0142
121	alkene and acetophenone, 2'-hydroxy-5'methoxy-		0.033	0.066
26	benzene, 1,2-dimethyl-	95-47-6	0.046	0.087
25	benzene, ethyl-	100-41-4	0.015	0.031
31	benzene, 1,3-dimethyl-	108-38-3	0.019	0.037
45	benzene, 1-ethyl-2-methyl	611-14-3	0.011	0.022

WHC-SD-WM-ER-464 Rev. 1

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
68	benzene, (1,1-dimethylethyl)-	98-06-6	0.013	0.027
57	benzene, 1-propenyl-	637-50-3	0.022	0.043
41	benzene, propyl-	103-65-1	0.0070	0.0140
50	benzene, (1-methylethyl)-	98-82-8	0.0086	0.0173
202	benzenesulfonamide, n-butyl-	3622-84-2	0.082	0.062
53	benzonitrile	100-47-0	0.019	0.037
38	bicyclo[2.2.1]heptane and others		0.0098	0.0116
83	bicyclo[2.2.2]octane, 1,2,3,6-tetramethyl-	62338-45-8	0.015	0.030
35	bicyclo[2.2.1]heptane	279-23-2	0.010	0.012
34	bicyclo[4.1.0]heptane	286-08-8	0.0056	0.0112
10	butanal, 3-methyl-	590-86-3	0.013	0.015
61	c10-alkane and others		0.0081	0.0099
92	c11-alkene		0.061	0.015
111	c12-alkene		0.056	0.066
140	c13-alkane		0.012	0.025
138	c13-alkene		0.056	0.040
167	c15-alkane		0.069	0.017
161	c15-alkane		0.023	0.027
166	c15-alkane		0.060	0.041
159	c15-alkane		0.019	0.038
180	c17-alkane		0.064	0.004
196	c18-alkane		0.035	0.006
134	c6-cyclohexane		0.0063	0.0126
62	c6-cyclopentane		0.041	0.033
148	c7-cyclohexane		0.15	0.09
156	c7-cyclohexane		0.027	0.054
39	c8-alkanone		0.21	0.06
145	c8-cyclohexane		0.019	0.037
139	c9-cyclopentane		0.013	0.026

WHC-SD-WM-ER-464 Rev. 1

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
174	c9-cyclohexane		0.045	0.089
173	c9-cyclohexane		0.015	0.030
17	cyclobutane, 1,2-diethyl-, trans-	19341-98-1	0.022	0.044
23	cyclobutanone, 2-ethyl-	10374-14-8	0.0054	0.0108
113	cyclododecane	294-62-2	0.13	0.02
48	cyclohexanal, 4-(1-methylethyl)-		0.016	0.011
125	cyclohexane, (4-methylpentyl)-	61142-20-9	0.090	0.181
103	cyclohexane, pentyl-	4292-92-6	0.055	0.110
117	cyclohexane, 1-methyl-4-(1-methylbutyl)-	54411-00-6	0.012	0.025
122	cyclohexane, 2-butyl-1, 1,3-trimethyl-	54676-39-0	0.13	0.12
60	cyclohexane, diethyl-	1331-43-7	0.0048	0.0096
81	cyclohexane, 1,2-diethyl-1-methyl-	61141-79-5	0.013	0.026
72	cyclohexane, (1-methylpropyl)-	7058-01-7	0.036	0.024
86	cyclohexane, 1,1,3,5-tetramethyl-, trans-	50876-31-8	0.0053	0.0105
84	cyclohexane, 1,2-diethyl- 1-methyl- and ethanone, 1-phenyl-		0.018	0.036
114	cyclohexane, 1-methyl-3-pentyl-	54411-02-8	0.019	0.038
90	cyclohexane, 1-ethyl-2-propyl-	62238-33-9	0.011	0.022
94	cyclohexane, 2-butyl-1, 1,3-trimethyl-	54676-39-0	0.065	0.044
73	cyclohexane, cyclopropyl-	32669-86-6	0.067	0.009
184	cyclohexane, 1,2,4,5-tetraethyl-	61142-24-3	0.025	0.029
70	cyclohexane, (1-methylpropyl)-	7058-01-7	0.13	0.02
144	cyclohexane, 1-(cyclohexylmethyl)-2-ethyl	54934-93-9	0.0083	0.0166
96	cyclohexene, 1-pentyl-	15232-85-6	0.041	0.029
12	cyclopentane	287-92-3	0.024	0.021
129	cyclopentane, 1-hexyl-3-methyl-	61142-68-5	0.072	0.144
49	cyclopentane, 1,2-dimethyl- 3-(1-methylethyl)-	489-20-3	0.024	0.018
56	cyclopentane, 2-isopropyl-1, 3,-dimethyl-	32281-85-9	0.0071	0.0083
54	cyclopentane, 1-butyl-2-ethyl-	72993-32-9	0.019	0.013

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
59	cyclopentane, 1-methyl-3-(2-methylpropyl)-	29053-04-1	0.0027	0.0055
71	cyclopentane, 1-methyl-3-(2-methylpropyl)-	29053-04-1	0.065	0.007
126	cyclopentane, 1-hexyl-3-methyl-	61142-68-5	0.13	0.15
22	cyclopentanone, 3-methyl-	1757-42-2	0.0060	0.0120
33	cyclopentanone, 2,4-dimethyl-	1121-33-1	0.0065	0.0129
47	cyclopropane, pentyl-	2511-91-3	0.022	0.026
51	cyclotetrasiloxane, octamethyl-	556-67-2	0.12	0.14
19	cyclotrisiloxane, hexamethyl-	541-05-9	0.0096	0.0192
76	decane, 4-methyl-	2847-72-5	0.090	0.014
191	decane 3-cyclohexyl-, 3-cyclohexyl-	13151-74-1	0.0018	0.0037
75	decane, 5-methyl-	13151-35-4	0.070	0.050
77	decane, 2-methyl-	6975-98-0	0.24	0.03
112	decane, 2,3,6-trimethyl-	62238-12-4	0.023	0.045
78	decane, 3-methyl-	13151-34-3	0.054	0.108
55	decane	124-18-5	0.27	0.03
179	docosane, 7-hexyl	55373-86-9	0.015	0.030
152	dodecane, 2,6,10-trimethyl-	3891-98-3	0.39	0.42
158	dodecane, 2,6,11-trimethyl	31295-56-4	0.034	0.067
143	dodecane, 2,5-dimethyl-	56292-65-0	0.17	0.08
181	dodecane, 5,8-diethyl-	24251-86-3	0.029	0.002
142	dodecane, 4,6-dimethyl-	61141-72-8	0.057	0.020
119	dodecane and acetophenone, 2'-hydroxy-5'-methoxy		0.095	0.016
178	dodecane, 2-methyl-8-propyl-	55045-07-3	0.042	0.028
133	dodecane, 4,6-dimethyl	61141-72-8	0.25	0.50
130	dodecane, 4-methyl-	6117-97-1	0.11	0.05
175	dodecane, 2-methyl-6-propyl-	55045-08-4	0.011	0.007
163	dodecane, 2-methyl-8-propyl	55045-07-3	0.21	0.42

WHC-SD-WM-ER-464 Rev. 1

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
82	ethanone, 1-phenyl and cyclohexane, 1,2-diethyl-1-methyl-		0.045	0.054
85	formic acid, 2,6-dimethyl-5-hepten-2-ol ester		0.044	0.029
6	furan, tetrahydro-	109-99-9	0.037	0.074
206	heptadecane	629-78-7	0.00090	0.00180
189	heptadecane, 3-methyl-	6418-44-6	0.050	0.003
195	heptadecane	629-78-7	0.035	0.005
32	heptanal	111-71-7	0.023	0.019
28	heptane, 2,5-dimethyl-	2216-30-0	0.0047	0.0093
65	heptane, 3,3-dimethyl-	4032-86-4	0.0046	0.0093
36	heptane, 3-ethyl-2-methyl-	14676-29-0	0.015	0.010
169	hexadecane	544-76-3	0.024	0.028
186	hexadecane	544-76-3	0.16	0.03
209	hexadecane, 2,6,10,14-tetramethyl-	638-36-8	0.0013	0.0025
165	hexadecane	544-76-3	0.031	0.062
208	hexadecanoic acid	57-10-3	0.058	0.084
211	hexadecanoic acid, 1-methylethyl ester	142-91-6	0.013	0.027
20	hexamethylcyclotrisiloxane	541-05-9	0.023	0.046
16	hexanal	66-25-1	0.038	0.023
58	hexanal	66-25-1	0.0032	0.0063
1	methane, trichlorofluoro-	75-69-4	0.17	0.15
104	methyl-decahydronaphthalene		0.60	0.03
14	methylamine, n-(1-methy-butylidene)-	22431-09-0	0.0046	0.0091
89	mixture		0.019	0.038
193	mixture		0.0044	0.0088
24	mixture		0.0060	0.0119
79	naphthalene, decahydro-, trans-	493-02-7	0.019	0.037
116	naphthalene, decahydro-2, 3-dimethyl-	1008-80-6	0.0057	0.0114
115	naphthalene and others		0.017	0.034

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
124	naphthalene, decahydro-1, 6-dimethyl-	1750-51-2	0.016	0.032
101	naphthalene, decahydro- 2-methyl-	2958-76-1	0.10	0.20
21	nitric acid, butyl ester	928-45-0	0.0048	0.0096
64	nonane, 2,6-dimethyl-	17302-28-2	0.23	0.04
80	nonane, 3,7-dimethyl-	17302-32-8	0.15	0.11
40	nonane, 4-methyl-	17301-94-9	0.010	0.012
199	octadecane	593-45-3	0.0024	0.0048
67	octane, 6-ethyl-2-methyl-	62016-19-7	0.030	0.025
93	octane, 6-ethyl-2-methyl-	62016-19-7	0.019	0.038
168	pentadecane, 3-methyl	2882-96-4	0.016	0.032
164	pentadecane	629-62-9	0.063	0.125
172	pentadecane	629-62-9	0.33	0.31
155	pentadecane	629-62-9	0.12	0.13
204	pentadecanoic acid	1002-84-2	0.018	0.012
4	pentane and others		0.13	0.12
188	phthlate		0.072	0.032
11	propane, 2-methyl-2-nitro-	594-70-7	0.021	0.014
13	propane, 2-isocyanato-	1795-48-8	0.011	0.022
201	siloxane		0.0035	0.0069
30	styrene	100-42-5	0.016	0.033
190	TBP and benzenamine, N-phenyl		0.013	0.026
154	tetradecane	629-59-4	0.42	0.40
197	tetradecanoic acid	544-63-8	0.030	0.024
132	tridecane, 4-methyl-	26730-12-1	0.26	0.16
177	tridecane, 5-propyl-	55045-11-9	0.078	0.020
162	tridecane, 3-ethyl-	13286-73-2	0.070	0.047
151	tridecane, 3-methyl-	6418-41-3	0.17	0.08
160	tridecane, 3-ethyl-	13286-73-2	0.066	0.102
149	tridecane, 4-methyl-	26730-12-1	0.14	0.06

WHC-SD-WM-ER-464 Rev. 1

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
150	tridecane, 2-methyl-	1560-96-9	0.19	0.08
147	tridecane, 6-methyl-	13287-21-3	0.085	0.051
141	tridecane, 5-methyl-	25117-31-1	0.018	0.013
107	undecane, 4-methyl-	2980-69-0	0.25	0.07
98	undecane, 2-methyl-	7045-71-8	0.39	0.26
99	undecane, 3-methyl-	1002-43-3	0.070	0.049
97	undecane, 4-methyl-	2980-69-0	0.055	0.066
95	undecane, 5-methyl-	1632-70-8	0.27	0.02
91	undecane	1120-21-4	0.95	0.25
131	undecane, 2,10-dimethyl-	17301-27-8	0.22	0.11
108	undecane, 2-methyl-	7045-71-8	0.48	0.12
127	undecane, 2,5-dimethyl	17301-22-3	0.025	0.049
128	undecane, 2,4-dimethyl	17312-80-0	0.019	0.038
109	undecane, 2,3-dimethyl-	17312-77-5	0.042	0.085
120	undecane, 3,7-dimethyl-	17301-29-0	0.024	0.048
118	undecane, 2,6-dimethyl-	17301-23-4	0.36	0.22
110	undecane, 3-methyl-	1002-43-3	0.26	0.06
7	unknown		0.057	0.114

1 CAS = Chemical Abstract Service.

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

Table 4-9
Tank C-110 Tentatively Identified Organic Compounds in TST Samples
Sorted by Estimated Concentration --
Analyses by Oak Ridge National Laboratory

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
91	undecane	1120-21-4	0.95	0.25
104	methyl-decahydronaphthalene		0.60	0.03
106	6-methylundecane	17302-33-9	0.50	0.06
108	undecane, 2-methyl-	7045-71-8	0.48	0.12
154	tetradecane	629-59-4	0.42	0.40
152	dodecane, 2,6,10-trimethyl-	3891-98-3	0.39	0.42
98	undecane, 2-methyl-	7045-71-8	0.39	0.26
118	undecane, 2,6-dimethyl-	17301-23-4	0.36	0.22
172	pentadecane	629-62-9	0.33	0.31
95	undecane, 5-methyl-	1632-70-8	0.27	0.02
55	decane	124-18-5	0.27	0.03
3	2-butanone	78-93-3	0.26	0.13
132	tridecane, 4-methyl-	26730-12-1	0.26	0.16
110	undecane, 3-methyl-	1002-43-3	0.26	0.06
107	undecane, 4-methyl-	2980-69-0	0.25	0.07
133	dodecane, 4,6-dimethyl	61141-72-8	0.25	0.50
77	decane, 2-methyl-	6975-98-0	0.24	0.03
64	nonane, 2,6-dimethyl-	17302-28-2	0.23	0.04
131	undecane, 2,10-dimethyl-	17301-27-8	0.22	0.11
163	dodecane, 2-methyl-8-propyl	55045-07-3	0.21	0.42
39	c8-alkanone		0.21	0.06
87	5-undecene	4941-53-1	0.20	0.08
150	tridecane, 2-methyl-	1560-96-9	0.19	0.08
46	3-buten-2-ol	598-32-3	0.17	0.06
1	methane, trichlorofluoro-	75-69-4	0.17	0.15
143	dodecane, 2,5-dimethyl-	56292-65-0	0.17	0.08

WHC-SD-WM-ER-464 Rev. 1

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
151	tridecane, 3-methyl-	6418-41-3	0.17	0.08
186	hexadecane	544-76-3	0.16	0.03
148	c7-cyclohexane		0.15	0.09
80	nonane, 3,7-dimethyl-	17302-32-8	0.15	0.11
149	tridecane, 4-methyl-	26730-12-1	0.14	0.06
122	cyclohexane, 2-butyl-1, 1,3-trimethyl-	54676-39-0	0.13	0.12
113	cyclododecane	294-62-2	0.13	0.02
4	pentane and others		0.13	0.12
70	cyclohexane, (1-methylpropyl)-	7058-01-7	0.13	0.02
126	cyclopentane, 1-hexyl-3-methyl-	61142-68-5	0.13	0.15
51	cyclotetrasiloxane, octamethyl-	556-67-2	0.12	0.14
155	pentadecane	629-62-9	0.12	0.13
130	dodecane, 4-methyl-	6117-97-1	0.11	0.05
101	naphthalene, decahydro- 2-methyl-	2958-76-1	0.10	0.20
119	dodecane and acetophenone, 2'-hydroxy-5'-methoxy		0.095	0.016
125	cyclohexane, (4-methylpentyl)-	61142-20-9	0.090	0.181
76	decane, 4-methyl-	2847-72-5	0.090	0.014
147	tridecane, 6-methyl-	13287-21-3	0.085	0.051
88	2-nonanone	821-55-6	0.083	0.057
202	benzenesulfonamide, n-butyl-	3622-84-2	0.082	0.062
102	1-undecene, 7-methyl-	74630-42-5	0.080	0.012
177	tridecane, 5-propyl-	55045-11-9	0.078	0.020
182	5-undecanone, 2-methyl-	50639-02-6	0.073	0.007
129	cyclopentane, 1-hexyl-3-methyl-	61142-68-5	0.072	0.144
188	phthlate		0.072	0.032
74	1,1-dimethyl-2-propylcyclohexane		0.071	0.006
99	undecane, 3-methyl-	1002-43-3	0.070	0.049
162	tridecane, 3-ethyl-	13286-73-2	0.070	0.047

WHC-SD-WM-ER-464 Rev. 1

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
75	decane, 5-methyl-	13151-35-4	0.070	0.050
167	c15-alkane		0.069	0.017
73	cyclohexane, cyclopropyl-	32669-86-6	0.067	0.009
160	tridecane, 3-ethyl-	13286-73-2	0.066	0.102
94	cyclohexane, 2-butyl-1, 1,3-trimethyl-	54676-39-0	0.065	0.044
71	cyclopentane, 1-methyl-3-(2-methylpropyl)-	29053-04-1	0.065	0.007
180	c17-alkane		0.064	0.004
164	pentadecane	629-62-9	0.063	0.125
137	3-tetradecene, (z)-	41446-67-7	0.062	0.124
92	c11-alkene		0.061	0.015
166	c15-alkane		0.060	0.041
208	hexadecanoic acid	57-10-3	0.058	0.084
171	3-tridecanone	1534-26-5	0.058	0.015
7	unknown		0.057	0.114
142	dodecane, 4,6-dimethyl-	61141-72-8	0.057	0.020
111	c12-alkene		0.056	0.066
138	c13-alkene		0.056	0.040
103	cyclohexane, pentyl-	4292-92-6	0.055	0.110
97	undecane, 4-methyl-	2980-69-0	0.055	0.066
78	decane, 3-methyl-	13151-34-3	0.054	0.108
189	heptadecane, 3-methyl-	6418-44-6	0.050	0.003
146	1-tetradecene	1120-36-1	0.046	0.025
26	benzene, 1,2-dimethyl-	95-47-6	0.046	0.087
174	c9-cyclohexane		0.045	0.089
82	ethanone, 1-phenyl and cyclohexane, 1,2-diethyl-1-methyl-		0.045	0.054
85	formic acid, 2,6-dimethyl-5-hepten-2-ol ester		0.044	0.029
178	dodecane, 2-methyl-8-propyl-	55045-07-3	0.042	0.028

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
109	undecane, 2,3-dimethyl-	17312-77-5	0.042	0.085
96	cyclohexene, 1-pentyl-	15232-85-6	0.041	0.029
62	c6-cyclopentane		0.041	0.033
42	1,1,2,3-tetramethylcyclohexane A		0.038	0.045
16	hexanal	66-25-1	0.038	0.023
6	furan, tetrahydro-	109-99-9	0.037	0.074
72	cyclohexane, (1-methylpropyl)-	7058-01-7	0.036	0.024
195	heptadecane	629-78-7	0.035	0.005
196	c18-alkane		0.035	0.006
158	dodecane, 2,6,11-trimethyl	31295-56-4	0.034	0.067
43	1,1,2,3-tetramethyl-cyclohexane B		0.034	0.040
121	alkene and acetophenone, 2'-hydroxy-5'methoxy-		0.033	0.066
165	hexadecane	544-76-3	0.031	0.062
135	2-decyne and 6-methyl-8,9-(7H)-dihydro-1,2,4-triazolo [4,3-B]-1,2,4-Triazepin-8-one		0.031	0.063
67	octane, 6-ethyl-2-methyl-	62016-19-7	0.030	0.025
197	tetradecanoic acid	544-63-8	0.030	0.024
181	dodecane, 5,8-diethyl-	24251-86-3	0.029	0.002
156	c7-cyclohexane		0.027	0.054
44	2-octanol	123-96-6	0.026	0.030
136	1-tridecane	2437-56-1	0.025	0.050
105	1-undecene, 8-methyl-	74630-40-3	0.025	0.029
5	2,3-dihydrofuran	1191-99-7	0.025	0.028
127	undecane, 2,5-dimethyl	17301-22-3	0.025	0.049
184	cyclohexane, 1,2,4,5-tetraethyl-	61142-24-3	0.025	0.029
12	cyclopentane	287-92-3	0.024	0.021
120	undecane, 3,7-dimethyl-	17301-29-0	0.024	0.048
49	cyclopentane, 1,2-dimethyl-3-(1-methylethyl)-	489-20-3	0.024	0.018

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
169	hexadecane	544-76-3	0.024	0.028
112	decane, 2,3,6-trimethyl-	62238-12-4	0.023	0.045
161	c15-alkane		0.023	0.027
185	3-dodecanone	1534-27-6	0.023	0.002
20	hexamethylcyclotrisiloxane	541-05-9	0.023	0.046
32	heptanal	111-71-7	0.023	0.019
47	cyclopropane, pentyl-	2511-91-3	0.022	0.026
17	cyclobutane, 1,2-diethyl-, trans-	19341-98-1	0.022	0.044
57	benzene, 1-propenyl-	637-50-3	0.022	0.043
29	3-heptanone	106-35-4	0.021	0.016
11	propane, 2-methyl-2-nitro-	594-70-7	0.021	0.014
183	4-undecanone	14476-37-0	0.021	0.041
192	5-tridecanone	30692-16-1	0.020	0.002
52	(Z)-2,3,4,5-tetramethyl-3-hexane		0.020	0.040
93	octane, 6-ethyl-2-methyl-	62016-19-7	0.019	0.038
89	mixture		0.019	0.038
159	c15-alkane		0.019	0.038
31	benzene, 1,3-dimethyl-	108-38-3	0.019	0.037
69	alkane and others		0.019	0.038
53	benzonitrile	100-47-0	0.019	0.037
145	c8-cyclohexane		0.019	0.037
79	naphthalene, decahydro-, trans-	493-02-7	0.019	0.037
54	cyclopentane, 1-butyl-2-ethyl-	72993-32-9	0.019	0.013
128	undecane, 2,4-dimethyl	17312-80-0	0.019	0.038
114	cyclohexane, 1-methyl- 3-pentyl-	54411-02-8	0.019	0.038
204	pentadecanoic acid	1002-84-2	0.018	0.012
141	tridecane, 5-,methyl-	25117-31-1	0.018	0.013
84	cyclohexane, 1,2-diethyl- 1-methyl- and ethanone, 1-phenyl-		0.018	0.036

WHC-SD-WM-ER-464 Rev. 1

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
115	naphthalene and others		0.017	0.034
100	2-undecene, 8-methyl-, (Z)-	74630-44-7	0.016	0.018
30	styrene	100-42-5	0.016	0.033
124	naphthalene, decahydro-1, 6-dimethyl-	1750-51-2	0.016	0.032
168	pentadecane, 3-methyl	2882-96-4	0.016	0.032
15	2h-pyran-2-one, tetrahydro-5, 6-dimethyl-, trans-	24405-16-1	0.016	0.019
48	cyclohexanal, 4-(1-methylethyl)-		0.016	0.011
207	9-hexadecenoic acid	2091-29-4	0.015	0.022
25	benzene, ethyl-	100-41-4	0.015	0.031
2	3-buten-2-one	78-94-4	0.015	0.031
173	c9-cyclohexane		0.015	0.030
83	bicyclo[2.2.2]octane, 1,2,3,6-tetramethyl-	62338-45-8	0.015	0.030
36	heptane, 3-ethyl-2-methyl-	14676-29-0	0.015	0.010
179	docosane, 7-hexyl	55373-86-9	0.015	0.030
27	1-hexene, 5-methyl-	3524-73-0	0.015	0.018
68	benzene, (1,1-dimethylethyl)-	98-06-6	0.013	0.027
190	TBP and benzenamine, N-phenyl		0.013	0.026
10	butanal, 3-methyl-	590-86-3	0.013	0.015
139	c9-cyclopentane		0.013	0.026
211	hexadecanoic acid, 1-methylethyl ester	142-91-6	0.013	0.027
81	cyclohexane, 1,2-diethyl- 1-methyl-	61141-79-5	0.013	0.026
140	c13-alkane		0.012	0.025
117	cyclohexane, 1-methyl-4- (1-methylbutyl)-	54411-00-6	0.012	0.025
66	1-hexanol, 2-ethyl- and others		0.011	0.013
170	2-dodecene, 4-methyl-	56851-45-7	0.011	0.013
13	propane, 2-isocyanato-	1795-48-8	0.011	0.022
37	1-pentyn-3-ol, 4-methyl- and others		0.011	0.022
45	benzene, 1-ethyl-2-methyl	611-14-3	0.011	0.022

WHC-SD-WM-ER-464 Rev. 1

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
90	cyclohexane, 1-ethyl-2-propyl-	62238-33-9	0.011	0.022
175	dodecane, 2-methyl-6-propyl-	55045-08-4	0.011	0.007
157	alkane		0.010	0.020
35	bicyclo[2.2.1]heptane	279-23-2	0.010	0.012
40	nonane, 4-methyl-	17301-94-9	0.010	0.012
38	bicyclo[2.2.1]heptane and others		0.0098	0.0116
19	cyclotrisiloxane, hexamethyl-	541-05-9	0.0096	0.0192
50	benzene, (1-methylethyl)-	98-82-8	0.0086	0.0173
144	cyclohexane, 1-(cyclohexylmethyl)-2-ethyl	54934-93-9	0.0083	0.0166
61	c10-alkane and others		0.0081	0.0099
176	alkane		0.0074	0.0148
123	alkene		0.0071	0.0142
56	cyclopentane, 2-isopropyl-1, 3,-dimethyl-	32281-85-9	0.0071	0.0083
205	1-hexadecanol	36653-82-4	0.0070	0.0112
41	benzene, propyl-	103-65-1	0.0070	0.0140
33	cyclopentanone, 2,4-dimethyl-	1121-33-1	0.0065	0.0129
134	c6-cyclohexane		0.0063	0.0126
22	cyclopentanone, 3-methyl-	1757-42-2	0.0060	0.0120
24	mixture		0.0060	0.0119
9	acetic acid and others		0.0059	0.0118
116	naphthalene, decahydro-2, 3-dimethyl-	1008-80-6	0.0057	0.0114
34	bicyclo[4.1.0]heptane	286-08-8	0.0056	0.0112
153	bicyclohexyl, 2-methyl-,trans	50991-09-8	0.0054	0.0108
23	cyclobutanone, 2-ethyl-	10374-14-8	0.0054	0.0108
86	cyclohexane, 1,1,3,5-tetramethyl-, trans-	50876-31-8	0.0053	0.0105
18	acetic acid, butyl ester	123-86-4	0.0049	0.0097
60	cyclohexane, diethyl-	1331-43-7	0.0048	0.0096
21	nitric acid, butyl ester	928-45-0	0.0048	0.0096

Cmpd #	Compound	CAS ¹ Number	Average ² (mg/m ³)	Standard Deviation (mg/m ³)
28	heptane, 2,5-dimethyl-	2216-30-0	0.0047	0.0093
210	1-hexadecanol	36653-82-4	0.0046	0.0092
14	methylamine, n-(1-methylbutylidene)-	22431-09-0	0.0046	0.0091
65	heptane, 3,3-dimethyl-	4032-86-4	0.0046	0.0093
63	1-hexene, 5,5,-dimethyl-	7116-86-1	0.0045	0.0091
193	mixture		0.0044	0.0088
8	2-butenenitrile	4786-20-3	0.0044	0.0087
194	1-tridecyn-4-ol	74646-37-0	0.0044	0.0033
198	9H-fluoren-9-one	486-25-9	0.0042	0.0085
187	1-butanone, 4-(dimethylamine)-1-phenyl	3760-63-2	0.0039	0.0078
212	alkane		0.0037	0.0075
201	siloxane		0.0035	0.0069
58	hexanal	66-25-1	0.0032	0.0063
59	cyclopentane, 1-methyl-3-(2-methylpropyl)-	29053-04-1	0.0027	0.0055
199	octadecane	593-45-3	0.0024	0.0048
200	alkane and benzaldehyde, 4-hydroxy-		0.0018	0.0037
191	decane 3-cyclohexyl-, 3-cyclohexyl-	13151-74-1	0.0018	0.0037
209	hexadecane, 2,6,10,14-tetramethyl-	638-36-8	0.0013	0.0025
203	alkanoic acid		0.0010	0.0021
206	heptadecane	629-78-7	0.00090	0.00180

1 CAS = Chemical Abstract Service.

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

THIS PAGE INTENTIONALLY
LEFT BLANK