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Pacific Northwest National Laboratory
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Executive Summary

Washington River Protection Solutions (WRPS) tested four types of chemical cartridges for use in air-purifying respirators (APR) and powered air-purifying respirators (PAPR). These tests were undertaken to determine the period of time that the cartridges would provide adequate performance[1] for APRs and PAPRs used to protect workers when exposed to a mixture of Chemicals of Potential Concern (COPC) from vapors exiting the headspaces of Hanford BY-108 and BY-110 waste storage tanks. The Occupational Safety and Health Administration (OSHA) considers cartridge testing to be a valid approach for establishing cartridge change schedules.[2] Testing commonly is applied in situations where mixtures of COPCs exist, and where other approaches, such as manufacturer recommendations and modeling, are less reliable. The tests were designed and conducted to assure measurement and/or control of the key variables OSHA identified as important to estimate the cartridge service life, including temperature, humidity, COPC concentration, breathing rate, and cartridge adsorption capacity.

Cartridge tests were conducted over two days from February 23–25, 2018, using headspace vapors from Hanford tanks BY-108 and BY-110. Headspace vapors from the BY-108 tank were fed to the PAPR respirator cartridge test stand, while vapors from the BY-110 headspace were fed to the APR respirator cartridge test stand. Both the APR and PAPR test stands were developed by WRPS in collaboration with HiLine Engineering (Richland, Washington). Two different cartridges were assessed on each tank. Multipurpose APR cartridges—SCOTT 7422-SD1 and SCOTT 7422-SC1 (SCOTT Safety, Monroe, North Carolina)—were assessed for vapors from BY-110 using the APR cartridge test stand. Multipurpose PAPR cartridges—MSA OptiFilter TL (MSA Safety Inc., Pittsburgh, Pennsylvania) and 3M FR-57 (3M Company, Maplewood, Minnesota)—also were assessed over the same two days for vapors from BY-108 using the PAPR cartridge test stand. Sample media (i.e., sorbent tubes) were used to collect samples of the vapor stream entering and exiting the respirator cartridges, and the samples then were analyzed for COPC concentrations. Pacific Northwest National Laboratory was tasked with conducting an independent analysis of the analytical results and making recommendations based on the results for respiratory cartridge performance and service life. The key conclusions from the analysis are described below.

APR Cartridge Testing

Based on measured APR cartridge inlet vapor concentrations from the BY-110 tank headspace, there were five COPCs—N-nitrosodimethylamine (NDMA), N-nitrosodiethylamine (NDEA), and N-nitrosomethylethylamine (NMEA), ammonia, and furan—that exceeded their corresponding Occupational Exposure Limits (OEL).[3] Two additional COPCs—2,5-dihydrofuran and 2-methylfuran—had one or more inlet concentration measurements >10% of their OELs, but <100%. Of these seven

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[1] "Adequate performance" refers to being below the breakthrough criterion used in this analysis, which is having a sustained cartridge outlet concentration >10% of the OEL of a compound. Ultimately, Industrial Hygiene professionals will use these results along with specific hazard assessments to determine service life, change schedules, and cartridge use that provides the necessary performance.

[2] OSHA Respirator Change Schedules Mathematical Modeling, and Factors that Influence Cartridge Service Life, https://www.osha.gov/SLTC/etools/respiratory/change_schedule.html.

[3] OELs accepted for Hanford tank farm use are based on OELs established by a U.S. governmental agency or national professional organization (e.g., OSHA, National Institute for Occupational Safety and Health, American Conference of Governmental Industrial Hygienists), or if no U.S. OEL exists, standard toxicological practices are applied to develop OELs based on the best available science. The OEL for NDMA was established in 2005 based on the MAK (Maximale Arbeitsplatzkonzentration) Commission standard adopted in Europe.

COPCs, only ammonia showed evidence of breakthrough, above 10% of its OEL. Overviews of the cartridge test results for these COPCs follow:

- Maximum ammonia concentrations at the respirator cartridge inlet to the SCOTT 7422-SD1 and SCOTT 7422-SC1 cartridges were 817% and 943% of the OEL, respectively. These concentrations were lower than, but generally consistent with, historic maximum headspace measurements from BY-110 tank (1704% of the OEL). Most of the cartridge outlet concentrations for ammonia exceeded 10% of its OEL. Ammonia breakthrough appeared to occur in the SCOTT 7422-SD1 cartridge, above 10% of the OEL, between 2 and 4 hours of run time. Breakthrough of the SCOTT 7422-SC1 cartridge was evident between 0 and 2 hours of run time. These breakthrough times are consistent with those measured in prior respirator cartridge tests for Hanford tank vapors, based on the inlet concentrations to the cartridges.
- Maximum furan concentrations at the inlets to the SCOTT 7422-SD1 and SCOTT 7422-SC1 cartridges were 13.3% and 168% of the OEL, respectively. These concentrations were lower than the historic maximum of 295% of the OEL. All cartridge outlet concentrations for furan were below the reporting limit (RL), indicating that no breakthrough occurred. Two substituted furans—2,5-dihydrofuran and 2-methylfuran—had one or two inlet or outlet concentrations that exceeded their respective detection limit[1] (DL) on one of the cartridge tests. However, analytical quality flags on these measurements indicated the elevated concentrations were estimates only. Therefore, there was no evidence of breakthrough for either 2,5 dihydrofuran or 2-methylfuran.
- Three nitrosamines—NDMA, NDEA, and NMEA—had cartridge inlet concentrations for the SCOTT 7422-SD1 and SCOTT 7422-SC1 cartridges well in excess of 100% of their corresponding OELs (392 to 1874% for NDMA, <10.3 to 150% for NDEA, and 108 to 252% for NMEA). These concentrations were significantly higher than historic BY-110 headspace maximums (<40% of their OELs). Numerous analytical quality flags associated with the cartridge inlet concentrations indicate that most of the inlet values are estimates only. Regardless, all measured outlet concentrations for the three nitrosamines were less than the analytical DL or RL, indicating no breakthrough for either cartridge. A single elevated outlet concentration (8.6% of the OEL) for the 16-hour NDMA sample from the SCOTT 7422-SD1 cartridge was quality flagged with a high spike recovery, and NDMA was not detected upon confirmatory analysis.

The technical report *Overview of 2016 through 2018 Testing of Air-Purifying Respirator Cartridge Performance on Multiple Hanford Tank Headspaces and Exhausters*[2] provides additional information on the use of the cartridge testing results for the first 28 cartridge tests with the manufacturers service life models.

PAPR Cartridge Testing

Based on measured PAPR cartridge inlet vapor concentrations from the BY-108 headspace, four COPCs—ammonia, furan, NDMA, and NMEA—exceeded their corresponding OELs. Three COPCs—mercury, 2-methylfuran, and NDEA—had one or more inlet concentration measurements >10%

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[1] In this report, DL is used to refer either to an analytical RL or a DL. The use of either an RL or a DL varied among analytical laboratories. An RL (equivalent to a limit of quantification) was used instead of an analytical method DL by several laboratories for specific COPC analyses. See Appendix C and Appendix F for additional information on the specific use of RLs or DLs for each COPC.

[2] Freeman CJ, J Liu, C Clayton, SK Nune, LA Mahoney, CL Bottenus, TM Brouns, P Humble, and MJ Minette. 2019. *Overview of 2016 through 2018 Testing of Respirator Cartridge Performance on Multiple Hanford Tank Headspaces and Exhausters*. PNNL-26821 Revision 1, Pacific Northwest National Laboratory, Richland, Washington.

of their respective OELs and greater than their analytical DLs or RLs, but <100% of the OELs. All other COPC inlet and outlet measurements did not exceed 10% of their OELs or exceed their RLs. Of the seven COPCs with higher inlet concentrations, only ammonia, showed clear evidence of breakthrough, above 10% of the OEL. Overviews of the cartridge test results for these COPCs follow:

- Maximum ammonia concentrations at the respirator cartridge inlet to the MSA TL and 3M FR-57 cartridges were 767% and 586% of the OEL, respectively. These concentrations were about 2 to 3× lower than historic maximum headspace measurements from BY-108 (1764% [2016] to 2576% [2009] of the OEL). Ammonia breakthrough appeared to occur in the MSA TL cartridge, above 10% of the OEL, between 4 and 6 hours. Breakthrough of the 3M FR-57 cartridge, above 10% of the OEL, occurred in less than 2 hours. These breakthrough times are consistent with those measured in prior respirator cartridge tests for Hanford tanks, based on the inlet concentrations to the cartridges.
- Maximum furan concentrations at the inlets to the MSA TL and 3M FR-57 cartridges were 576% and 396% of the OEL, respectively. These concentrations were substantially lower than the historic maximum from 1994 (57,600% of the OEL), but only 3× lower than those from 2016 sampling (1840% of the OEL). All the cartridge outlet concentrations for furan were below the DL of approximately 13.9% of the OEL, indicating that no breakthrough occurred.
- Two nitrosamines—NDMA and NMEA—had cartridge inlet concentrations for the MSA TL and 3M FR-57 cartridges in excess of 100% of their corresponding OELs (167 to 721% for NDMA and less than the RL to 188% for NMEA). The historic maximum headspace concentration of NDMA in vapors from BY-108 was approximately 3× higher (2063% of the OEL) than the cartridge maximum, whereas the historic maximum for NMEA was less than the RL. Numerous analytical quality flags associated with the cartridge inlet concentrations indicate that many of the inlet values are estimates only. Regardless, all measured outlet concentrations for the three nitrosamines were less than the analytical DL or RL, indicating no breakthrough for either cartridge.
- Maximum mercury concentrations at the inlets to the MSA TL and 3M FR-57 cartridges were 27.3% and 21.5% of the OEL, respectively. These concentrations were approximately 3× lower than the historical maximum concentrations (68% of the OEL). All the cartridge outlet concentrations for mercury were below the RL, indicating that no breakthrough occurred.
- Maximum 2-methylfuran concentrations at the inlets to the MSA TL and 3M FR-57 cartridges were 16.1% and 16.6% of the OEL, respectively. The maximum historic headspace concentrations for 2-methylfuran were less than the RL, but the high RL quantitation limit (<4840% of the OEL) on historic samples makes comparison to current inlet concentrations inconclusive. All measured outlet concentrations were less than the analytical DL of approximately 9.1% of the OEL, indicating no breakthrough for either cartridge.
- Maximum NDEA concentrations at the inlets to the MSA TL and 3M FR-57 cartridges were less than analytical DL and 13.1% of the OEL, respectively. The maximum historic headspace concentration for NDEA greater than the RL was 8.1% of the OEL, which is generally consistent with cartridge inlet maximum. All measured outlet concentrations were less than the analytical RL of approximately 10.6% of the OEL, indicating no breakthrough for either cartridge.

Based on the measurements in this study only ammonia exhibited breakthrough above 10% of its OEL. This is consistent with prior tank vapors testing where ammonia breakthrough appears to precede breakthrough of other COPCs. As a result, it is recommended that ammonia continue to be considered as the leading breakthrough indicator for the SCOTT 7422-SD1 and SCOTT 7422-SC1 APR cartridges. Furthermore, data being accumulated for the MSA TL and 3M FR-57 PAPR cartridges are indicating the propensity for ammonia to be a leading indicator of breakthrough in those cartridges as well.

Based on cartridge performance studies to date on Hanford tank vapor sources, vendor cartridge performance calculators appear to be representative for ammonia, despite being in a mixed vapor stream. The ammonia service life estimates based on the maximum inlet concentration for the current study were consistent for the SCOTT 7422-SD1 and SCOTT 7422-SC1 cartridges—3.5 and 2.4 hours, respectively, versus the observed times of 2 and 4 hours and 0 to 2 hours. The slightly longer estimated service life for the SC1 cartridge is likely due to variability in the inlet concentration. Similarly, the ammonia estimated service life based on the maximum inlet concentration for the MSA TL and 3M FR-57[1] PAPR cartridges in this study were 2.2 and 0.9 hours, respectively, versus the observed times of 4 to 6 hours and 0 to 2 hours, respectively.

Variations in humidity, temperature, or cartridge inlet concentration for any of the COPCs, especially ammonia, compared to those measured in the current study could impact breakthrough times. Still, the combined estimations continue to give confidence in the use of ammonia service-life estimations for informing Industrial Hygiene experts in developing an appropriate respirator cartridge change-out schedule for adequate worker protection.

The *Overview of 2017 Through 2018 Testing of Powered Air-Purifying (PAPR) Respirator Cartridge Performance on Multiple Hanford Tank Headspaces and Exhausters*[2] provides additional information on the use of the cartridge testing results for the first 10 PAPR cartridge tests with the manufacturers service life models and estimating methodologies.

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[1] The 3M FR-57 cartridge was not available in the 3M Service Life Software (http://extra8.3m.com/SLSWeb/chemicalInformationSLife.html?page=serviceLife&disclaimerPageFlag=Y, Version: 3.3); however, 3M consultants were able to provide estimates that were conservative compared to test results, which continues to give confidence in the use of ammonia with the manufacturers' calculators for service-life estimations.

[2] J Liu, C Clayton, LA Mahoney, MJ Minette, SK Nune, C Clayton, CL Bottenus, CJ Freeman, and TM Brouns. 2020. *Overview of 2017 Through 2018 Testing of Powered Air-Purifying (PAPR) Respirator Cartridge Performance on Multiple Hanford Tank Headspaces and Exhausters*. PNNL-29416 Revision 0, Pacific Northwest National Laboratory, Richland, Washington.

Revision History

Revision Number	Effective Date	Description of Change
A		Initial Draft
0	August 2020	This report has been revised to address external peer review comments on the draft PAPR reports and to correct data reporting errors. The principal changes included: 1. Addressing several external peer review comments including: a. Referencing the *Overview of 2017 Through 2018 Testing of Powered Air-Purifying (PAPR) Respirator Cartridge Performance on Multiple Hanford Tank Headspaces and Exhausters* (PNNL-29416 Revision 0), which provided additional information on historic COPC source concentrations and the significance of any differences between cartridge-testing results and historic maxima. b. Adding descriptive information to Appendices A, B, and C to provide additional clarity on the contents and methods applied c. Clarifying terminology regarding breakthrough time versus service life and change-out schedule.

Acronyms and Abbreviations

ALS	ALS Environmental Salt Lake City
APR	air-purifying respirator
CBAL	Columbia Basin Analytical Laboratory, part of the RJ Lee Group
CFR	Code of Federal Regulations
COPC	Chemicals of Potential Concern
CVAA	Cold Vapor Atomic Absorption
DL	detection limit
EPA	U.S. Environmental Protection Agency
GC–FID	Gas Chromatography–Flame Ionization Detector
GC/MS	Gas Chromatography/Mass Spectrometry
GC–TEA	Gas Chromatography–Thermal Energy Analyzer
HPLC	High Performance Liquid Chromatography
HPLC–UV	High Performance Liquid Chromatography–Ultraviolet
IC	ion chromatography
LCS	laboratory control samples
LCSD	laboratory control sample duplicates
MDL	method detection limit
NDEA	N-nitrosodiethylamine
NDMA	N-nitrosodimethylamine
NIOSH	National Institute of Occupational Safety and Health
NMEA	N-nitrosomethylethylamine
OEL	Occupational Exposure Limit
OSHA	Occupational Safety and Health Administration
PAPR	powered air-purifying respirator
ppm	parts per million
PNNL	Pacific Northwest National Laboratory
RL	reporting limit
SCBA	Self-Contained Breathing Apparatus
SWIHD	Site-Wide Industrial Hygiene Database
TIC	Tentatively Identified Compound
VOC	Volatile Organic Compound
WHL	Wastren Hanford Laboratory (222S)
WRPS	Washington River Protection Solutions

Contents

Figures

Tables

1.0 Introduction/Project Description

As the Tank Operations Contractor for U.S. Department of Energy operations at the Hanford site in Washington State, Washington River Protection Solutions (WRPS) is responsible for managing highly radioactive wastes stored in tanks at Hanford. WRPS recently identified the need to test air-purifying respirator (APR) and powered air-purifying respirator (PAPR) chemical cartridges commonly used by workers at Hanford tank farms. The tests were conducted to determine the period of time that the cartridges would provide adequate performance for APRs and PAPRs used to protect workers when exposed to a mixture of Chemicals of Potential Concern (COPC) from any vapors exiting headspaces in the storage tanks. The Occupational Safety and Health Administration (OSHA) Standard promulgated in Title 29 of the Code of the Federal Regulations (CFR) 1910.134(d)(3)(iii)(b)(2) specifies that for protection against gases and vapors, employers shall implement a schedule for cartridges to ensure that change-outs occur before the end of service life.[1-4] The change schedule can be based on objective information or data that ensures cartridge change-outs occur before the end of their service life.[2-5] The primary function of the WRPS Cartridge Test Program is to obtain objective data to determine service lives for the APR and PAPR cartridges used at Hanford tank farms. WRPS contracted with Pacific Northwest National Laboratory to analyze the test data and offer an independent analysis and any recommendations. This report summarizes data analysis of APR and PAPR cartridge testing on BY-110 and BY-108 headspace vapors, respectively. Two different APR cartridges from SCOTT Safety (Monroe, North Carolina) were assessed for the BY-110 headspace vapors, and two different PAPR cartridges—one from MSA Safety Inc. (Pittsburgh, Pennsylvania) and another from 3M (Maplewood, Minnesota)—were assessed for the BY-108 headspace vapors.

2.0 Regulatory Requirements

2.1 Background on Regulatory Requirements

OSHA Respiratory Protection Standard (29 CFR 1910.134) mandates/requires that employers provide protective equipment, including respirators, to their employees to protect them against potential exposure to contaminants at or above documented Occupational Exposure Limits (OEL) and establish cartridge change-out schedules to ensure cartridges are changed before the end of service life.[1] End of service life is the time when a respirator cartridge can no longer filter/capture harmful contaminants (i.e., the time at which the cartridge no longer functions effectively).

Protective respirator cartridges are frequently used in workplaces with low contaminant concentrations, and where respirators provide essential protection for longer periods of time (>2 hours). If the contaminant concentration in a workplace is high, supplied air respirators or self-contained breathing apparatuses (SCBA) must be used to provide additional protection. While the use of supplied air respirators or SCBAs offers more protection, a tradeoff exists, particularly for SCBAs that employ a large, heavy (approximately 30-pound), back-mounted compressed air cylinder.[1]

2.2 OSHA-Approved Methods for Determining Cartridge Change-Out Times

The National Institute of Occupational Safety and Health (NIOSH) certifies organic vapor cartridges using the criteria in 42 CFR 84, Approval of Respiratory Protective Devices. Still, there is no widely accepted, standard protocol for performing service-life testing.[4] However, OSHA has identified the three approaches described below as valid for establishing cartridge service lives.[3]

- Conduct experimental tests – The first step in this approach is to gather all available information about the nature of all contaminants present in the workplace. Obtain breathing rates of workers and estimate worst-case exposures. For most employers, this approach is the most time consuming, and resources needed to perform these tests may not be available. If an employer has the resources needed to pursue this approach, it is the most reliable method of estimating cartridge service life. Concentrations at different points in time are obtained using actual respirator cartridges exposed to actual or simulated gases to gather service-life information. A safety factor that includes the assumptions made, variable factors, or conditions needs to be applied to the service life and used in the respiratory protection program. This approach is commonly used in situations where mixtures of contaminants are present and also can be used to validate an existing cartridge change-out schedule.
- Use the manufacture's recommendation – When information about airborne contaminants (including concentrations, temperature, and humidity) has been obtained, contact the manufacturer of the respirator to be used and provide all the information. Manufacturers should be able to provide the exact objective information they used to project the service life. Using the information obtained, service lives are proposed. This approach is not as reliable as conducting application-specific experiments, and manufacturers may not have all the information for workplace hazards and user factors. If any safety factor is applied considering all the variable factors, it must be clearly identified in the respiratory protection program. For complex mixtures such as those present in the Hanford waste storage tanks, manufacturer recommendations may be of limited value, and experimental testing is recommended.

- Use mathematical models – Mathematical models are usually applicable for single contaminant exposure situations. OSHA and NIOSH have worked over the years with researchers and industrial partners to develop mathematical models for predicting respirator cartridge service life.[3, 5-11] OSHA offers guidance on using mathematical models to estimate respirator cartridge service life based on single components, but the models have not been adopted for mixtures of components. NIOSH has developed a computer tool for estimating breakthrough times and service lives of respirator cartridges. Manufacturers can use those results to make service-life recommendations for their products (canister/cartridge) in multi-gas environments. Two types of mathematical models are used: 1) predictive models [3, 5-7] and 2) descriptive models.[9] Each model has its own mathematical basis for its estimations. To estimate the service lives of cartridges, the following information is needed:
  - Number of cartridges used by the respirator
  - Mass of the sorbent used in each cartridge
  - Carbon micro-pore volume
  - Density of the packed bed
  - Maximum temperature
  - Maximum relative humidity
  - Maximum concentration of the contaminants and the work (volumetric flow) rate.

  The primary advantages of using mathematical models are that they are relatively inexpensive and take little time. However, the estimates are not as accurate as testing; sometimes modeling might result in a service-life estimate that is shorter than it needs to be because of conservative assumptions upon which the calculations are based.

In addition to the methods described above, "rules of thumb" can be allowed as part of the overall workplace organic vapor assessment for determining a cartridge change-out schedule. Chapter 36 of the American Industrial Hygiene Association publication, *The Occupational Environment: Its Evaluation and Control and Management*, outlines the "rules of thumb" approach.[12] This approach may not work for every chemical or situation, but it provides an estimate of cartridge life. The following are rules of thumb outlined in the publication:

- If the compound's boiling point is >70°C and the concentration is <200 ppm, a service life of 8 hours at a normal work rate can be expected.
- Service life is inversely proportional to worker breathing rate.
- Reducing the concentration of a contaminant by a factor of 10 will increase service life by a factor of 5.
- Relative humidity above 85% will reduce the service life by 50%.

These rules of thumb do not apply in certain situations, including for mixtures of hazardous contaminants (e.g., Hanford tank farm vapors) and inorganic gases such as ammonia, sulfur dioxide, and hydrogen sulfide, compositions that vary with time and location, and contaminants that undergo continuous reactions. However, some of the general drivers[8] can help in interpreting the results obtained from experimental testing of respirator cartridges.

[8] The general drivers (a.k.a., rules of thumb) are applicable to certain compounds but not to all compounds in a mixture, such as those in specific Hanford tank mixtures. However, an Industrial Hygiene professional can use these rules of thumb to support interpretation of results from both experiments and predictions.

3.0 Description of Testing Program

Based on the OSHA guidance described in Section 2, a sample testing approach was pursued for quantifying respirator cartridge effectiveness for Hanford tank vapors. WRPS developed a sampling approach outlined in TFC-PLN-168, "Industrial Hygiene Sampling and Analysis Plan for Respirator Cartridge Testing," and "Air Purifying Respirator Cartridge Test Apparatus, RPP-STE-59226."[13,14]

Appendix A provides a description of the APR and PAPR cartridge-testing setup developed by WRPS and used for measurements of vapors from BY-110 and BY-108 headspaces, respectively.[13-15] The test system and methodology were developed in consultation with recognized subject matter experts to follow the example of tank farm headspace field sampling for the purposes of cartridge testing. The design of the APR cartridge test rig used previously [16-25] was modified to accommodate the higher flow rates and larger PAPR cartridges.

The Sampling and Analysis Plan was developed under the direction and oversight of the Industrial Hygienist in conjunction with the Tank Farms Operations Contractor Retrieval and Closure, and Tank Farms Project and/or Production Operations Project Management Team, as applicable. Trained Industrial Hygiene Technicians under the direction of a qualified Industrial Hygienist collected chemical vapor samples from the influent and effluent sides of the cartridge test apparatus. Before the test stands were transported to the tank farms, WRPS Sampling Equipment Operators, Industrial Hygiene Technicians, and Field Work Supervisors underwent training at HiLine Engineering (Richland, Washington).

The APR and PAPR cartridge test was designed and constructed to operate to the following environmental conditions without negatively impacting system performance:

- Temperature: 32 to 115°F
- Relative Humidity: 5 to 100%
- Precipitation: Up to 4 inches in 6 hours
- Wind: Up to 20 mph with blowing dust.

To ensure cartridges effectively protect workers, WRPS developed a testing program with the following conservative conditions:

- The flow rate through each APR cartridge was set at 30 L/min (equivalent to 60 L/min for a pair of cartridges), which corresponds to more than twice the normal breathing rate of a worker and is slightly higher than the OSHA recommended testing flow rate of 53.3 L/min.[3,5]
- The flow rate through the PAPR cartridges was set at approximately 90 to 100 L/min, which is equivalent to 180 to 200 L/min for a two-cartridge unit, or 270 to 300 L/min for a three-cartridge unit. These test flow rates are significantly higher than the minimum PAPR flow rate requirements.[9] The flow rate also is conservative relative to the 3M-specified flow rate of 220 L/min for use in service-life estimates of their Breathe Easy PAPR with FR-57 cartridge,[10] and slightly below MSA-

[9] PAPR cartridges have a minimum flow rate requirement of 115 L/min for a tight-fitting mask and 170 L/min for a loose-fitting hood [26]. The MSA PAPR uses two TL cartridges, and the 3M PAPR uses three FR-57 cartridges. Testing at ~95 L/min provided a conservatively high flow rate for the MSA cartridge (equivalent to 190 L/min = 12% higher than minimum for a loose-fitting hood), and the 3M cartridge (equivalent to 285 L/min = 68% higher than minimum for a loose-fitting hood).

[10] Email exchange on October 27, 2017, between J. Liu (PNNL scientist) and E.W. Johnson (3M Technical Service Specialist). See Appendix G, Figure G.1

specified flow rate of 205 L/min assigned in their Response® Guide cartridge life expectancy calculator for the Optimair TL PAPR with hood [27].

- Tank farm vapors source sampling was performed on headspace vapors rather than from Hanford tank farm atmospheric concentrations (i.e., source sampling versus the breathing zone).
- A threshold concentration of 10% of the OEL for each COPC was chosen.

Using the cartridge-testing setup described in Appendix A, separate test surveys were performed on four NIOSH-approved respiratory protection cartridges—SCOTT 7422-SD1 for Survey 18-01494 and SCOTT 7422-SC1[11] for Survey 18-01495 using the APR test rig,[28] and MSA Optifilter TL[12] (TL1) for Survey 18-01496 and 3M FR-57[13] (TL2) for Survey 18-01497 using the PAPR test rig.[29,30] These cartridges were chosen because they can capture organic vapors, acid gases, ammonia, formaldehyde, and particulates.[27,28]

Vapor concentrations upstream and downstream of the cartridges were monitored with an array of sorbent tubes (see Appendix B). Influent (upstream) concentrations were recorded every 2 hours during the 16-hour verification survey. Downstream sorbent tubes also were changed out every 2 hours until the experiment was finished.[14] A measured quantity of sample air was drawn in through the sorbent tube (see Appendix A).[13,14] Compounds from the sorbent tubes were extracted and analyzed using analytical methods referenced in Appendix B.

The characteristics of 61 COPCs were the primary focus of the testing. The 61 COPCs represent a set of tank vapor chemicals found in a tank farm source >10% of the OEL or are considered “known” or “probable” carcinogens by the International Agency for Research Cancer or other regulatory agencies.[31,32] A full listing of these COPCs is provided in Section 4.0.

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[11] SCOTT part numbers 7422-SC1 and 7422-SD1 are multipurpose APR respirator cartridges for use on Xcel Half-Mask and all SCOTT full face pieces with NIOSH approval for applications in which the following compounds might be present: organic vapors (OV), ammonia (AM), methylamine (MA), chlorine (CL), hydrogen chloride (HC), sulfur dioxide (SD), chlorine dioxide (CD), hydrogen fluoride (HF), formaldehyde (FM), and hydrogen sulfide (HS). The 7422-SD1 cartridge has the same multipurpose features as the 7422-SC1, but also includes a P100 particulate filter. https://www.3mscott.com/download/742-series-cartridges-user-instructions-english/

[12] MSA OptiFilter TL (Part number 10143421; Reorder Number 10080456) is a multipurpose PAPR respirator cartridge for use with the OptimAir® TL PAPR, with NIOSH approval for AM/CL/CD/FM/HC/MA/SD/HE application (Email from P Jones October 2017). https://us.msasafety.com/Air-Purifying-Respirators-%28APR%29/Powered-Air-Purifying-Respirators-%28PAPR%29/OptimAir%C2%AE-TL-PAPR/p/000100003000001600.

[13] 3M FR-57 (Part number 453-03-02R06) is a multipurpose PAPR respirator cartridge for use with the 3M RRPAS 6000 series facepieces or BE-10 series hood powered supplied air respirator systems, with NIOSH approval for OV/SD/HC/CL/CD/HF/AM/MA/FM/HE application (Email from P Jones October 2017). https://www.3m.com/3M/en_US/company-us/all-3m-products/~/3M-High-Efficiency-Cartridge-FR-57-453-03-02R06-6-EA-Case/?N=5002385+3294780228&rt=rud

[14] Sorbent tubes for both influent and effluent sides of the cartridges were used to collect 2-hour time-weighted average samples, which were changed out every 2 hours during the duration of each test.

4.0 Data Analysis

Respirator cartridge tests on vapors from the Hanford Tank BY-108 and BY-110 headspaces were conducted over two days from February 23-25, 2018. Two APR cartridges—SCOTT 7422-SD1 and SCOTT 7422-SC1—and two multipurpose PAPR cartridges—MSA TL and 3M FR-57—were tested on vapors from BY-110 and BY-108, respectively, for approximately the same time period. Testing and analyses focused on the 61 COPCs identified in Table 1 (APR cartridges) and Table 2 (PAPR cartridges) and other hazardous airborne contaminants.[15] Analytical sorbent tubes were changed every 2 hours. More than 400 sorbent tubes were sent to the 222S Laboratory at Hanford and dispositioned for analyses. Note that dimethylmercury was not measured in these tests because it requires special sampling and analysis methods, and nitrous oxide was not analyzed as it is not susceptible to respirator filtration, and there are no known NIOSH-approved respirator filtration cartridges approved for nitrous oxide.

In previously published cartridge reports, raw data for all contaminants analyzed during the tests were provided in Appendix C to the document. However, the extensive amount of data (over 900 pages for this report) resulted in unwieldy document file sizes. To solve this problem, the raw data is provided in a separate volume (Volume 2) to this report. We have included an Appendix C in this Volume 1 document to maintain consistency with the structure of the previously published reports and 2) direct readers who want to review the raw data to Volume 2. Volume 2 also provides the temperature and relative humidity of the sample slipstream during testing.

Appendix D of this report lists the corresponding calculated concentrations. The BY-108 tank headspace vapor cartridge inlet temperature ranged from 36 to 56°F, and the relative humidity ranged from 66 to 88%. The BY-110 tank headspace temperature ranged from 35 to 60°F, and the relative humidity ranged from 61 to 85%.

4.1 APR Cartridge Testing

Table 1 shows the measured concentrations from Hanford BY-110 tank headspace testing of the APR cartridges (SCOTT 7422-SD1 and SCOTT 7422-SC1) for all of the COPCs evaluated. Five inlet COPC concentrations exceeded their corresponding OELs. These COPCs were ammonia, furan, N-nitrosodimethylamine (NDMA), N-nitrosodiethylamine (NDEA) and N-nitrosomethylethylamine (NMEA). The inlet (or outlet) concentrations of two other COPCs were lower than their corresponding OELs but exceeded 10%. These COPCs were 2,5-dihydrofuran and 2-methylfuran. All seven of the stated COPCs are highlighted in yellow in Table 1 and are assessed in more detail in Section 5.1. Appendix E shows similar detailed assessments for additional three COPCs with respirator cartridge inlet (or outlet) concentrations or detection limits (DL)/reporting limits (RL) <10% of their OELs but >2%.[16] These COPCs were 3-butene-2-one, formaldehyde, and acetonitrile. All of the other COPCs had inlet (or outlet) concentrations <2% of their OELs or their DLs.

[15] At the time of testing in June 2017, the tank farms COPCs list comprised 59 chemical compounds. In September 2017, after testing but prior to completion of data analysis and reporting, two additional compounds, 2-propenal and dimethylmercury, were added to the tank farms COPC list increasing the number of COPCs to 61. 2-Propenal is regularly addressed in IH sampling as part of the aldehydes sorbent tube suite of compounds. Dimethylmercury was not measured in these tests as it requires special sampling and analysis methods. For completeness, these two new COPCs are listed in Table 1 after COPC #18 and #59.

[16] The term "detection limit" or DL is used here to refer either to an analytical RL or a DL. The use of either an RL or a DL varied among analytical laboratories. An RL (equivalent to a limit of quantification) was used instead of an analytical DL by several laboratories for specific COPC analyses. See Appendices C and F for additional information on the specific use of the RL or DL for each COPC.

Table 1. Summary of Analyzed COPCs-APR Cartridge Testing

COPC Number and Name		CAS Number	Highest Measured Value (this study)	Occupational Exposure Limit (OEL)	Approximate Analytical Detection Limit, DL[1] (% of OEL)	All Data Values (inlet and outlet) <DL or <RL	Highest Detected Value Compared to OEL
Inorganic							
1	Ammonia	7664-41-7	261 ppm	25 ppm	2.29%		Up to 943% of OEL for inlet values. All outlets ≤1043%.
2	Nitrous Oxide	10024-97-2	Not Measured	50 ppm			
3	Mercury	7439-97-6	2.02 ug/m3	25 ug/m3	8.09%	X	
Hydrocarbons							
4	1,3-Butadiene	106-99-0	0.0387 ppm	1 ppm	3.87%	X	
5	Benzene	71-43-2	0.0017 ppm	0.5 ppm	0.022%		Up to 0.3% of OEL for inlet values. All outlets <0.2%.
6	Biphenyl	92-52-4	0.0001 ppm	0.2 ppm	0.026%	X	
Alcohols							
7	1-Butanol	71-36-3	0.338 ppm	20 ppm	0.003%		Up to 1.7% of OEL for inlet values. All outlets <DL.
8	Methanol	67-56-1	Not Measured	200 ppm			
Ketones							
9	2-Hexanone	591-78-6	0.0071 ppm	5 ppm	0.001%		Up to 0.1% of OEL for inlet values. All outlets <DL.
10	3-Methyl-3-butene-2-one	814-78-8	Not Detected	0.02 ppm	TIC[2]	X	
11	4-Methyl-2-hexanone	105-42-0	0.0006 ppm	0.5 ppm	0.016%		Up to 0.1% of OEL for inlet values. All outlets <DL.
12	6-Methyl-2-heptanone	928-68-7	0.0034 ppm	8 ppm	TIC		Up to 0.04% of OEL for single inlet. All outlets <DL.[2]
13	3-Buten-2-one	78-94-4	0.0051 ppm	0.2 ppm	0.070%		Up to 2.5% of OEL for inlet values. All outlets ≤0.1%.
Aldehydes							
14	Formaldehyde	50-00-0	0.0063 ppm	0.3 ppm	0.571%		Up to 2.1% of OEL for inlet values. All outlets <1.5%.
15	Acetaldehyde	75-07-0	0.0957 ppm	25 ppm	0.005%		Up to 0.4% of OEL for inlet values. All outlets ≤0.1%.
16	Butanal	123-72-8	0.143 ppm	25 ppm	0.002%		Up to 0.6% of OEL for inlet values. All outlets <DL.
17	2-Methyl-2-butenal	1115-11-3	Not Detected	0.03 ppm	TIC	X	
18	2-Ethyl-hex-2-enal	645-62-5	Not Detected	0.1 ppm	TIC	X	
New	2-Propenal	107-02-8	0.0010 ppm	0.1 ppm	0.957%	X	

[1] An approximate DL is calculated using the reported DLs (or RLs) from the analytical laboratory and the average volume (from flow rate × time) of vapor exposed to the sorbent tube. For the furans, both DL and RL values [25] are reported as "DL/RL."

[2] Tentatively Identified Compound (TIC) indicates that a mass spectrometry "peak" not associated with calibrated compounds has been tentatively assigned to a compound based on an adequate match to the analytical methods reference library. Reference standards for the compound are not available to accurately quantify, assign an analytical DL, or definitively confirm the identity of the TIC. TICs are reported when the peak area is sufficiently large, estimated as ≥5 nanograms of TIC mass, and other analytical criteria are met. For the respirator cartridge testing, this mass of TIC represents an approximate concentration of <1.0 ppb, based on the average of all TICs in the COPC list.

[3] Furan, 2,5-dihydrofuran, and 2-methylfuran are quantified using the Carbotrap 300 TDU sorbent media tube. All other substituted furans are quantified using the furans tube. See Appendix B and Appendix C for more information.

Table 1. (continued)

COPC Number and Name	CAS Number	Highest Measured Value (this study)	Occupational Exposure Limit (OEL)	Approximate Analytical Detection Limit, DL[1] (% of OEL)	All Data Values (inlet and outlet) <DL or <RL	Highest Detected Value Compared to OEL
Furans						
19 Furan	110-00-9	1.68 ppb	1 ppb	DL | RL[1] 13.5% | 116%[4]		Up to 168% of OEL for inlet values. All outlets <DL.
20 2,3-Dihydrofuran	1191-99-7	0.03 ppb	1 ppb	3.34% | 19.9%	X	
21 2,5-Dihydrofuran	1708-29-8	0.44 ppb	1 ppb	23.4% | 112%[4]		Inlet values <DL. All outlets ≤43.8%.
22 2-Methylfuran	534-22-5	0.11 ppb	1 ppb	8.78% | 95.8%[4]		Up to 10.6% of OEL for inlet values. All outlets <DL
23 2,5-Dimethylfuran	625-86-5	0.03 ppb	1 ppb	3.14% | 14.5%	X	
24 2-Ethyl-5-methylfuran	1703-52-2	Not Detected	1 ppb	TIC	X	
25 4-(1-Methylpropyl)-2,3-dihydrofuran	34379-54-9	Not Detected	1 ppb	TIC	X	
26 3-(1,1-Dimethylethyl)-2,3-dihydrofuran	34314-82-4	Not Detected	1 ppb	TIC	X	
27 2-Pentylfuran	3777-69-3	0.03 ppb	1 ppb	3.16% | 10.1%	X	
28 2-Heptylfuran	3777-71-7	0.03 ppb	1 ppb	2.98% | 8.40%	X	
29 2-Propylfuran	4229-91-8	0.02 ppb	1 ppb	1.88% | 12.7%	X	
30 2-Octylfuran	4179-38-8	Not Detected	1 ppb	TIC	X	
31 2-(3-Oxo-3-phenylprop-1-enyl)furan	717-21-5	Not Detected	1 ppb	TIC	X	
32 2-(2-Methyl-6-oxoheptyl)furan	51595-87-0	Not Detected	1 ppb	TIC	X	
Phthalates						
33 Diethylphthalate	84-66-2	0.0017 mg/m3	5 mg/m3	0.011%		Up to 0.02% of OEL for all inlet values. All outlet values ≤0.03%.
Nitriles						
34 Acetonitrile	75-05-8	0.783 ppm	20 ppm	0.001%		Up to 1.1% of OEL for all inlet values. All outlet values ≤3.9%.
35 Propanenitrile	107-12-0	0.0030 ppm	6 ppm	0.003%		Up to 0.05% of OEL for inlet values. All outlets <DL.
36 Butanenitrile	109-74-0	0.0118 ppm	8 ppm	0.001%		Up to 0.1% of OEL for inlet values. All outlets <0.01%.
37 Pentanenitrile	110-59-8	0.0015 ppm	6 ppm	0.002%		Up to 0.03% of OEL for inlet values. All outlets <DL.
38 Hexanenitrile	628-73-9	0.0010 ppm	6 ppm	0.001%		Up to 0.02% of OEL for inlet values. All outlets <DL.
39 Heptanenitrile	629-08-3	Not Detected	6 ppm	TIC	X	
40 2-Methylene butanenitrile	1647-11-6	Not Detected	0.3 ppm	TIC	X	
41 2,4-Pentadienenitrile	1615-70-9	Not Detected	0.3 ppm	TIC	X	
Amines						
42 Ethylamine	75-04-7	0.0440 ppm	5 ppm	0.092%		Up to 0.9% of OEL for inlet values. All outlets <0.6%.

Table 1. (continued)

COPC Number and Name	CAS Number	Highest Measured Value (this study)	Occupational Exposure Limit (OEL)	Approximate Analytical Detection Limit, DL[1] (% of OEL)	All Data Values (inlet and outlet) <DL or <RL	Highest Detected Value Compared to OEL
Nitrosamines						
43 N-Nitrosodimethylamine	62-75-9	5.62 ppb	0.3 ppb	5.15%		Up to 1874% of OEL for inlet values. All outlets ≤8.6%.
44 N-Nitrosodiethylamine	55-18-5	0.15 ppb	0.1 ppb	10.31%		Up to 150% of OEL for inlet values. All outlets <DL.
45 N-Nitrosomethylethylamine	10595-95-6	0.76 ppb	0.3 ppb	3.98%		Up to 252% of OEL for inlet values. All outlets ≤6.7%
46 N-Nitrosomorpholine	59-89-2	0.01 ppb	0.6 ppb	1.66%	X	
Organophosphates						
47 Tributyl phosphate	126-73-8	0.07 ppb	200 ppb	0.034%	X	
48 Dibutyl butylphosphonate	78-46-6	0.03 ppb	7 ppb	0.38%	X	
Halogenated						
49 Chlorinated Biphenyls	Varies	Not Detected	1 mg/m3	TIC	X	
50 2-Fluoropropene	1184-60-7	Not Detected	0.1 ppm	TIC	X	
Pyridines						
51 Pyridine	110-86-1	1.17 ppb	1000 ppb	0.007%		Up to 0.1% of OEL for inlet values. All outlets <DL.
52 2,4-Dimethylpyridine	108-47-4	0.16 ppb	500 ppb	0.010%		Up to 0.03% of OEL for inlet values. All outlets <DL.
Organonitrites						
53 Methyl nitrite	624-91-9	Not Detected	0.1 ppm	TIC	X	
54 Butyl nitrite	544-16-1	Not Detected	0.1 ppm	TIC	X	
Organonitrates						
55 Butyl nitrate	928-45-0	Not Detected	2.5 ppm	TIC	X	
56 1,4-Butanediol, dinitrate	3457-91-8	Not Detected	0.05 ppm	TIC	X	
57 2-Nitro-2-methylpropane	594-70-7	Not Detected	0.3 ppm	TIC	X	
58 1,2,3-Propanetriol, 1,3-dinitrate	623-87-0	Not Detected	0.05 ppm	TIC	X	
Isocyanates						
59 Methyl Isocyanate	624-83-9	Not Detected	20 ppb	TIC	X	
Organometallic						
New Dimethylmercury	593-74-8	Not Measured	10 ug/m3			

4.2 PAPR Cartridge Testing

Table 2 shows the measured concentrations in the current study using PAPR cartridges MSA TL and 3M FR-57 for all of the COPCs tested on vapors from the Hanford BY-108 tank headspace. Four inlet COPC concentrations exceeded their corresponding OELs. These COPCs were ammonia, furan, NDMA, and NMEA. The inlet (or outlet) concentrations of three other COPCs were lower than their corresponding OELs but exceeded 10%. These COPCs were mercury, 2-methylfuran, and NDEA. All seven of these COPCs are highlighted in yellow in Table 2 and are assessed in more detail in Section 5.2. Appendix E shows similar detailed assessments for an additional four COPCs with respirator cartridge inlet (or outlet) concentrations or DL/RL <10% of their OELs but >2%. These COPCs were 1-butanol, 3-butene-2-one, formaldehyde, and acetonitrile. All of the other COPCs had inlet (or outlet) concentrations <2% of their OELs or their DLs.

Table 2. Summary of Analyzed COPCs-PAPR Cartridge Testing

COPC Number and Name		CAS Number	Highest Measured Value (this study)	Occupational Exposure Limit (OEL)	Approximate Analytical Detection Limit, DL[1] (% of OEL)	All Data Values (inlet and outlet) <DL or <RL	Highest Detected Value Compared to OEL
Inorganic							
1	Ammonia	7664-41-7	192 ppm	25 ppm	2.35%		Up to 767% of OEL for inlet values. All outlets ≤718%.
2	Nitrous Oxide	10024-97-2	Not Measured	50 ppm			
3	Mercury	7439-97-6	6.83 ug/m3	25 ug/m3	6.91%		Up to 27.3% of OEL for inlet values. All outlets <DL.
Hydrocarbons							
4	1,3-Butadiene	106-99-0	0.0382 ppm	1 ppm	3.82%	X	
5	Benzene	71-43-2	0.0024 ppm	0.5 ppm	0.020%		Up to 0.5% of OEL for inlet values. All outlets ≤0.2%.
6	Biphenyl	92-52-4	0.0001 ppm	0.2 ppm	0.026%	X	
Alcohols							
7	1-Butanol	71-36-3	0.551 ppm	20 ppm	0.004%		Up to 2.8% of OEL for inlet values. All outlets <DL.
8	Methanol	67-56-1	1.16 ppm	200 ppm	0.196%		Up to 0.6% of OEL for inlet values. All outlets ≤0.3%.
Ketones							
9	2-Hexanone	591-78-6	0.0127 ppm	5 ppm	0.001%		Up to 0.3% of OEL for inlet values. All outlets <DL.
10	3-Methyl-3-butene-2-one	814-78-8	Not Detected	0.02 ppm	TIC[2]	X	
11	4-Methyl-2-hexanone	105-42-0	0.0011 ppm	0.5 ppm	0.017%		Up to 0.2% of OEL for inlet values. All outlets <DL.
12	6-Methyl-2-heptanone	928-68-7	0.0036 ppm	8 ppm	TIC		Up to 0.05% of OEL for single inlet. All outlets <DL.[2]
13	3-Buten-2-one	78-94-4	0.0072 ppm	0.2 ppm	0.066%		Up to 3.6% of OEL for inlet values. All outlets ≤0.1%.
Aldehydes							
14	Formaldehyde	50-00-0	0.0100 ppm	0.3 ppm	0.605%		Up to 3.3% of OEL for inlet values. All outlets ≤2.1%.
15	Acetaldehyde	75-07-0	0.131 ppm	25 ppm	0.005%		Up to 0.5% of OEL for inlet values. All outlets ≤0.3%.
16	Butanal	123-72-8	0.124 ppm	25 ppm	0.002%		Up to 0.5% of OEL for inlet values. All outlets <DL.
17	2-Methyl-2-butenal	1115-11-3	Not Detected	0.03 ppm	TIC	X	
18	2-Ethyl-hex-2-enal	645-62-5	Not Detected	0.1 ppm	TIC	X	
New	2-Propenal	107-02-8	0.0010 ppm	0.1 ppm	0.972%	X	

[1] Approximate DL is calculated using the reported DLs (or RLs) from the analytical laboratory and the average volume (from flow rate x time) of vapor exposed to the sorbent tube. For the furans, both DL and RL values [25] are reported as "DL/RL."
[2] TIC indicates that a mass spectrometry "peak" not associated with calibrated compounds has been tentatively assigned to a compound based on an adequate match to the analytical methods reference library. Reference standards for the compound are not available to accurately quantify, assign an analytical DL, or definitively confirm the identity of the TIC. TICs are reported when the peak area is sufficiently large, estimated as ≥5 nanograms of TIC mass, and other analytical criteria are met. For the respirator cartridge testing, this mass of TIC represents an approximate concentration of <1.0 ppb, based on the average of all TICs in the COPC list.
[3] Furan, 2, 5-dihydrofuran, and 2-methylfuran are quantified using the Carbotrap 300 TDU sorbent media tube. All other substituted furans are quantified using the furans tube. See Appendix B and C for more information.

Table 2. (continued)

COPC Number and Name	CAS Number	Highest Measured Value (this study)	Occupational Exposure Limit (OEL)	Approximate Analytical Detection Limit, DL[1] (% of OEL)	All Data Values (inlet and outlet) <DL or <RL	Highest Detected Value Compared to OEL
Furans						
19 Furan	110-00-9	5.76 ppb	1 ppb	DL | RL[1] 13.9% | 119%[3]		Up to 576% of OEL for inlet values. All outlets <DL.
20 2,3-Dihydrofuran	1191-99-7	0.03 ppb	1 ppb	3.18% | 19.0%	X	
21 2,5-Dihydrofuran	1708-29-8	0.24 ppb	1 ppb	24.1% | 116%[3]	X	
22 2-Methylfuran	534-22-5	0.17 ppb	1 ppb	9.05% | 98.7%[3]		Up to 16.6% of OEL for inlet values. All outlets <DL.
23 2,5-Dimethylfuran	625-86-5	0.03 ppb	1 ppb	2.99% | 13.8%	X	
24 2-Ethyl-5-methylfuran	1703-52-2	Not Detected	1 ppb	TIC	X	
25 4-(1-Methylpropyl)-2,3-dihydrofuran	34379-54-9	Not Detected	1 ppb	TIC	X	
26 3-(1,1-Dimethylethyl)-2,3-dihydrofuran	34314-82-4	Not Detected	1 ppb	TIC	X	
27 2-Pentylfuran	3777-69-3	0.03 ppb	1 ppb	3.01% | 9.61%	X	
28 2-Heptylfuran	3777-71-7	0.03 ppb	1 ppb	2.84% | 7.99%	X	
29 2-Propylfuran	4229-91-8	0.02 ppb	1 ppb	1.79% | 12.1%	X	
30 2-Octylfuran	4179-38-8	Not Detected	1 ppb	TIC	X	
31 2-(3-Oxo-3-phenylprop-1-enyl)furan	717-21-5	Not Detected	1 ppb	TIC	X	
32 2-(2-Methyl-6-oxoheptyl)furan	51595-87-0	Not Detected	1 ppb	TIC	X	
Phthalates						
33 Diethylphthalate	84-66-2	0.0008 mg/m3	5 mg/m3	0.011%		Up to 0.02% of OEL for all inlet values. All outlets ≤0.01%.
Nitriles						
34 Acetonitrile	75-05-8	0.551 ppm	20 ppm	0.001%		Up to 0.9% of OEL for all inlet values. All outlets <2.8%.
35 Propanenitrile	107-12-0	0.0080 ppm	6 ppm	0.003%		Up to 0.1% of OEL for inlet values. All outlets <DL.
36 Butanenitrile	109-74-0	0.0197 ppm	8 ppm	0.001%		Up to 0.2% of OEL for inlet values. All outlets ≤0.01%.
37 Pentanenitrile	110-59-8	0.0024 ppm	6 ppm	0.002%		Up to 0.04% of OEL for inlet values. All outlets <DL.
38 Hexanenitrile	628-73-9	0.0016 ppm	6 ppm	0.001%		Up to 0.03% of OEL for inlet values. All outlets <DL.
39 Heptanenitrile	629-08-3	Not Detected	6 ppm	TIC	X	
40 2-Methylene butanenitrile	1647-11-6	Not Detected	0.3 ppm	TIC	X	
41 2,4-Pentadienenitrile	1615-70-9	Not Detected	0.3 ppm	TIC	X	
Amines						
42 Ethylamine	75-04-7	0.0459 ppm	5 ppm	0.094%		Up to 0.9% of OEL for inlet values. All outlets ≤0.6%.

Table 2. (continued)

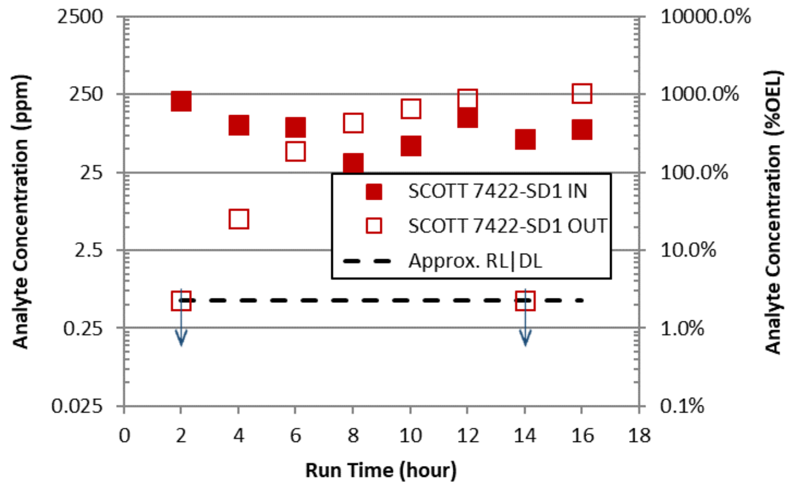
COPC Number and Name	CAS Number	Highest Measured Value (this study)	Occupational Exposure Limit (OEL)	Approximate Analytical Detection Limit, DL[1] (% of OEL)	All Data Values (inlet and outlet) <DL or <RL	Highest Detected Value Compared to OEL
Nitrosamines						
43 N-Nitrosodimethylamine	62-75-9	2.16 ppb	0.3 ppb	5.49%		Up to 721% of OEL for inlet values. All outlets <DL
44 N-Nitrosodiethylamine	55-18-5	0.01 ppb	0.1 ppb	10.6%		Up to 13.1% of OEL for inlet values. All outlets <DL.
45 N-Nitrosomethylethylamine	10595-95-6	0.56 ppb	0.3 ppb	4.43%		Up to 188% of OEL for inlet values. All outlets <DL.
46 N-Nitrosomorpholine	59-89-2	0.01 ppb	0.6 ppb	1.68%	X	
Organophosphates						
47 Tributyl phosphate	126-73-8	0.07 ppb	200 ppb	0.034%	X	
48 Dibutyl butylphosphonate	78-46-6	0.03 ppb	7 ppb	0.374%	X	
Halogenated						
49 Chlorinated Biphenyls	Varies	Not Detected	1 mg/m3	TIC	X	
50 2-Fluoropropene	1184-60-7	Not Detected	0.1 ppm	TIC	X	
Pyridines						
51 Pyridine	110-86-1	1.72 ppb	1000 ppb	0.008%		Up to 0.2% of OEL for inlet values. All outlets <DL.
52 2,4-Dimethylpyridine	108-47-4	0.36 ppb	500 ppb	0.010%		Up to 0.07% of OEL for inlet values. All outlets <DL.
Organonitrites						
53 Methyl nitrite	624-91-9	Not Detected	0.1 ppm	TIC	X	
54 Butyl nitrite	544-16-1	Not Detected	0.1 ppm	TIC	X	
Organonitrates						
55 Butyl nitrate	928-45-0	Not Detected	2.5 ppm	TIC	X	
56 1,4-Butanediol, dinitrate	3457-91-8	Not Detected	0.05 ppm	TIC	X	
57 2-Nitro-2-methylpropane	594-70-7	Not Detected	0.3 ppm	TIC	X	
58 1,2,3-Propanetriol, 1,3-dinitrate	623-87-0	Not Detected	0.05 ppm	TIC	X	
Isocyanates						
59 Methyl Isocyanate	624-83-9	Not Detected	20 ppb	TIC	X	
Organometallic						
New Dimethylmercury	593-74-8	Not Measured	10 ug/m3			

5.0 Plots of COPCs with Significant Detected Values

5.1 APR Cartridge Testing

This section provides details for the seven COPCs from the APR testing on Hanford BY-110 tank headspace vapors identified in Table 1. These COPCs have concentrations (at the inlet or outlet to the cartridge) >10% of the corresponding OELs. Plots of the corresponding data are given, as well as the associated analyses.

Ammonia *(see Figure 1)* – The DL for ammonia corresponds to approximately 2.3% of its OEL. For both SCOTT 7422-SD1 and 7422-SC1 cartridges, the inlet ammonia concentrations ranged from 112% to 943% of the OEL. For the SCOTT 7422-SD1 cartridge, outlet concentrations exceeded 10% of the OEL between 2 and 4 hours of testing.



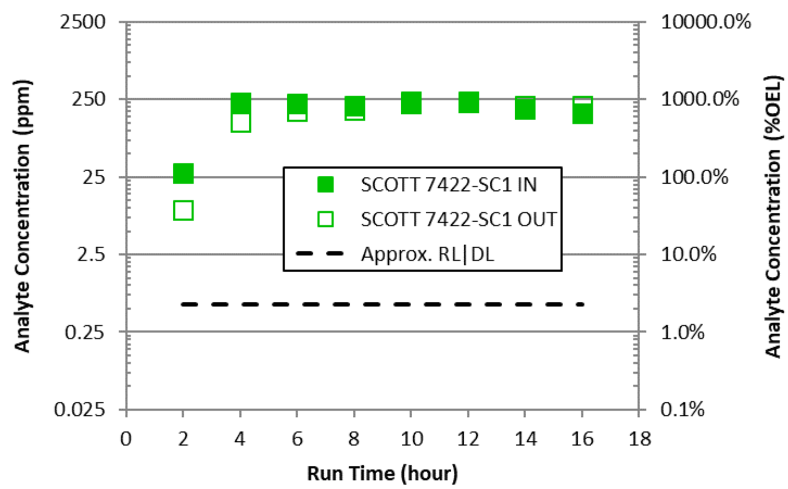


Figure 1. Plots of Measured Ammonia Concentrations before the Inlets and after the Outlets of the Two APR Cartridges Tested (SCOTT 7422-SD1 and SCOTT 7422-SC1). Data points noted with ↓ indicates measurements less than the DL or RL. Outlet data points not visible are obscured by the inlet data points.

Note the outlet concentration measurement at 14 hours was low (less than the DL), but this result is suspected to be due to sample flow rate issues. For the SCOTT 7422-SC1 cartridge, outlet concentrations exceeded 10% of the OEL within the first 2 hours of testing. Breakthrough times align with those from prior respirator cartridge tests on Hanford tanks, with the inlet concentration being the predominant driver of the observed breakthrough times.

We used vendor-developed calculators for ammonia to make service-life estimates for the various cartridges tested. The results of these estimations are given in Appendix G. Although the experimental breakthrough time for ammonia, >10% of its OEL, was obtained under a mixture composed of many chemicals, the cartridge service-life calculators are intended to be used only on a single ammonia component concentration (i.e., not for conditions with a mixture of chemicals). For the current study, ammonia service life estimates were complicated by several experimental factors specific to these tests. For the 7422-SD1 cartridge, the total slipstream flow through the cartridge decreased significantly from the start to the end of the test, potentially because of ice formation in the return line at the tank riser, which introduced uncertainty in the total gas flow through the cartridge prior to breakthrough. In addition, inlet concentrations decreased 50% between the 2- and 4-hour samples concurrent with the time of breakthrough. Using an average flow rate and average inlet ammonia concentration, the estimated service life is 4.3 hours, which is longer than the experimental breakthrough of 2 to 4 hours. However, using the starting slipstream flow rate and maximum (2 hour) ammonia inlet concentration, the estimated service life is 3.5 hours, which is consistent with the experimental breakthrough time. For the 7422-SC1 cartridge, breakthrough occurred within 2 hours, and the first inlet ammonia measurement was unusually low relative to all other inlet concentrations. The slipstream flow rate also decreased during the test, but not as significantly as with the 7422-SD1 cartridge. A service-life estimate using the average inlet ammonia concentration and average flow rate was significantly longer (~12 hours) than the experimental breakthrough result of less than 2 hours. Using a maximum inlet ammonia concentration and starting flow rate resulted in a 2.4-hour service life, which is slightly longer than the observed breakthrough. Therefore, differences in service-life estimates and experimental breakthrough times are likely a result of uncertainty between the average measured inlet concentrations and/or flow rates and the actual concentrations and flow rates to which the cartridge was subjected prior to breakthrough.

Furan *(see Figure 2)* – The DL for furan corresponds to approximately 13.5% of the OEL and the RL corresponds to 116%. Inlet concentrations measured throughout the testing period for the SCOTT 7422-SD1 cartridge were less than their analytical DL. The inlet concentrations measured for the SCOTT 7422-SC1 cartridge were relatively scattered, ranging from less than the analytical DL to 168% of the OEL. Five of these inlet concentrations taken at 4, 6, 10, 14, and 16 hours had data-quality flags indicating they were estimates only. All of the outlet measurements were below the analytical DL for both respirator cartridges. Thus, there is no evidence of breakthrough over the measured time period for either cartridge tested.

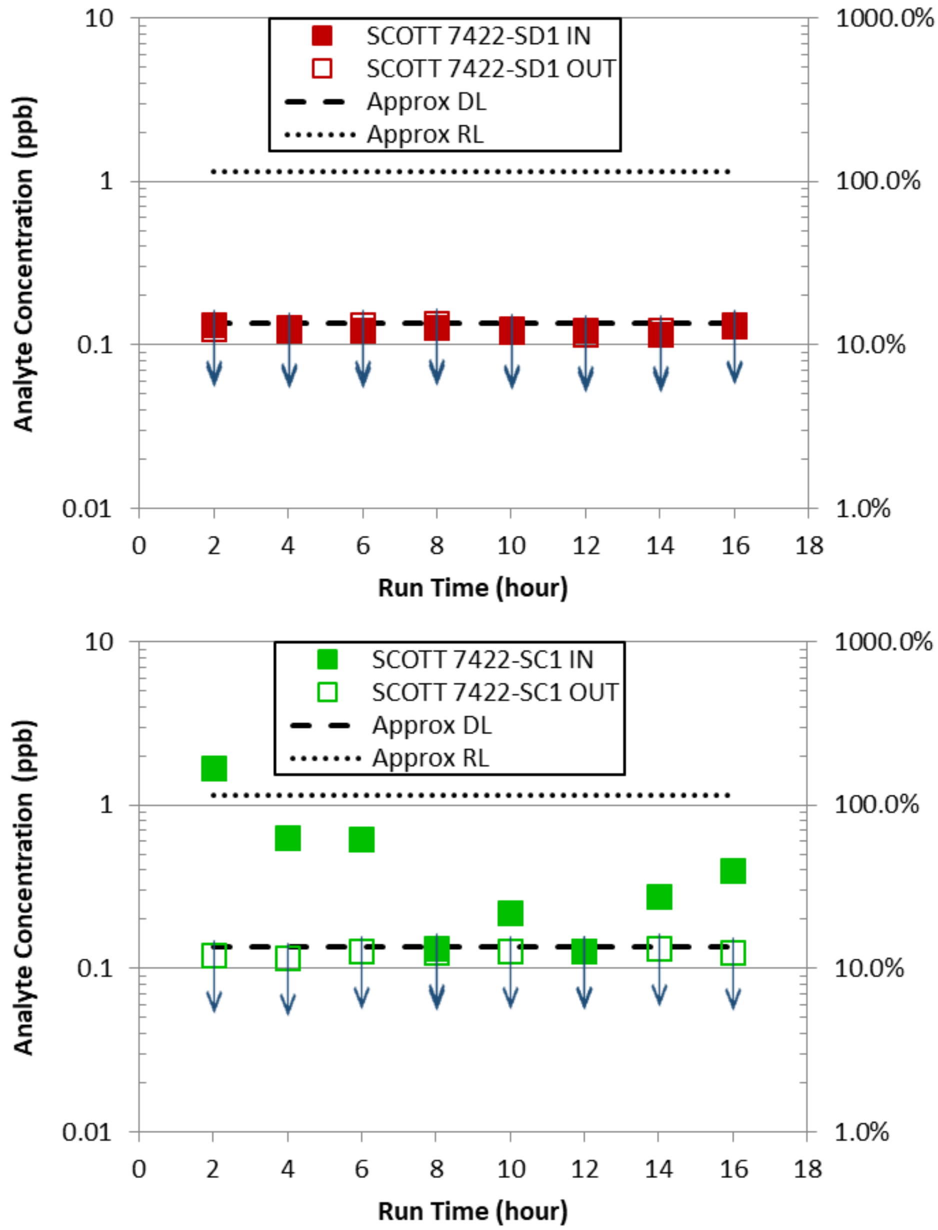


Figure 2. Plots of Measured Furan Concentrations before the Inlets and after the Outlets of the Two Respirator Cartridges Tested (SCOTT 7422-SD1 and SCOTT 7422-SC1). Data points noted with ↓ indicates measurements less than the DL. Outlet data points not visible are obscured by the inlet data points.

***2,5-Dihydrofuran** (see Figure 3)* – The DL for 2,5-dihydrofuran corresponds to approximately 23.4% of the OEL, and the RL corresponds to 112%. Inlet concentrations measured throughout the testing period for both cartridges tested were less than their analytical DL. For the SCOTT 7422-SD1 cartridge, the outlet concentrations measured exceeded the DL and 10% of the OEL for the 2 hour and 14 hour measurements, up to 43.8% of the OEL. All other outlet concentrations were less than the analytical DL. These two elevated outlet measurements for the SCOTT 7422-SD1 cartridge did not coincide with any obvious flow issues or data-quality flags. However, because these two measurements are higher than any of the inlet concentration measurements, their significance is suspect, especially because the measurements are still below the RL. Furthermore, the two high outlet measurements do not appear to represent any kind of trend that would suggest breakthrough over the measured time period. All of the inlet and outlet measurements for the SCOTT 7422-SC1 cartridge were below the analytical DL. Based on these results, there is no evidence of breakthrough over the measured time period for either cartridge tested.

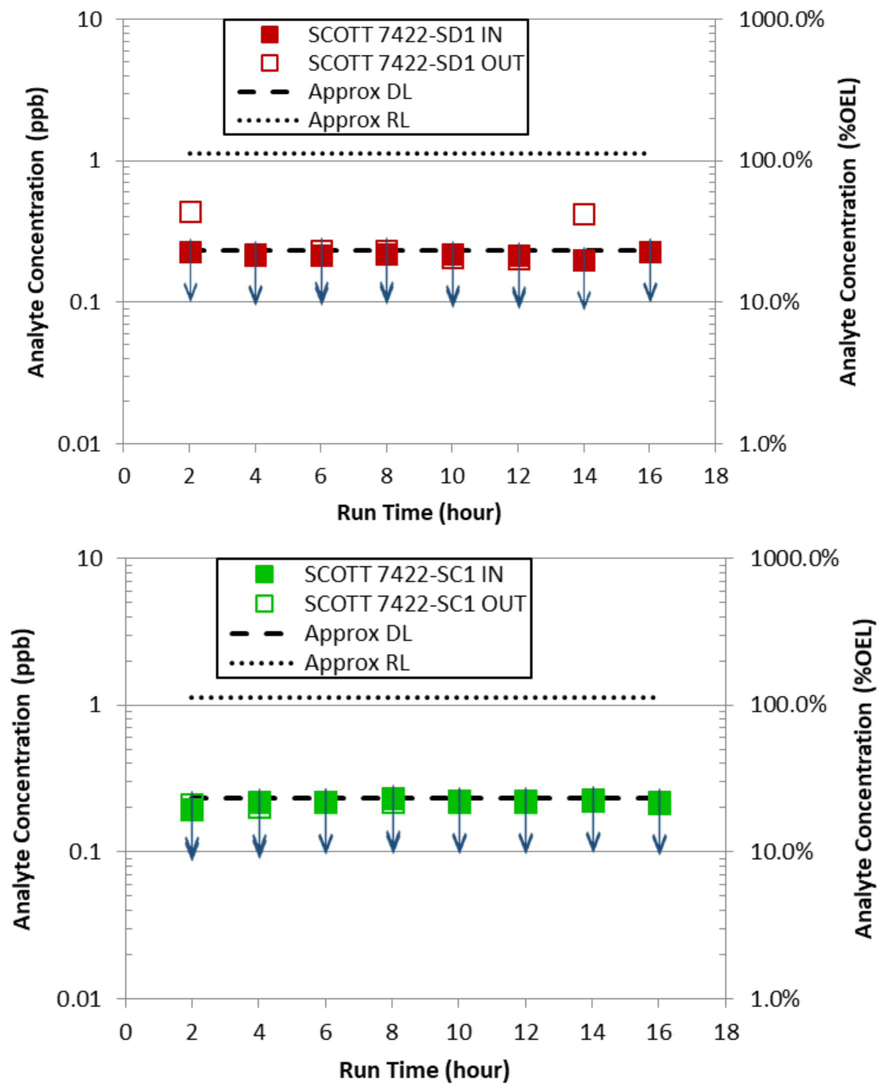


Figure 3. Plots of Measured 2,5-Dihydrofuran Concentrations before the Inlets and after the Outlets of the Two Respirator Cartridges Tested (SCOTT 7422-SD1 and SCOTT 7422-SC1). Data points noted with ↓ indicates measurements less than the DL or RL. Outlet data points not visible are obscured by the inlet data points.

2-Methylfuran (see Figure 4) – The DL for 2-methylfuran corresponds to approximately 8.8% of the OEL, and the RL corresponds to 99%. Inlet concentrations measured throughout the testing period for the SCOTT 7422-SD1 cartridges were less than the analytical DL. The first (2-hour) inlet concentration measured for the SCOTT 7422-SC1 cartridge was greater than the DL, reaching 10.6% of the OEL; this concentration had a data-quality flag indicating it was an estimate. All of the other inlet measurements and all outlet measurements were below the analytical DL for both respirator cartridges. Thus, there is no evidence of breakthrough over the measured time period for either cartridge tested.

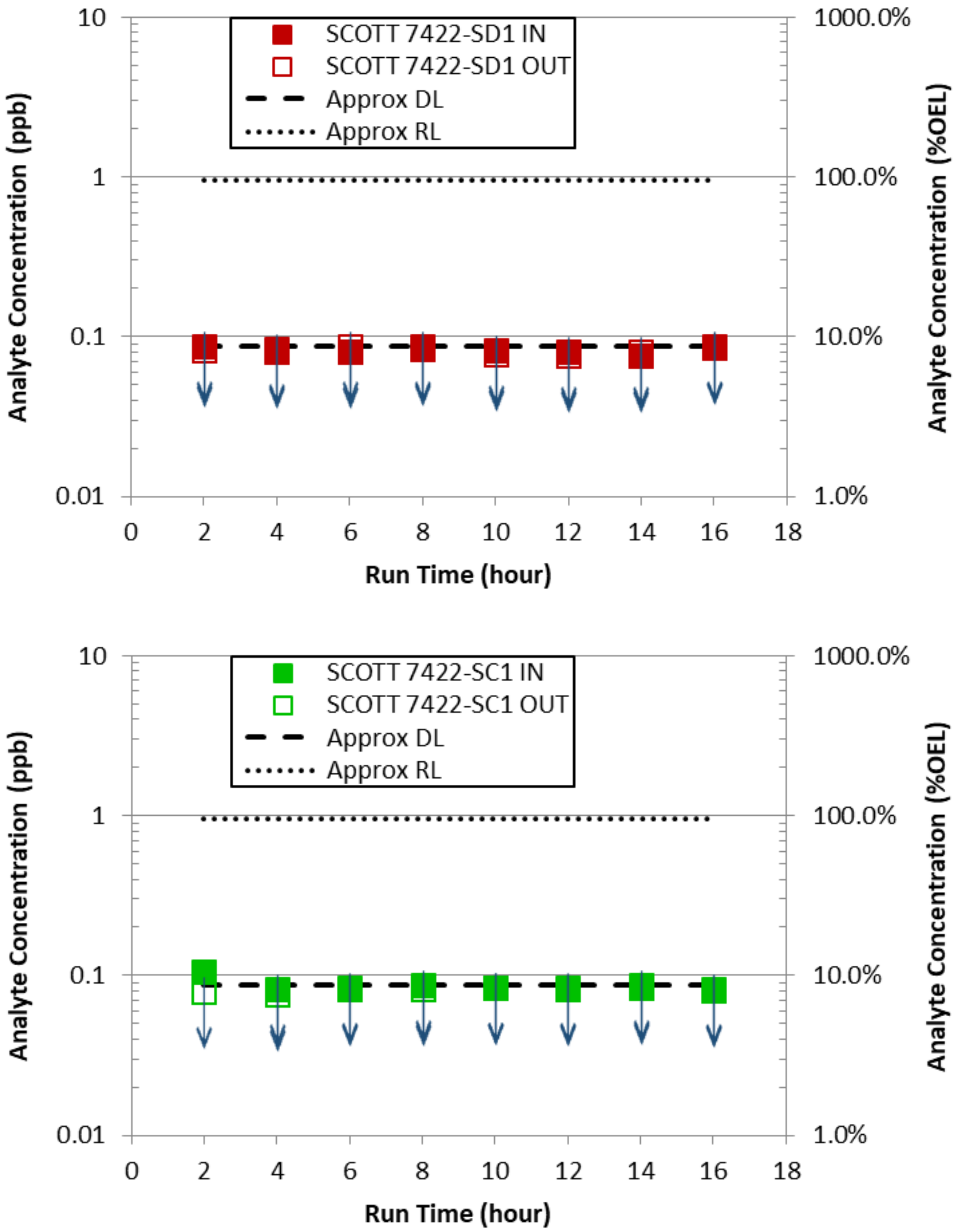


Figure 4. Plots of Measured 2-Methylfuran Concentrations before the Inlets and after the Outlets of the Two Respirator Cartridges Tested (SCOTT 7422-SD1 and SCOTT 7422-SC1). Data points noted with ↓ indicates measurements less than the DL or RL. Outlet data points not visible are obscured by the inlet data points.

N-nitrosodimethylamine (see Figure 5) – The DL for NDMA corresponds to approximately 5.2% of its OEL. All inlet concentration measurements for both cartridge tests were significantly greater than the DL, ranging from 392% to 1874% of the OEL. However, analytical flags on all inlet concentrations indicate that these results are qualitative only. There were no similar analytical flags on outlet concentrations. All outlet measurements from both cartridges tested were below the analytical DL except for the 16-hour measurement for the SCOTT 7422-SD1 cartridge, which reached a concentration of 8.6% of the OEL. While this final data point suggests the potential beginning of breakthrough, quality flags for both the 14- and 16-hour outlet samples indicates that there was a high spike recovery, and NDMA was not detected upon confirmatory analysis. Based on these data, there is no evidence of breakthrough, above 10% OEL, over the measured time period for either cartridge tested.

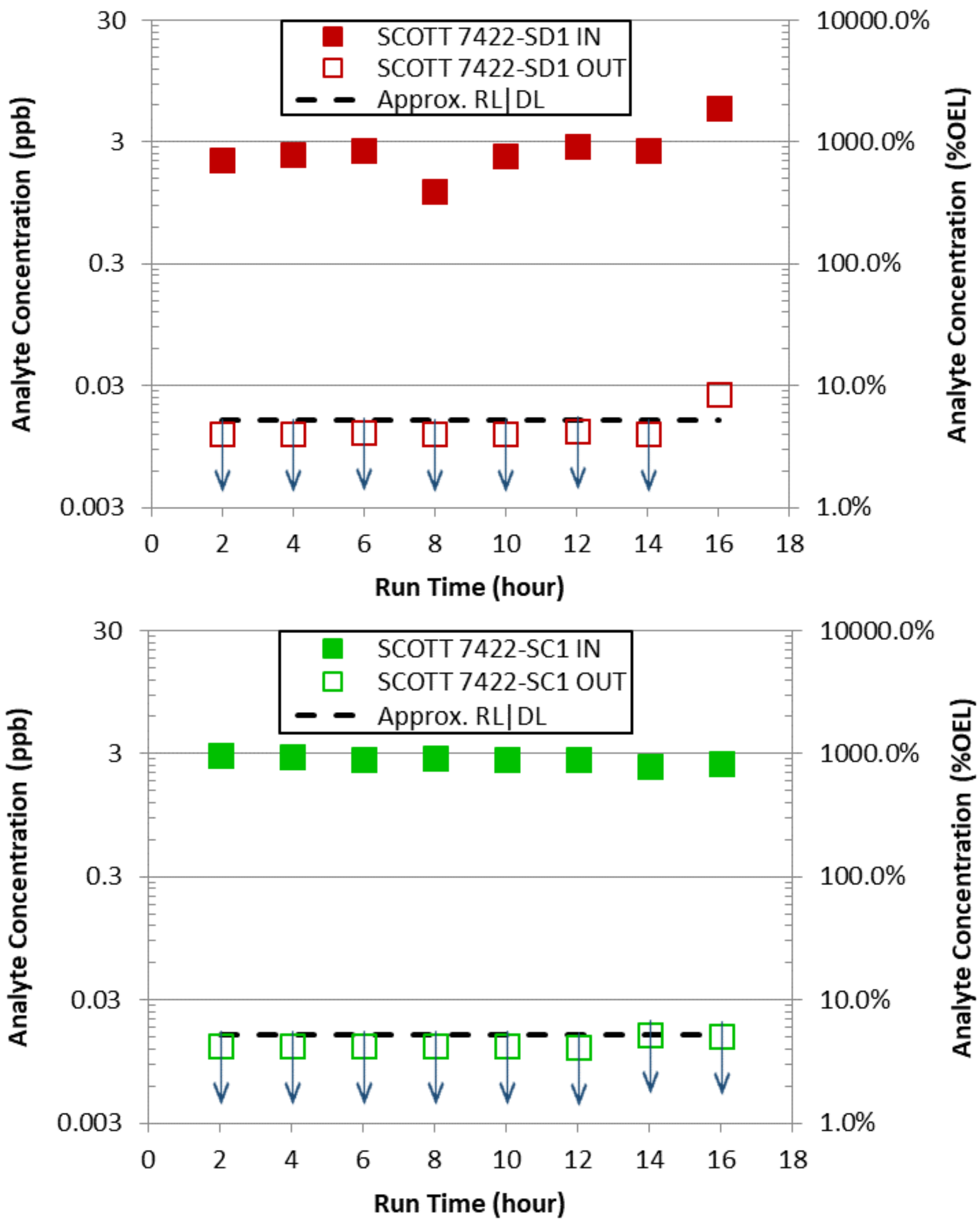


Figure 5. Plots of Measured N-nitrosodimethylamine Concentrations before the Inlets and after the Outlets of the Two Respirator Cartridges Tested (SCOTT 7422-SD1 and SCOTT 7422-SC1). Data points noted with ↓ indicates measurements less than the DL or RL.

***N*-nitrosodiethylamine** *(see Figure 6)* – The DL for NDEA corresponds to approximately 10.3% of its OEL. The inlet concentration measurements for both cartridge tests ranged from 41 to 150% of the OEL, except the 10-hour inlet measurement for the SCOTT 7422-SC1 cartridge, which was less than the DL. All of the outlet measurements were below the analytical DL for both respirator cartridges. Thus, there is no evidence of breakthrough over the measured time period for either cartridge tested.

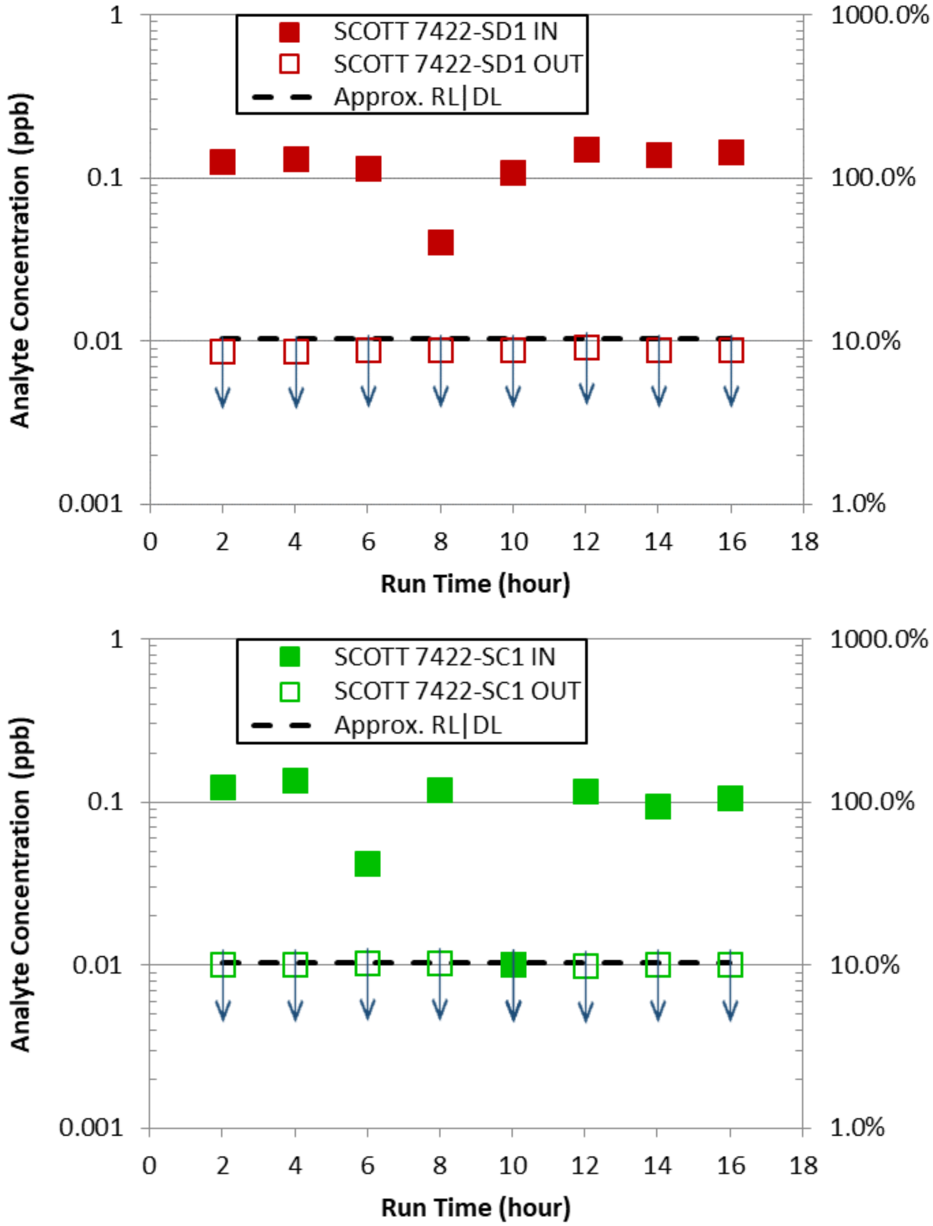
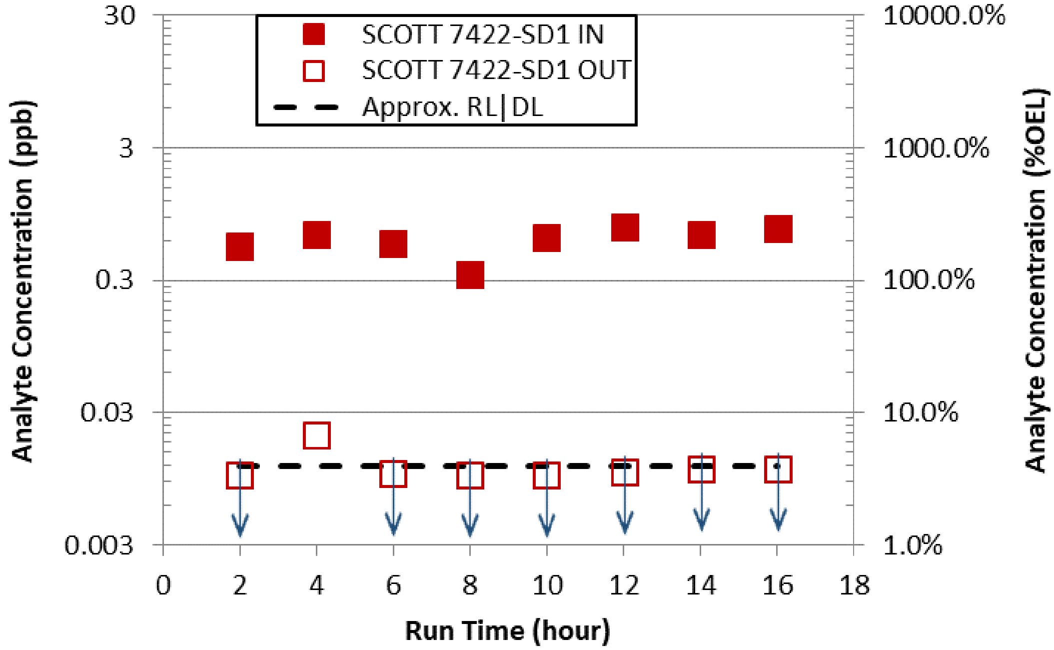


Figure 6. Plots of Measured N-nitrosodiethylamine Concentrations before the Inlets and after the Outlets of the Two Respirator Cartridges Tested (SCOTT 7422-SD1 and SCOTT 7422-SC1). Data points noted with ↓ indicates measurements less than the DL or RL. Outlet data points not visible are obscured by the inlet data points.

N-nitrosomethylethylamine *(see Figure 7)* – The DL for NMEA corresponds to approximately 4.0% of its OEL. All inlet concentration measurements for both cartridge tests were significantly greater than the DL, ranging from 108% to 252% of the OEL. All of the outlet measurements were below the analytical DL for both respirator cartridges except for the 4-hour measurement for the SCOTT 7422-SD1 cartridge, which reached 6.7% of the OEL. Thus, there is no evidence of breakthrough over the measured time period for either cartridge tested.



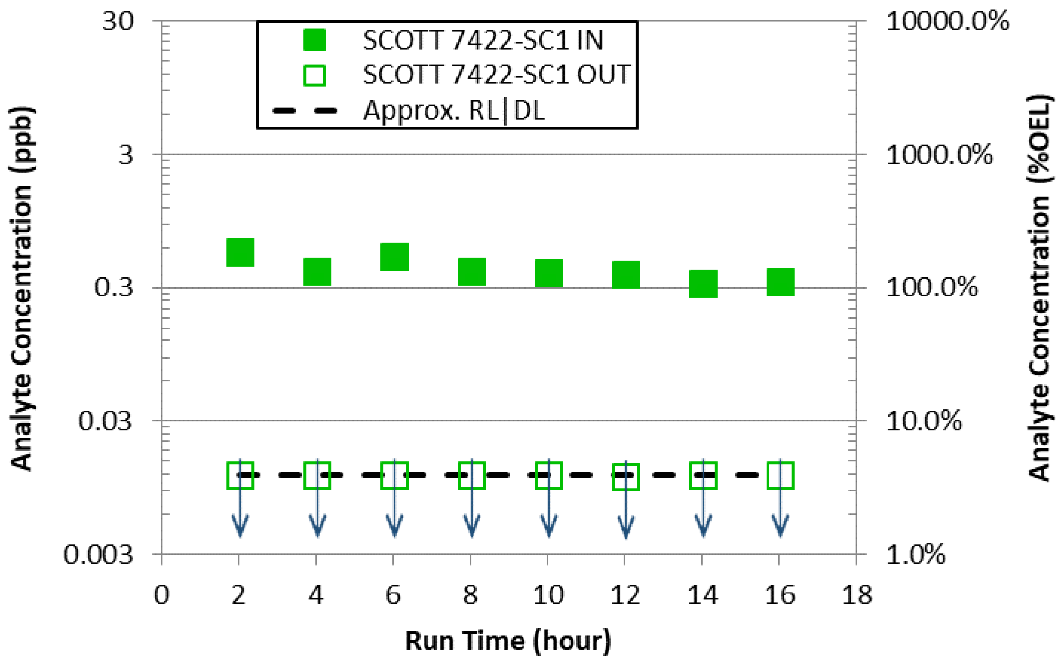


Figure 7. Plots of Measured N-nitrosomethylethylamine Concentrations before the Inlets and after the Outlets of the Two Respirator Cartridges Tested (SCOTT 7422-SD1 and SCOTT 7422-SC1). Data points noted with ↓ indicates measurements less than the DL or RL.

5.2 PAPR Cartridge Testing

This section provides more detail on the seven COPCs from the PAPR testing on a slipstream from the Hanford BY-108 tank headspace identified in Table 2 as having concentrations (inlet or outlet to the cartridge) >10% of the corresponding OEL. Plots of the corresponding data are given, as well as the associated analyses.

***Ammonia** (see Figure 8)* – The DL for ammonia corresponds to approximately 2.4% of its OEL. For both MSA TL and 3M FR-57 cartridges, the inlet ammonia concentrations ranged between 421% and 767% of the OEL.

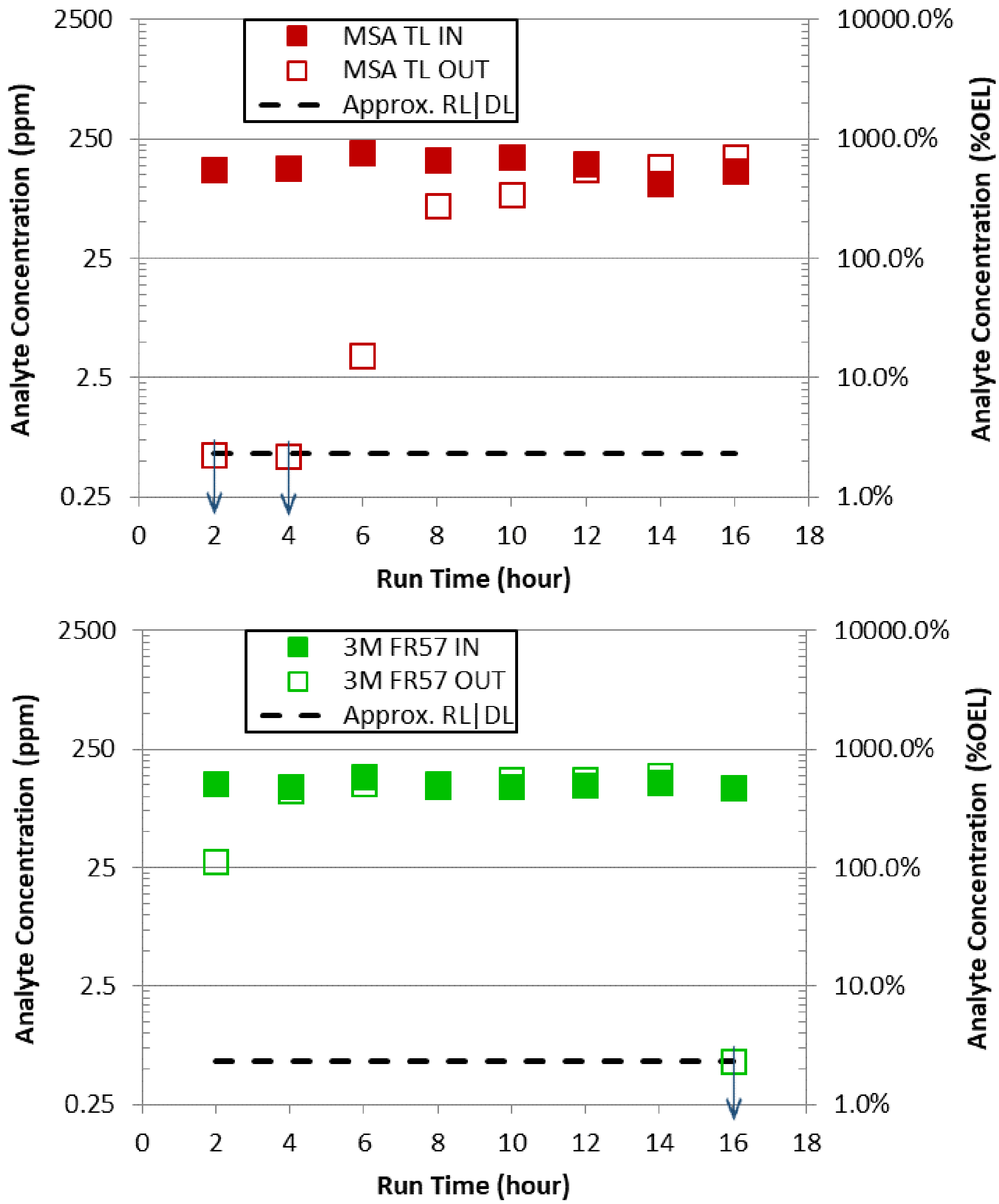


Figure 8. Plots of Measured Ammonia Concentrations before the Inlets and after the Outlets of the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Outlet data points not visible are obscured by the inlet data points.

For the MSA TL cartridge, the outlet concentrations exceeded 10% of the OEL between 4 and 6 hours of testing and increased to near the inlet concentrations after 8 hours of testing. For the 3M FR-57 cartridge, outlet concentrations exceeded 10% of the OEL within the first 2 hours of testing and increased to near the inlet concentration after 4 hours, except for the 16-hour measurement which was less than the DL. This result is suspected to be related to sample flow rate issues. The breakthrough times align with those from prior respirator cartridge tests on Hanford tanks, with the inlet concentration being the predominant driver.

We used vendor-developed calculators for ammonia to make service-life estimations for the various cartridges tested. The results of these estimations are given in Appendix G. Although the experimental breakthrough time for ammonia, above 10% of its OEL, was obtained under a mixture composed of many chemicals, the cartridge service-life calculators or algorithms are intended to be used only on a single ammonia component concentration (i.e., not for conditions with a mixture of chemicals). Nevertheless, prior comparisons with the MSA cartridges have shown consistent values between estimated service life and actual measures, which means that the ammonia estimations are representative of actual behavior in Hanford tank waste conditions when using the MSA cartridge. For the current study, the ammonia estimations for the MSA TL and 3M FR-57 PAPR cartridges were 2.2 and 0.9 hours based on maximum inlet concentration (2.5 and 1.0 hours based on average inlet concentration), respectively, versus the observed times of 4 to 6 hours and 0 to 2 hours.

Mercury (see Figure 9) – The DL for mercury corresponds to approximately 6.9% of the OEL. Inlet concentrations measured throughout the testing period for the MSA TL and 3M FR-57 cartridges ranged from 12.4 and 27.3% of the OEL. All of the outlet measurements were below the analytical DL for both respirator cartridges. Thus, there is no evidence of breakthrough over the measured time period for either cartridge tested.

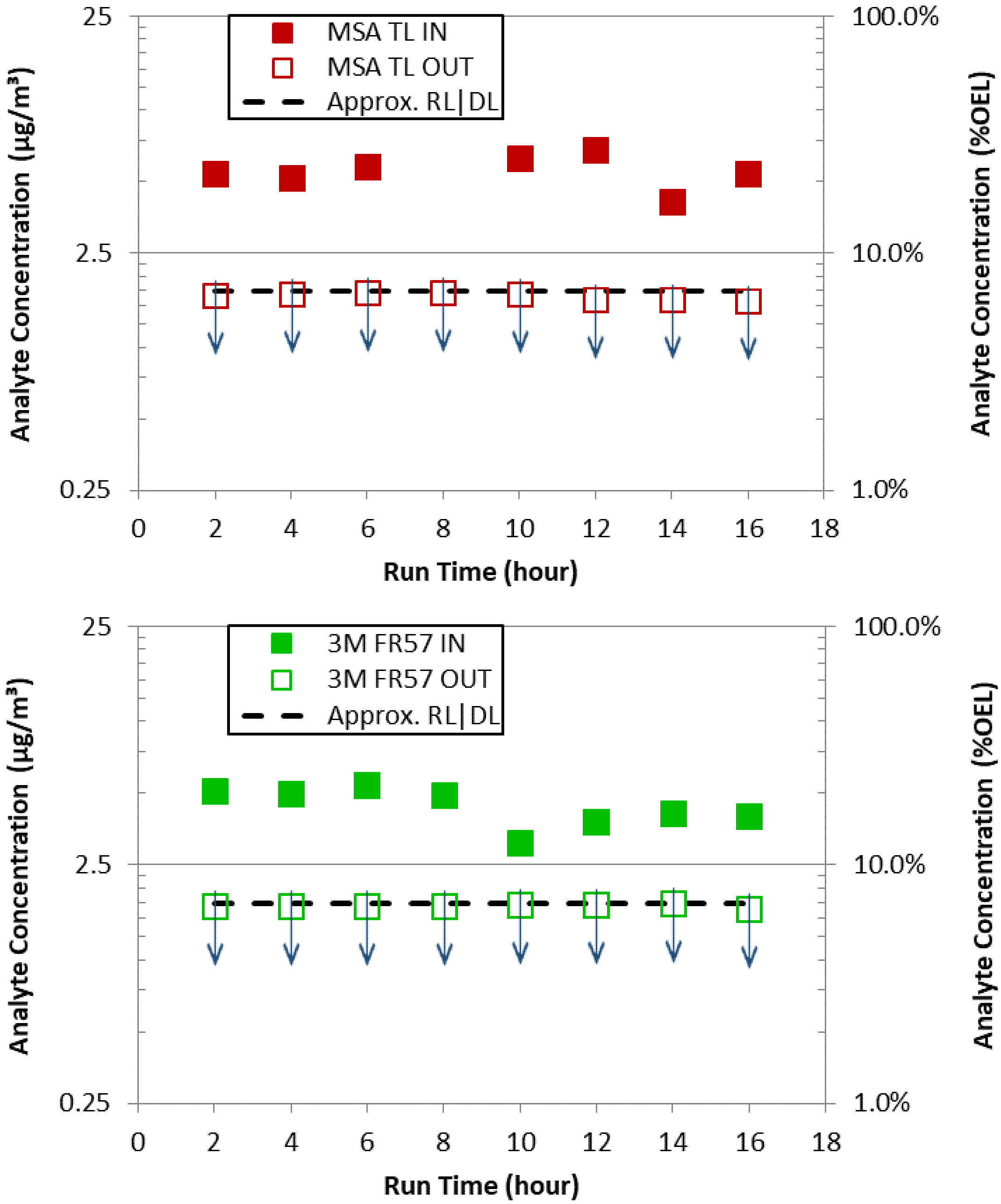


Figure 9. Plots of Measured Mercury Concentrations before the Inlets and after the Outlets of the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Data points noted with ↓ indicate measurements less than the DL or RL.

Furan *(see Figure 10)* – The DL for furan corresponds to approximately 13.9% of the OEL and the RL is approximately 116%. The inlet concentrations measured throughout the testing period for the MSA TL and 3M FR-57 cartridges ranged between 111 and 576% of the OEL, with the exception of the 2-hour measurement for 3M FR-57 , which was less than the DL. All of the outlet measurements were below the analytical DL for both respirator cartridges. Thus, there is no evidence of breakthrough over the measured time period for either cartridge tested.

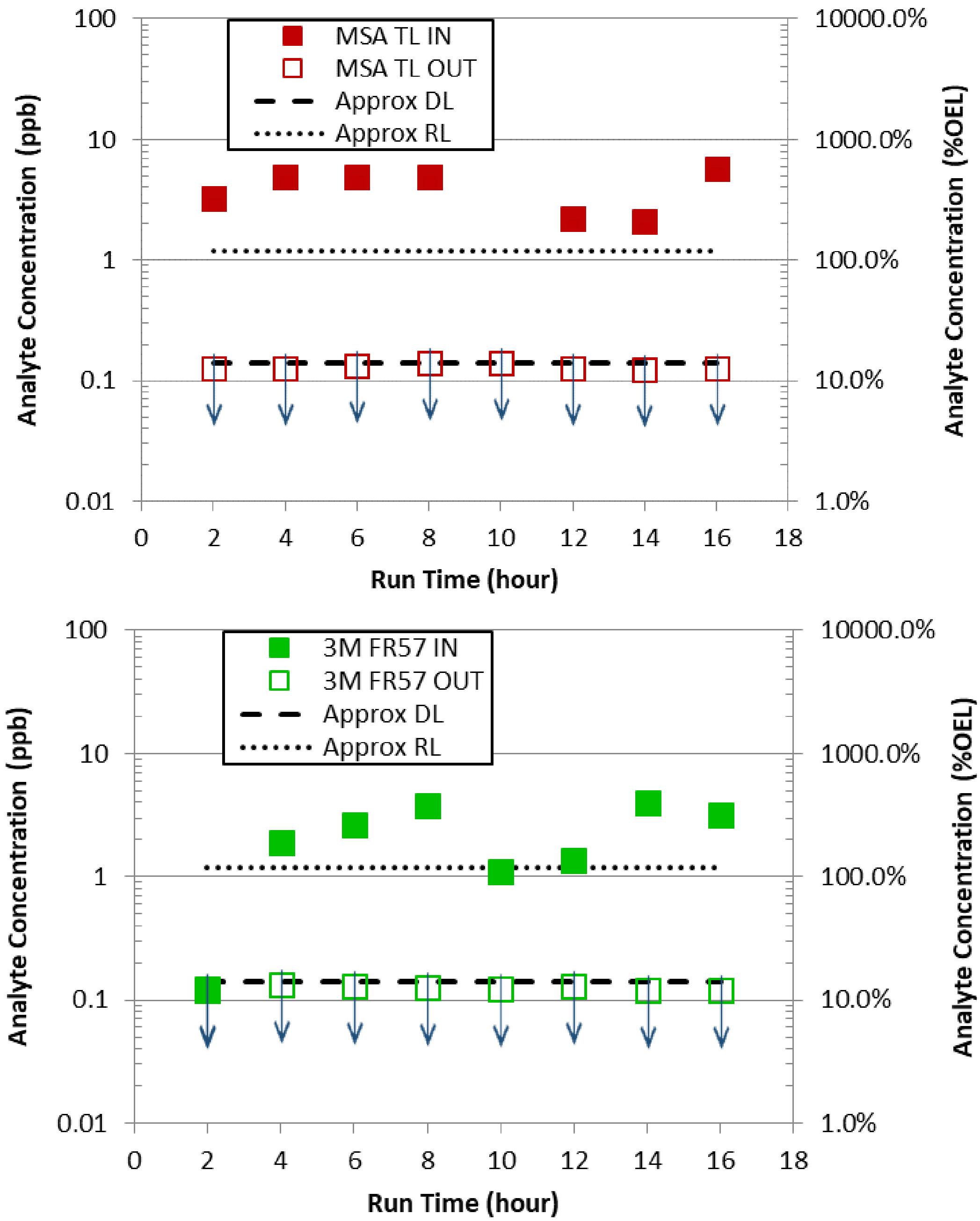


Figure 10. Plots of Measured Furan Concentrations before the Inlets and after the Outlets of the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Data points noted with ↓ indicates measurements less than the DL. Outlet data points not visible are obscured by the inlet data points.

2-Methylfuran *(see Figure 11)* – The DL for 2-methylfuran corresponds to approximately 9.1% of the OEL and the RL corresponds to 95.8%. Inlet concentrations measured throughout the testing period for the MSA TL and 3M FR-57 cartridges remained relatively constant, ranging between 7.8 and 16.6% of the OEL. All of the inlet concentrations on both cartridges reflected quality flags indicating results were estimates, except for the 2-hour measurement for the 3M FR-57 cartridge. All of the outlet measurements were below the analytical DL for both respirator cartridges. Thus, there is no evidence of breakthrough over the measured time period for either cartridge tested.

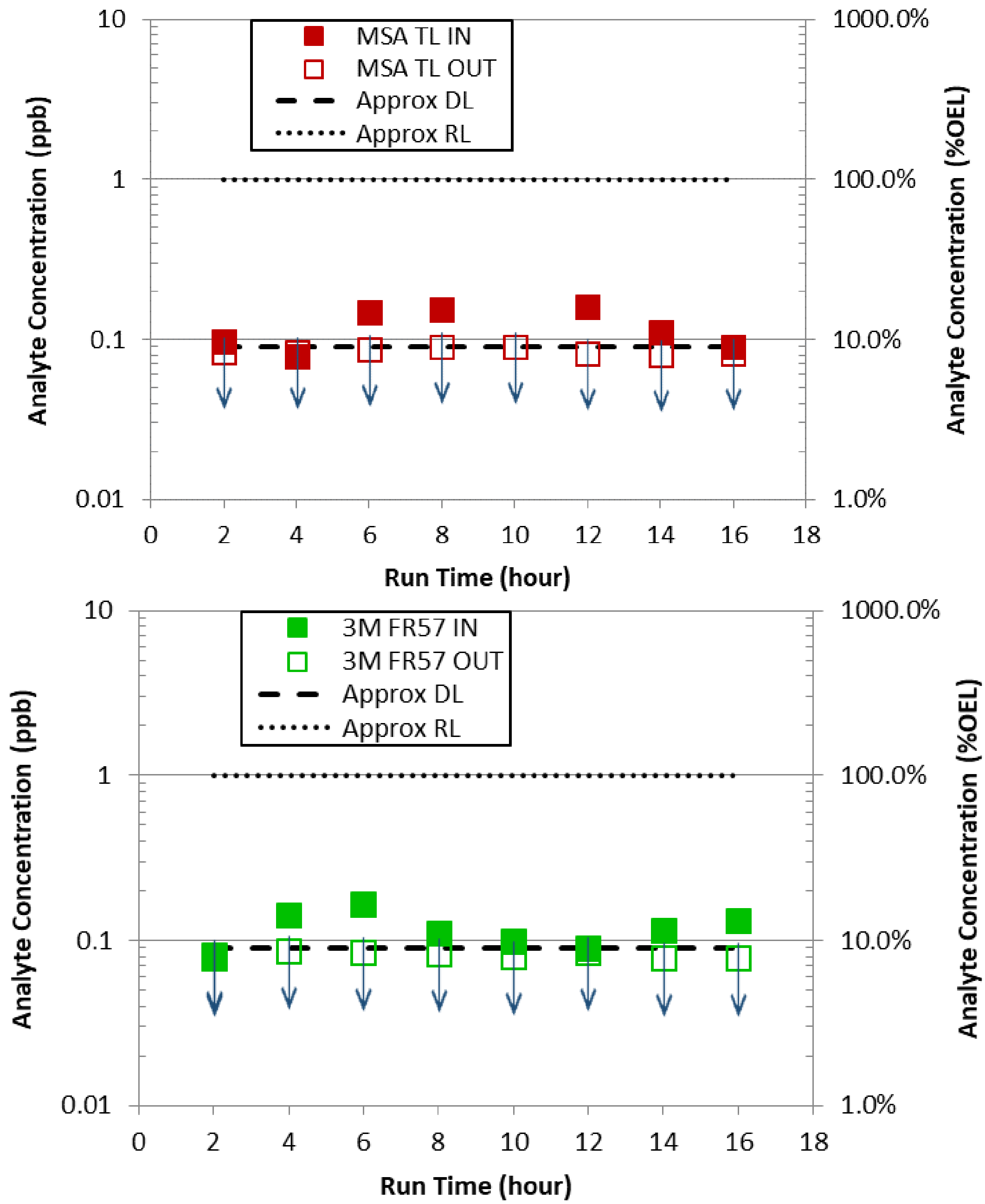


Figure 11. Plots of Measured 2-Methylfuran Concentrations before the Inlets and after the Outlets of the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Data points noted with ↓ indicates measurements less than the DL. Outlet data points not visible are obscured by the inlet data points.

***N-nitrosodimethylamine** (see Figure 12)* – The DL for NDMA corresponds to approximately 5.5% of its OEL. All inlet concentrations for both the MSA TL and 3M FR-57 cartridges ranged from 153% to 721% of the OEL. However, analytical flags on the inlet concentration measurements indicated that the MSA TL inlet data had poor repeatability and were qualitative only. All outlet measurements were below the analytical DL for both cartridges. Thus, there is no evidence of breakthrough over the measured time period for either cartridge tested.

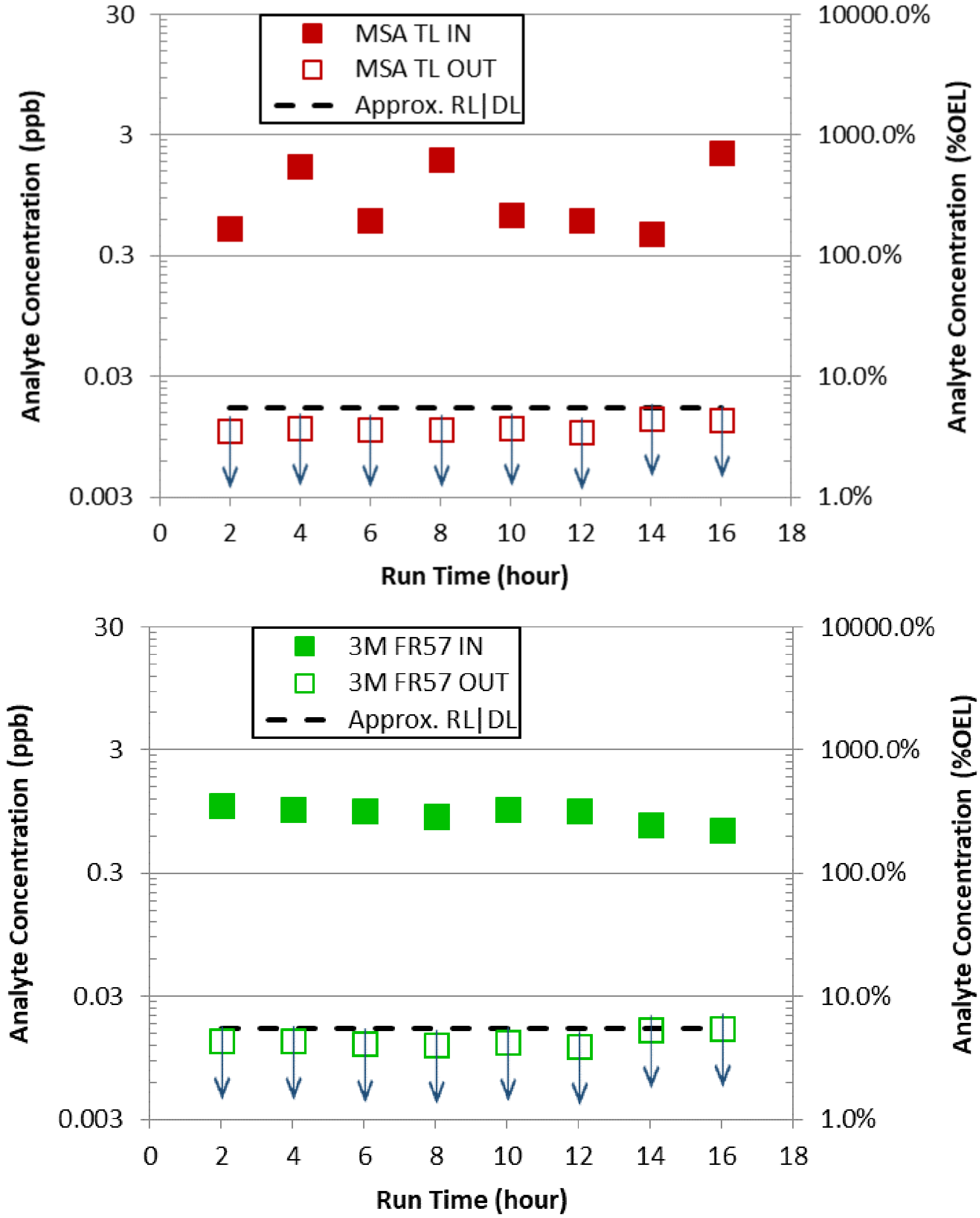


Figure 12. Plots of Measured N-nitrosodimethylamine Concentrations before the Inlets and after the Outlets of the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Data points noted with ↓ indicate measurements less than the DL or RL.

N-nitrosodiethylamine *(see Figure 13)* – The DL for NDEA corresponds to approximately 10.6% of its OEL. All inlet concentrations for the MSA TL cartridge were less than the analytical DL, but three of the inlet concentrations for 3M FR-57 cartridge were above 10% of the OEL, ranging from approximately 11.2 to 13.1%. However, analytical flags on the 3M FR-57 inlet concentration measurements indicated that the data were qualitative only. All of the outlet measurements were below the analytical DL for both respirator cartridges. Thus, there is no evidence of breakthrough over the measured time period for either cartridge tested.

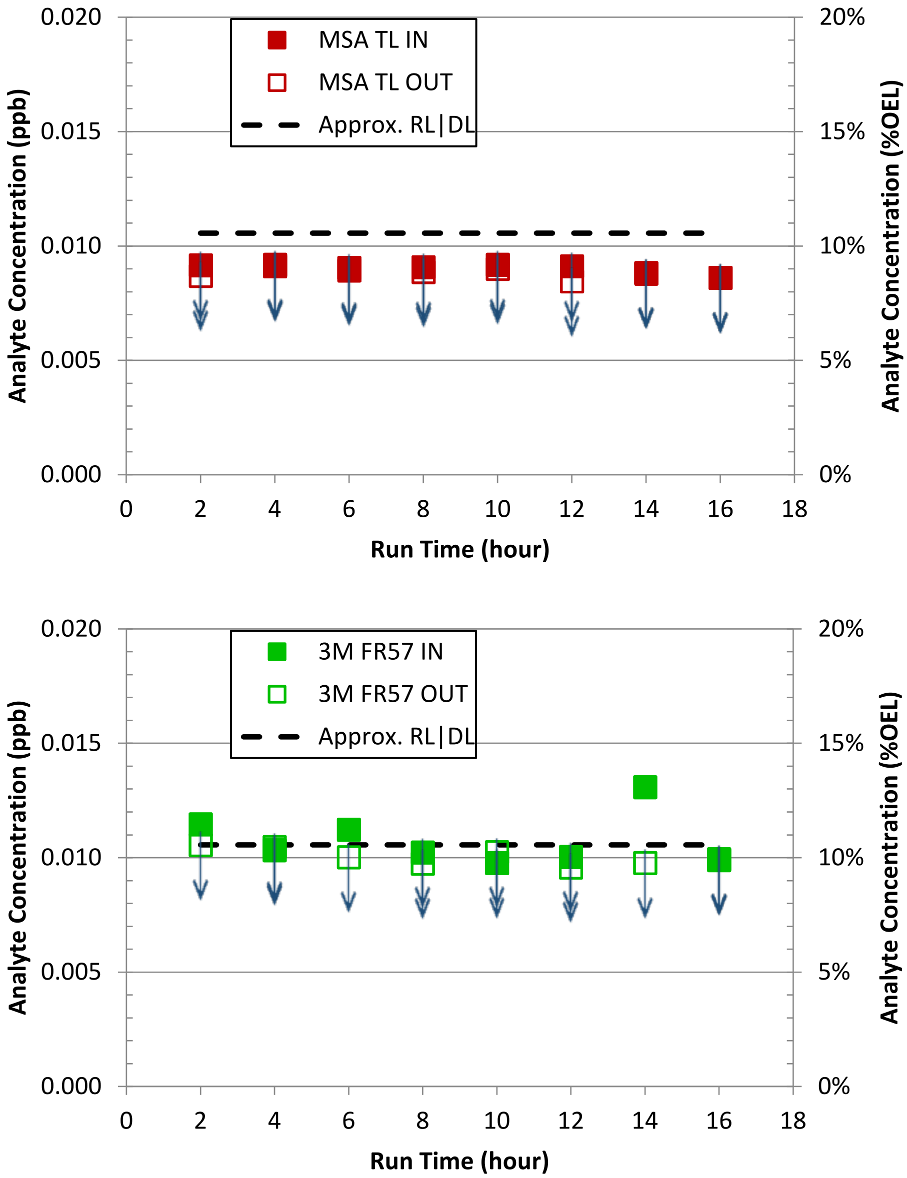


Figure 13. Plots of Measured N-nitrosodiethylamine Concentrations before the Inlets and after the Outlets of the Two PAPR Cartridges Tested (MSA TL and 3M FR-57) Data points noted with ↓ indicate measurements less than the DL or RL. Outlet data points not visible are obscured by the inlet data points.

N-nitrosomethylethylamine *(see Figure 14)* – The DL for NMEA corresponds to approximately 4.5% of its OEL. Inlet measurements for both MSA TL cartridge exceeded the 100% of the OEL during testing, with concentrations ranging from approximately 114 to 191% of the OEL. All of the inlet concentration measurements for 3M FR-57 cartridge were less than analytical DL. However, analytical quality flags indicated that the inlet concentration data were qualitative only. The difference between TL1 and TL2 inlet concentrations is likely due to a sample analytical problem rather than actual differences in headspace vapor concentrations. All of the outlet measurements were below the analytical DL for both respirator cartridges. Thus, there is no evidence of breakthrough over the measured time period for either cartridge tested.

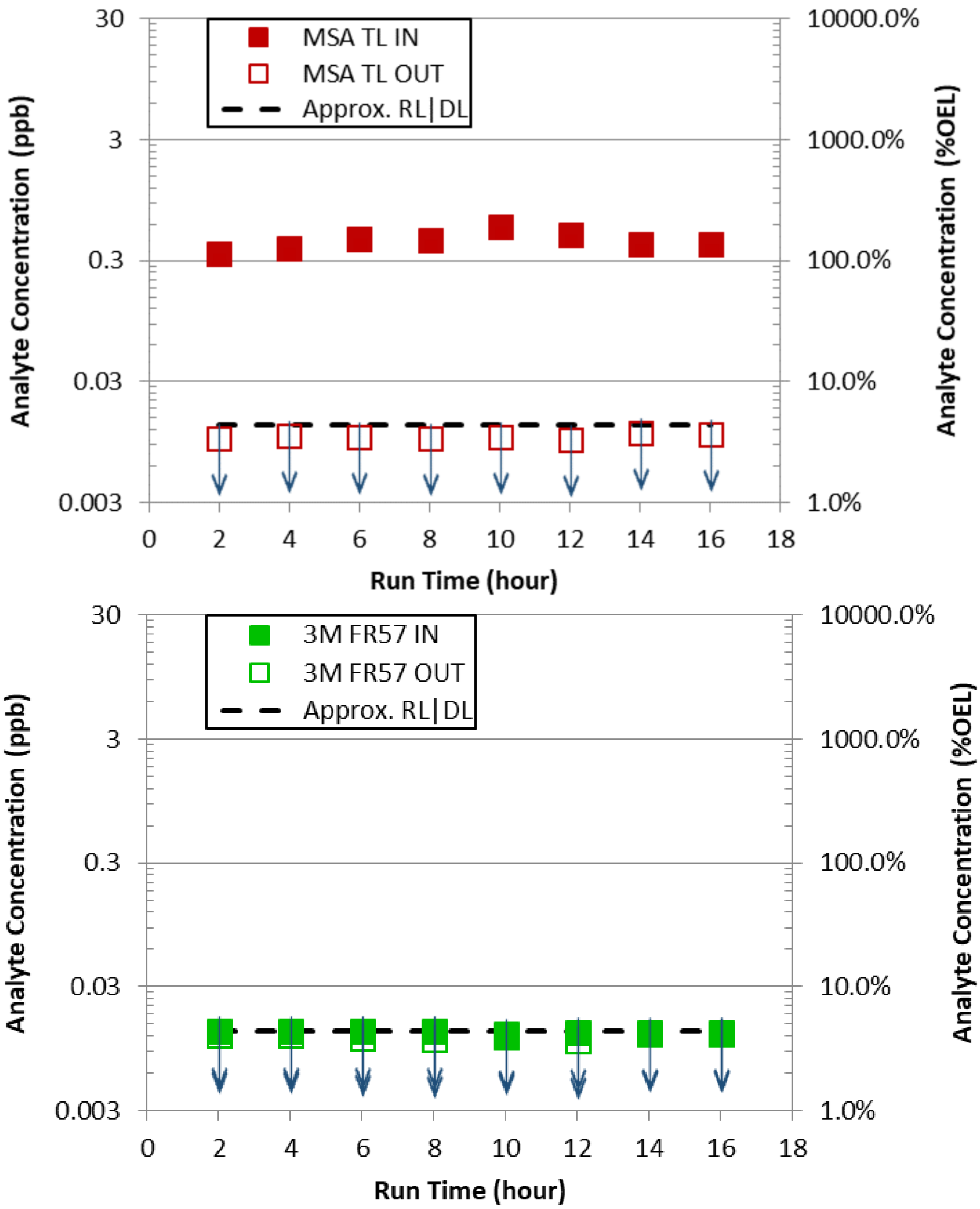


Figure 14. Plots of Measured N-nitrosomethylethylamine Concentrations before the Inlets and after the Outlets of the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Data points noted with ↓ indicate measurements less than the DL or RL. Outlet data points not visible are obscured by the inlet data points.

6.0 Factoring in Historical Concentration Data

To fully assess respirator performance for COPC removal, historical data were reviewed to determine if the recent inlet measurements were representative of typical values. Historical BY-110 and BY-108 headspace data from the Tank Waste Information Network System (TWINS) and the Site-Wide Industrial Hygiene Database were used for this assessment. In addition, the Hanford tank activity data available from TWINS were reviewed to assess whether any historic maximum headspace concentrations may have resulted from waste-disturbing activities not relevant to cartridge test conditions.[25]

Two complete tables with historical and measured results for all 61 COPCs and their boiling point data are shown in Appendix F for the BY-110 APR and BY-108 PAPR cartridge tests, along with a description of the historic source data that were used. Because a low boiling point can be a general indicator of poor adsorption on solid media, Tables 3 and 4 show a subset of historic BY-110 and BY-108 headspace data for COPCs with boiling points below 70°C.

Table 3. Historical BY-110 Headspace – APR Cartridge Data for COPCs with Boiling Points less than 70°C (158°F)

				Historical Measurements[1]					Measurements in this Study	
COPC Number and Name	**CAS Number**	**Boiling Point (°F)**	**Occupational Exposure Limit (OEL)**	**# of Values**	**Maximum Value (in OEL units)**	**Average Value (in OEL units)**	**Max. Value (% OEL)**	**Average Value (% OEL)**	**Max Inlet Value (% OEL)**	**Highest Value from Cartridge Outlet (% OEL)**
2 Nitrous Oxide	10024-97-2	-127	50 ppm	1	2.88	2.88	5.76%	5.76%	Not Measured	
				4	*125*	*78.2*	*250%*	*156%*		
1 Ammonia	7664-41-7	-28	25 ppm	1	1.11	1.11	4.44%	4.44%	943%	1043%
				7	*426*	*344*	*1704%*	*1376%*		
50 2-Fluoropropene	1184-60-7	-11	0.1 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC	
14 Formaldehyde	50-00-0	-6	0.3 ppm	2 (1)	0.019	0.010 (0.019)	6.33%	3.43% (6.33%)	2.1%	1.4%
53 Methyl nitrite	624-91-9	10	0.1 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC	
4 1,3-Butadiene	106-99-0	24	1 ppm	3 (1)	2.58	0.873 (2.58)	258%	87.3% (258%)	3.9% (RL)	3.9% (RL)[2]
42 Ethylamine	75-04-7	62	5 ppm	2	<0.018	<0.018	<0.36%	<0.36%	0.88%	0.55%
15 Acetaldehyde	75-07-0	69	25 ppm	2 (1)	0.24	0.18 (0.24)	0.96%	0.70% (0.96%)	0.38%	0.11%
19 Furan	110-00-9	88	1 ppb	4 (2)	2.95	2.16 (1.71)	295%	216% (171%)	168%[3]	13.5% (DL)
59 Methyl Isocyanate	624-83-9	103	0.02 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC	
New[5] 2-Propenal	107-02-8	127	0 ppm	1	<0.0009	<0.0009	<0.90%	<0.90%	0.96% (DL)	0.94% (DL)
20 2,3-Dihydrofuran	1191-99-7	130	1 ppb	1	3.09	3.09	309%	309%	3.3% (DL)[4]	3.3% (DL)
22 2-Methylfuran	534-22-5	147	1 ppb	4	<2.06	<1.39	<206%	<139%	10.6%[3]	8.8% (DL)
8 Methanol	67-56-1	148	200 ppm	1	<1.53	<1.53	<0.77%	<0.77%	Not Measured	
21 2,5-Dihydrofuran	1708-29-8	152	1 ppb	4 (1)	4.57	2.74 (4.57)	457%	274% (457%)	23.1% (DL)[3]	43.8%

[1] Historical data from TWINS industrial hygiene vapor database and SWIH database, as applicable; see text for links and dates of queries.

Plain font in the table indicates that only the recent databases (SWIHD headspace and TWINS Industrial Hygiene as applicable) were included. Italics, if present, mean that the pre-2006 TWINS headspace data were also included.

"n/a" indicates no historical data was found in the databases

Values in parenthesis "( )", if present, indicate the maximum or average reported (detected) value >RL or >DL.

"<" indicates that all pertinent measurements of the analyte were less than the reporting or detection level

[2] "(RL) or (DL)" indicates value represents approximate reporting limit (RL) or detection limit (DL), which is calculated using the reported detection limit (or reporting limit - RL, where noted) from the analytical laboratory and the average volume (from flowrate x time) of vapor exposed to the sorbent tube.

[3] Furans measured using VOA (Volatile Organic Analysis) method.

[4] Measured using Furan method.

[5] 2-Propenal and Dimethyl Mercury were added to the COPC List in September, 2017.

Table 4. Historical BY-108 Headspace – PAPR Cartridge Data for COPCs with Boiling Points less than 70°C (158°F)

				Historical Measurements[1]					Measurements in this Study	
COPC Number and Name	CAS Number	Boiling Point (°F)	Occupational Exposure Limit (OEL)	# of Values	Maximum Value (in OEL units)	Average Value (in OEL units)	Max. Value (% OEL)	Average Value (% OEL)	Max Inlet Value (% OEL)	Highest Value from Cartridge Outlet (% OEL)
2 Nitrous Oxide	10024-97-2	-127	50 ppm	1	1.80	1.80	3.60%	3.60%	Not Measured	
				40	*831*	*545*	*1662%*	*1090%*		
1 Ammonia	7664-41-7	-28	25 ppm	7 (6)	644	381 (445)	2576%	1524% (1780%)	767%	718%
50 2-Fluoropropene	1184-60-7	-11	0.1 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC	
				1	*0.53*	*0.53*	*530%*	*530%*		
14 Formaldehyde	50-00-0	-6	0.3 ppm	6	0.017	0.0126	5.67%	4.20%	3.3%	2.1%
53 Methyl nitrite	624-91-9	10	0.1 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC	
4 1,3-Butadiene	106-99-0	24	1 ppm	17 (8)	3.38	0.962 (2.03)	338%	96.2% (203%)	3.8% (RL)[2]	3.8% (RL)
42 Ethylamine	75-04-7	62	5 ppm	7	<0.0173	<0.00618!	<0.35%	<0.12%!	0.92%	0.58%
15 Acetaldehyde	75-07-0	69	25 ppm	7	2.82	0.62	11.3%	2.48%	0.52%	0.32%
19 Furan	110-00-9	88	1 ppb	21 (13)	<58.3 (18.4)	11 (9.54)	<5830% (1840%)	1100% (954%)	576%[3]	13.9% (DL)
				22 (14)	*547*	*35.3 (47.9)*	*54700%*	*3530% (4790%)*		
59 Methyl Isocyanate	624-83-9	103	0.02 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC	
New[5] 2-Propenal	107-02-8	127	0 ppm	15	<0.0112	<0.00708	<11.3%	<7.08%	0.90% (DL)	0.97% (DL)
20 2,3-Dihydrofuran	1191-99-7	130	1 ppb	5	<0.465	<0.321	<46.5%	<32.1%	3.2% (DL)[4]	3.1% (DL)
22 2-Methylfuran	534-22-5	147	1 ppb	21	<48.4	<6.79!	<4840%	<679%!	16.6%[3]	9.0% (DL)
8 Methanol	67-56-1	148	200 ppm	3 (2)	<1.54 (0.0218)	0.525 (0.0173)	<0.77% (0.011%)	0.26% (0.009%)	0.58%	0.32%
21 2,5-Dihydrofuran	1708-29-8	152	1 ppb	21	<56.6	<7.95!	<5660%	<795%!	23.5% (DL)[3]	24.1% (DL)

[1] Historical data from TWINS industrial hygiene vapor database and SWIH database, as applicable; see text for links and dates of queries.
Plain font in the table indicates that only the recent databases (SWIHD headspace and TWINS Industrial Hygiene as applicable) were included. Italics, if present, mean that the pre-2006 TWINS headspace data were also included.
"n/a" indicates no historical data was found in the databases
Values in parenthesis "( )", if present, indicate the maximum or average reported (detected) value >RL or >DL.
"<" indicates that all pertinent measurements of the analyte were less than the reporting or detection level
"!", if present, indicates a maximum RL that came from a sample with a volume less than 0.5 L or from a sample whose RL, for undiscernible reasons, was a factor of 5 or more high compared to other samples measured using the same analytical method.
[2] "(RL) or (DL)" indicates value represents approximate reporting limit (RL) or detection limit (DL), which is calculated using the reported detection limit (or reporting limit - RL, where noted) from the analytical laboratory and the average volume (from flowrate x time) of vapor exposed to the sorbent tube.
[3] Furans measured using VOA (Volatile Organic Analysis) method.
[4] Measured using Furan method.
[5] 2-Propenal and Dimethyl Mercury were added to the COPC List in September, 2017.

6.1 APR Cartridge Testing

Six COPCs—ammonia, nitrous oxide, 1,3-butadiene, furan, 2,3-dihydrofuran, and 2,5-dihydrofuran—were previously measured in the BY-110 tank headspace at concentrations above 100% of their OELs. One additional COPC—acetonitrile—was historically measured above 10% of its OEL. Of these seven COPCs, only ammonia and furan were measured at concentrations above 100% of their respective OELs in inlets to the APR cartridge testing. However, four additional COPCs—2-methylfuran, NDMA, NDEA, and NMEA—were detected in the inlets to the APR cartridge at concentrations exceeding 10% of their OEL. Following are the individual comparisons of cartridge source measurements and historical measurements for these eleven COPCs:

- The maximum ammonia inlet concentration measured in the APR cartridge tests was 943% of the OEL, approximately 0.5× the historic headspace maximum of 1704% of the OEL obtained in 1994.[17] A more recent sample collected in 2008 measured only 4.4% of the OEL, but likely represents a breather-filter sample that may be biased low.

[17] Inlet concentrations were considered generally consistent if they were within a factor of 2 (-50% to +100%) of historic maximum or average headspace measurements.

- Nitrous oxide maximum concentration measurements from BY-110 were 5.8% of the OEL from a 2009 breather-filter sample, and 250% of the OEL from a 1994 headspace measurement. Nitrous oxide is not susceptible to respirator cartridge filtration so it was not measured in the cartridge testing.
- The maximum concentration of 1,3-butadiene in BY-110 headspace was 258% of the OEL and obtained from a July 2015 sample. The APR cartridge inlet concentrations were less than the RL, and significantly lower than the historic maximum.
- Furan and several substituted furan COPCs have been measured at levels above 100% of their OELs in the BY-110 headspace. Maximum historic concentrations for furan, 2,3-dihydrofuran, and 2,5-dihydrofuran were measured in July 2015 and reported to be 295%, 309%, and 457% of their OELs, respectively. In APR cartridge test inlets, only furan exceeded 100% of the OEL, at approximately 0.6× the historic maximum. Cartridge test inlet concentrations of 2,3- and 2,5-dihydrofuran were both less than DL, significantly lower than historic maximums. 2-Methylfuran was detected at 10.6% of its OEL in the cartridge inlet, compared to the historic maximum that was less than the RL. Therefore, no conclusion can be drawn regarding comparability of 2-methylfuran cartridge and historic concentrations.
- Nitrosamines including NDMA, NDEA, and NMEA had maximum cartridge inlet concentrations of 1874%, 150%, and 252% of their OELs, respectively. These concentrations were significantly higher than the historic measurements of these COPCs, all of which were less than their RLs (RLs ranged from 9% to 39% of the OEL). However, there were numerous analytical quality flags associated with cartridge inlet concentrations for the nitrosamines, indicating that the inlet concentrations for several tests were qualitative estimates only.

Overall, the available historic vapor surveys for BY-110 headspace indicate several COPCs including 1,3-butadiene and substituted furans 2,3- and 2,5-dihydrofuran, with significantly higher concentrations than observed in cartridge testing. However, for ammonia and furan, cartridge inlet concentrations were generally consistent with historic headspace concentrations.[18] Differences in maximum concentrations observed between a cartridge and the headspace may be affected by ambient conditions during sampling because most of the maximum historic measurements came from sampling in July, whereas cartridge testing was performed in February.

6.2 PAPR Cartridge Testing

Eight COPCs—ammonia, nitrous oxide,1,3-butadiene, 1-butanol, furan, 2-heptylfuran, NDMA, and 2-fluoropropene—were previously measured in the BY-108 tank headspace at concentrations above 100% of their OELs. Three additional COPCs—mercury, acetaldehyde, and acetonitrile—have been historically measured above 10% of their OELs. Of these eleven COPCs, only ammonia, furan, and NDMA were measured at concentrations above 100% of their respective OELs in inlets to the PAPR cartridge testing. However, four additional COPCs—mercury, 2-methylfuran, NDEA, and NMEA—were detected in the inlets to the PAPR cartridge test stand at concentrations exceeding 10% of their OELs. Following are the individual comparisons of cartridge source measurements and historical measurements for these 15 COPCs:

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[18] Inlet concentrations were considered generally consistent if they were within a factor of 2 (-50% to +100%) of historic maximum or average headspace measurements.

- The maximum ammonia inlet concentration measured in the PAPR cartridge tests was 767% of the OEL, approximately 0.3× the historic BY-108 maximum of 2576% of the OEL obtained from a breather-filter measurement made in 2009. More recent headspace measurements from 2016 ranged from 1460 to 1750% of the OEL, which is approximately 2× the maximum cartridge inlet concentration.
- Nitrous oxide maximum concentration measurements from BY-108 were 1662% of the OEL from a 1996 headspace sample, but only 3.6% of the OEL from a more recent 2009 breather-filter measurement. Nitrous oxide is not susceptible to respirator cartridge filtration; therefore, it was not measured in the cartridge testing.
- The maximum mercury concentration measured in this PAPR cartridge study was approximately 0.4× the historic maximum. The historic maximum mercury concentration was 68% of the OEL, whereas the PAPR cartridge maximum was 27% of the OEL.
- The maximum concentration of 1,3-butadiene in BY-108 was 338% of the OEL and obtained from an April 2008 headspace sample. The PAPR cartridge inlet concentrations were less than the RL (3.8%), which is significantly lower than the historic maximum.
- The historic maximum headspace concentration for 1-butanol measured 318% of the OEL from a 1994 sample, compared to 21.6% of the OEL from a 2009 breather-filter sample. The maximum cartridge inlet concentration (2.8% of the OEL) was significantly lower than either historic BY-108 measurement.
- Acetaldehyde maximum historic concentration from BY-108 headspace measured 11.3% of the OEL from a 2008 sample. A more recent 2016 headspace sample measured 1.2% of the OEL. The maximum cartridge inlet concentration was 0.52% of the OEL, which is significantly lower than the historic maximum, but 0.4× the most recent headspace sample.
- Furan and 2-heptylfuran have been measured at levels above 100% of their OELs in the BY-108 headspace. Maximum historic concentrations for furan and 2-heptylfuran were both measured in 1994 and reported to be 54,700% and 6120% of their OELs, respectively.[19] More recent historic measurements have all been significantly lower than these maxima. The most recent furan headspace maximum from 2016 was reported to be 1840% of the OEL. All five more recent 2-heptylfuran headspace measurements were reported to be less than the RL. In PAPR cartridge test inlets, only furan exceeded 100% of the OEL at 576%, which is approximately 0.3× the 2016 furan maximum, and significantly lower than the 1994 maximum. 2-Heptylfuran was less than the DL (24% of the OEL) in the PAPR cartridge test. 2-Methylfuran was detected at a maximum of 16.6% of the OEL in the cartridge inlet, compared to the historic maximum which was less than the RL. Therefore, no conclusion can be drawn regarding comparability of 2-methylfuran cartridge and historic concentrations.
- Acetonitrile maximum headspace concentration of 94% of the OEL was measured in 2016. Other measurements of BY-108 headspace made during the same time frame reported concentrations ranging from 2.2% to 9.8% of the OEL. The maximum cartridge inlet concentration observed was <1% of the OEL, which is significantly lower than the historic maximum.

[19] The 1994 2-heptyfuran measurement of 6120% of the OEL from BY-108 headspace has subsequently been questioned and considered to be a misidentification (see Appendix F, section F.5.10.)

- Nitrosamines including NDMA, NDEA, and NMEA had maximum cartridge inlet concentrations of 721%, 13%, and 188% of their OELs, respectively. The NDMA concentration was approximately 0.4× the historic headspace maximum of 2063% of the OEL reported from a 2016 sample. The concentrations of NDEA and NMEA were significantly higher than any historic headspace measurements with concentrations above the RL. However, there were numerous analytical quality flags associated with cartridge inlet concentrations for the nitrosamines, thus indicating that the inlet concentrations for several tests were qualitative estimates only.
- 2-Fluoropropene is a TIC with a historic maximum of 530% of the OEL recorded from a single, 1994 headspace sample. No other headspace samples of BY-108 have reported a detection of this COPC. 2-Fluoropropene was not detected in the PAPR cartridge test.

Overall, the available historic vapor surveys for BY-108 headspace indicate several COPCs including 1,3-butadiene, 1-butanol, acetaldehyde, 2-heptylfuran, acetonitrile, and 2-fluoropropene with significantly higher concentrations than observed in cartridge testing. Of these, the 2-heptylfuran results are suspect. Ammonia, mercury, furan, and NDMA all had lower cartridge inlet concentrations than the historic maximums but were consistently 0.3× to 0.4× the historic maximum concentrations.

7.0 Conclusions

Tests on vapors from headspaces of the Hanford BY-108 and BY-110 waste storage tanks were conducted over two days from February 23–25, 2018. Vapors from each tank were fed separately to one of two respirator cartridge test stands developed by WRPS in collaboration with HiLine Engineering (Richland, Washington). BY-110 tank headspace vapors were fed to the APR respirator cartridge test stand, and BY-108 tank headspace vapors were fed to the PAPR respirator cartridge test stand. Two different cartridges were assessed for vapors from each tank headspace, four different cartridges in total. Multipurpose APR cartridges—SCOTT 7422-SD1 and SCOTT 7422-SC1 (SCOTT Safety, Monroe, North Carolina)—were assessed for vapors from the BY-110 tank headspace on separate days using an APR cartridge test stand. Multipurpose PAPR cartridges—MSA TL (MSA Safety Inc., Pittsburgh, Pennsylvania) and 3M FR-57 (3M Company, Maplewood, Minnesota)—also were assessed over the same two days using vapors from BY-108 tank headspace and a separate test stand configured for the PAPR cartridges. Sample media (i.e., sorbent tubes) were used to collect samples of the vapor stream entering and exiting the respirator cartridges, and the samples then were analyzed for COPC concentrations. Pacific Northwest National Laboratory was tasked to independently analyze the collected data and make recommendations based on the results for respiratory cartridge performance and service life. The key conclusions from the analysis are described below.

7.1 APR Cartridge Testing

Based on measured APR cartridge inlet vapor concentrations from the BY-110 tank headspace, five COPCs—ammonia, furan, NDMA, NDEA and NMEA—exceeded their corresponding OELs.[20] Two additional COPCs—2,5-dihydrofuran and 2-methylfuran—had one or more inlet concentration measurements >10% of their OELs, but <100%. Of these seven COPCs, only ammonia, showed evidence of breakthrough, above 10% of its OEL. Overviews of the cartridge test results for these COPCs are provided below:

- Maximum ammonia concentrations at the respirator cartridge inlet to the SCOTT 7422-SD1 and SCOTT 7422-SC1 cartridges were 817% and 943% of the OEL, respectively. These concentrations were lower than, but generally consistent with, historic maximum headspace measurements from the BY-110 tank (1704% of the OEL). Most of the cartridge outlet concentrations for ammonia exceeded 10% of its OEL. Ammonia breakthrough appeared to occur in the SCOTT 7422-SD1 cartridge, above 10% of the OEL, between 2 and 4 hours of the run time. Breakthrough of the SCOTT 7422-SC1 cartridge was evident between 0 and 2 hours of the run time. These breakthrough times are consistent with those measured in prior respirator cartridge tests for Hanford tanks, based on the inlet concentrations to the cartridges.
- Maximum furan concentrations at the inlets to the SCOTT 7422-SD1 and SCOTT 7422-SC1 cartridges were 13.3% and 168% of the OEL, respectively. These concentrations were lower than the historic maximum of 295% of the OEL. All the cartridge outlet concentrations for furan were below the RL, indicating that no breakthrough occurred.

[20] OELs accepted for Hanford tank farm use are based on OELs established by a U.S. governmental agency or national professional organization (e.g., OSHA, National Institute for Occupational Safety and Health, American Conference of Governmental Industrial Hygienists), or if no U.S. OEL exists, standard toxicological practices are applied to develop OELs based on the best available science. The OEL for NDMA was established in 2005 based on the MAK (Maximale Arbeitsplatzkonzentration) Commission standard adopted in Europe.

- Three nitrosamines—NDMA, NDEA, and NMEA—had cartridge inlet concentrations for the SCOTT 7422-SD1 and SCOTT 7422-SC1 cartridges well in excess of 100% of their corresponding OELs (392 to 1874% for NDMA, <10.3 to 150% for NDEA, and 108 to 252% for NMEA). These concentrations were significantly higher than historic maximums that were <40% of their OELs. Numerous quality flags associated with the cartridge inlet concentrations indicate that many of the inlet values are estimates only. Regardless, all measured outlet concentrations for the three nitrosamines were less than the analytical DLs or RLs, indicating no breakthrough for either cartridge. A single elevated outlet concentration (8.6% of the OEL) for the 16-hour NDMA sample from the SCOTT 7422-SD1 cartridge was quality flagged with a high spike recovery, and NDMA was not detected upon confirmatory analysis.
- Maximum 2,5-dihydrofuran concentrations at the inlets to the SCOTT 7422-SD1 and SCOTT 7422-SC1 cartridges were less than the DL (23.4% of the OEL). These concentrations were significantly lower than the historical maximum measurements (457% of the OEL). Two outlet concentrations for the 7422-SD1 cartridge were slightly above 40% of the OEL for 2,5-dihydrofuran (2- and 14-hour samples) but all other inlet and outlet concentrations for both cartridges were at or below the DL, suggesting that the two high outlet values were suspect. Analytical quality flags indicated that the two elevated outlet concentrations were estimates only. Therefore, no evidence of breakthrough was observed in the data.
- Maximum 2-methylfuran concentrations at the inlets to the SCOTT 7422-SD1 and SCOTT 7422-SC1 cartridges were less than the RL (8.7% of the OEL) and 10.6% of the OEL, respectively. The only inlet concentration above the RL for the 7422-SC1 cartridge had a data-quality flag indicating it was an estimate only. The maximum historic concentration for 2-methylfuran was less than the RL and generally consistent with cartridge test maxima. All measured outlet concentrations were less than the analytical DL of approximately 8.8% of the OEL, indicating no breakthrough for either cartridge.

The *Overview of 2016 through 2018 Testing of Air-Purifying Respirator Cartridge Performance on Multiple Hanford Tank Headspaces and Exhausters* provides additional information on the use of the cartridge testing results for the first 28 cartridge tests with the manufacturers service life models.[25]

7.2 PAPR Cartridge Testing

Based on measured PAPR cartridge inlet vapor concentrations from the BY-108 headspace, four COPCs—ammonia, furan, NDMA, and NMEA—exceeded their corresponding OELs. Three COPCs—mercury, 2-methylfuran, and NDEA—had one or more inlet concentration measurements >10% of their respective OELs and greater than their analytical DLs or RLs, but <100% of the OELs. All other COPC inlet and outlet measurements did not exceed 10% of their OELs or exceed their RLs. Of the seven COPCs with higher inlet concentrations, only ammonia, showed clear evidence of breakthrough, above 10% of the OEL. Overviews of the cartridge test results for these COPCs are provided below:

- Maximum ammonia concentrations at the respirator cartridge inlet to the MSA TL and 3M FR-57 cartridges were 767% and 586% of the OEL, respectively. These concentrations were about 2 to 3× lower than historic maximum headspace measurements from the BY-110 tank (1764% [2016] to 2576% [2009] of the OEL). Ammonia breakthrough appeared to occur in the MSA TL cartridge, above 10% of the OEL between 4 and 6 hours of the run time. Breakthrough of the 3M FR-57 cartridge, above 10% of the OEL, occurred less than 2 hours into the run. These breakthrough times are consistent with those measured in prior respirator cartridge tests for Hanford tanks, based on the inlet concentrations to the cartridges.

- Maximum furan concentrations at the inlets to the MSA TL and 3M FR-57 cartridges were 576% and 396% of the OEL, respectively. These concentrations were substantially lower than the historic maximum recorded in 1994 (57,600% of the OEL), but only 3× lower than recent 2016 sampling (1840% of the OEL). All the cartridge outlet concentrations for furan were below the DL of approximately 13.9% of the OEL, indicating that no breakthrough occurred.
- Two nitrosamines—NDMA and NMEA—had cartridge inlet concentrations for the MSA TL and 3M FR-57 cartridges in excess of 100% of their corresponding OELs (167 to 721% for NDMA and less than the RL to 188% for NMEA). The historic maximum headspace concentration of NDMA in vapors from BY-108 was approximately 3× higher (2063% of the OEL) than the cartridge maximum, whereas the historic maximum for NMEA was less than the RL. Numerous analytical quality flags associated with the cartridge inlet concentrations indicate that many of the inlet values are estimates only. Regardless, all measured outlet concentrations for the three nitrosamines were less than the analytical DL or RL, indicating no breakthrough for either cartridge.
- Maximum mercury concentrations at the inlets to the MSA TL and 3M FR-57 cartridges were 27.3% and 21.5% of the OEL, respectively. These concentrations were approximately 3× lower than the historical maximum concentrations (68% of the OEL). All the cartridge outlet concentrations for mercury were below the RL, indicating that no breakthrough occurred.
- Maximum 2-methylfuran concentrations at the inlets to the MSA TL and 3M FR-57 cartridges were 16.1% and 16.6% of the OEL, respectively. The maximum historic headspace concentrations for 2-methylfuran were less than the RL, but with a high RL quantitation limit (<4840% of the OEL) making comparison to current inlet concentrations inconclusive. All measured outlet concentrations were less than the analytical DL of approximately 9.1% of the OEL, indicating no breakthrough for either cartridge.
- Maximum NDEA concentrations at the inlets to the MSA TL and 3M FR-57 cartridges were less than analytical DL and 13.1% of the OEL, respectively. The maximum historic headspace concentration for NDEA greater than the RL was 8.1% of the OEL, which is generally consistent with cartridge inlet maximum. All measured outlet concentrations were less than the analytical RL of approximately 10.6% of the OEL, indicating no breakthrough for either cartridge.

The Overview of 2017 Through 2018 Testing of Powered Air-Purifying (PAPR) Respirator Cartridge Performance on Multiple Hanford Tank Headspaces and Exhausters[21] provides additional information on the use of the cartridge testing results for the first 10 PAPR cartridge tests with the manufacturers service life models and estimating methodologies.

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[21] J Liu, C Clayton, LA Mahoney, MJ Minette, SK Nune, C Clayton, CL Bottenus, CJ Freeman, and TM Brouns. 2020. *Overview of 2017 Through 2018 Testing of Powered Air-Purifying (PAPR) Respirator Cartridge Performance on Multiple Hanford Tank Headspaces and Exhausters*. PNNL-29416 Revision 0, Pacific Northwest National Laboratory, Richland, Washington.

8.0 Recommendations

Based on the measurements in this study only ammonia exhibited breakthrough above 10% of its OEL. This is consistent with prior tank vapors testing where ammonia breakthrough appears to precede breakthrough of other COPCs. As a result, it is recommended that ammonia continue to be considered as the leading breakthrough indicator for the SCOTT 7422-SD1 and SCOTT 7422-SC1 APR cartridges. Further, data being accumulated for the MSA TL and 3M FR-57 PAPR cartridges are indicating the propensity for ammonia to be a leading indicator of breakthrough in those cartridges as well.

Based on cartridge performance studies to date on Hanford tank vapor sources, vendor cartridge performance calculators appear to be representative for ammonia, despite being used in a mixed vapor stream. The ammonia estimates based on the maximum inlet concentration for the current study were consistent for the SCOTT 7422-SD1 and SCOTT 7422-SC1 cartridges—3.5 and 2.4 hours, respectively, versus the observed times of 2 to 4 hours and 0 to 2 hours (see Appendix G). We suspect the slightly longer estimated service life for the SC1 cartridge is due to variability in the inlet concentration. Similarly, the ammonia estimations based on the maximum inlet concentration for the MSA TL and 3M FR-57 PAPR cartridges in this study were 2.2 and 0.9 hours, respectively, versus the observed times of 4 to 6 hours and 0 to 2 hours, respectively.

Variations in humidity, temperature, or cartridge inlet concentration for any COPCs, especially ammonia, compared to those measured in the current study could impact breakthrough times. Still, for the BY-108 PAPR and the BY-110 APR testing, the estimations continue to give confidence in the use of ammonia service-life estimates for informing Industrial Hygiene experts in developing an appropriate respirator cartridge change-out schedule for adequate worker protection.

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Appendix A

Description of Respirator Cartridge-Testing Setup

Appendix A

Description of Respirator Cartridge-Testing Setup

The respirator cartridge-testing system was developed by Washington River Protection Solutions and HiLine Engineering (Richland, Washington) as a means to comprehensively test respirator cartridge performance with actual Hanford tank headspace or exhauster slipstream gases. Tank headspace or exhauster slipstream vapors are pulled directly from the source through a flexible hose connecting the tank or exhauster sampling port within the tank farm/exhauster fence line to the respirator cartridge-testing system outside the farm.[13,14, 16-25] Multiple in-line particulate filters are installed in the line between the tank/exhauster and test system to remove potential radioactive particulates. Each filter unit contains a hydrophobic Fluoropore™ polytetrafluoroethylene filter (Millipore Sigma, Billerica, Massachusetts) that complies with the terms of the radiological work permit. This filter medium is the same material used for routine tank vapor area monitoring as well as sampling and analysis of sources (headspace and exhausters). It was selected because of its broad chemical compatibility that minimizes sorption of, or reactions with, chemical compounds. Polytetrafluoroethylene as the filter medium is not expected to adversely impact the test objectives because all tank farm vapor-sampling efforts use this type of filter medium.

The test equipment allows for sampling a vapor stream both before and after the cartridge, so their effectiveness in removing a given COPC can be quantified. Sorbent media tubes were used to capture the COPCs and other hazardous contaminants. After a given test segment, the sorbent tubes were removed and analyzed. Sampling of the exhaust gas was performed every 2 hours, but this timing can be modified as necessary. Vapor-sampling canisters also are used to augment the sorbent tubes for specific COPCs.

Figure A.1 is a general schematic diagram for the respirator cartridge test apparatus, and Figure A.2 shows photographs of the two test stands that have been deployed for APR and PAPR cartridge testing. For the PAPR tests, the following modifications were made to the original APR test stand design:

- The cartridge housing was enlarged, and the mounting was modified to support the larger PAPR cartridge.
- An additional sampling line and control valve was added to accommodate 12 simultaneous inlet and outlet sorbent tubes versus the 11 sorbent tubes used in the original APR test stand. The additional sampling line provides added flexibility, including accommodation of a methanol-specific sorbent tube.
- To measure effluent conditions, another set of instruments was added to directly measure pressure, temperature, and relative humidity immediately after the cartridge filter.

Both test systems use vacuum to draw tank gases/vapors into the unit so the potential for leakage to atmosphere is minimized until the gases/vapors are under positive pressure downstream of the vacuum pumps. By the time gases reach the vacuum pump, COPCs are essentially captured or removed by either the sorbent tubes or the respirator cartridge.[16-25]

Flows through the respirator cartridge and through each sorbent tube are set and controlled/maintained using manual flow control valves on the outlet of each rotameter, and rotameters are calibrated against DryCal primary flow calibrators before and after testing. DryCal flow meters also are used downstream of the sorbent tubes to measure the flow through each sorbent tube (see Figure A.3). All equipment connections are leak tested before a test begins. Temperature, relative humidity, and pressure of the inlet gas/vapor stream are monitored by calibrated instrumentation.

Using Industrial Hygiene-approved materials, the cartridge test equipment was constructed so that it would not influence/interfere with vapor analysis. Stainless steel or Teflon™ tubing and fittings are used where possible because of their relatively inert nature to the vapors being analyzed. Limited portions of the assembly used acrylic, Viton™, glass, and Masterflex C-flex tubing, which are commonly used materials for various vapor-sampling applications.

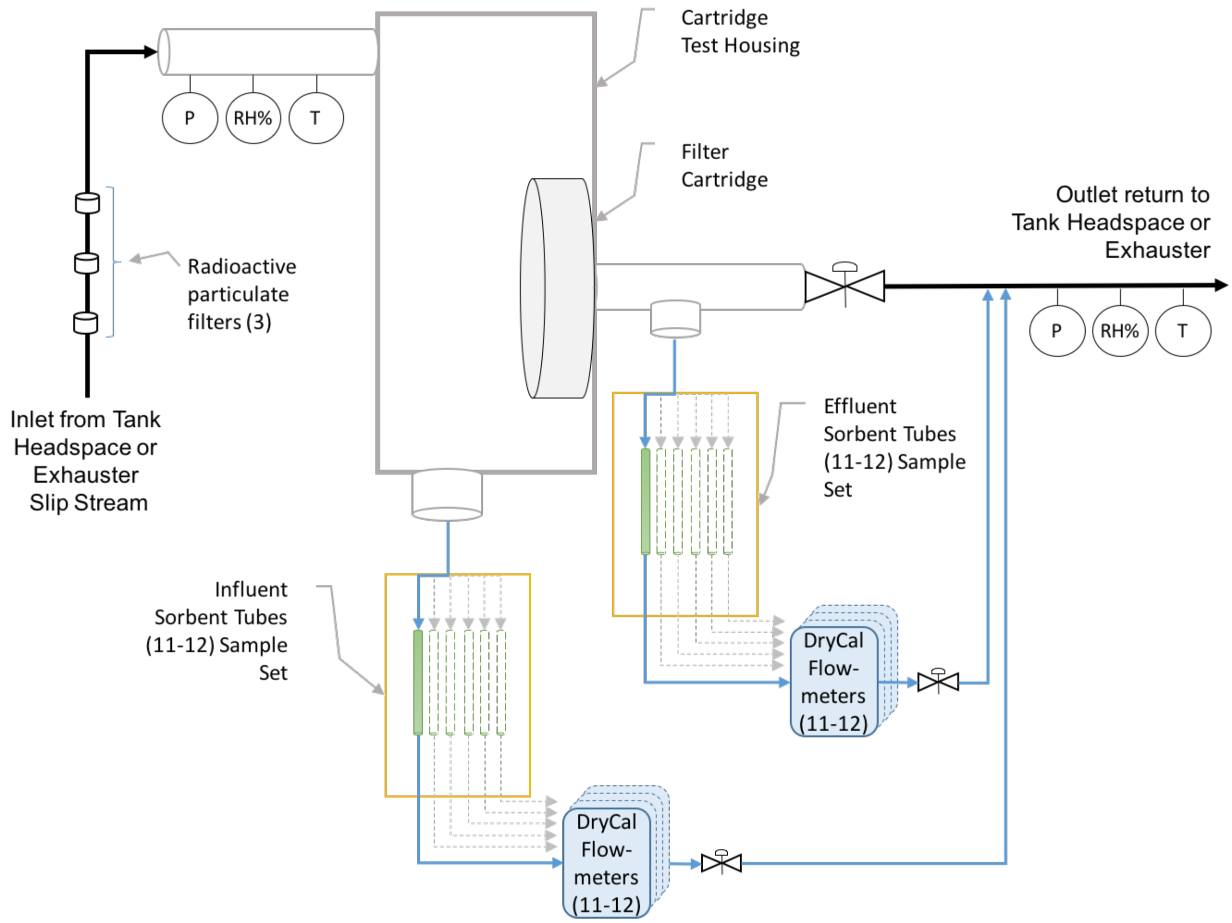


Figure A.1. General Schematic of Respirator Cartridge Test Apparatus

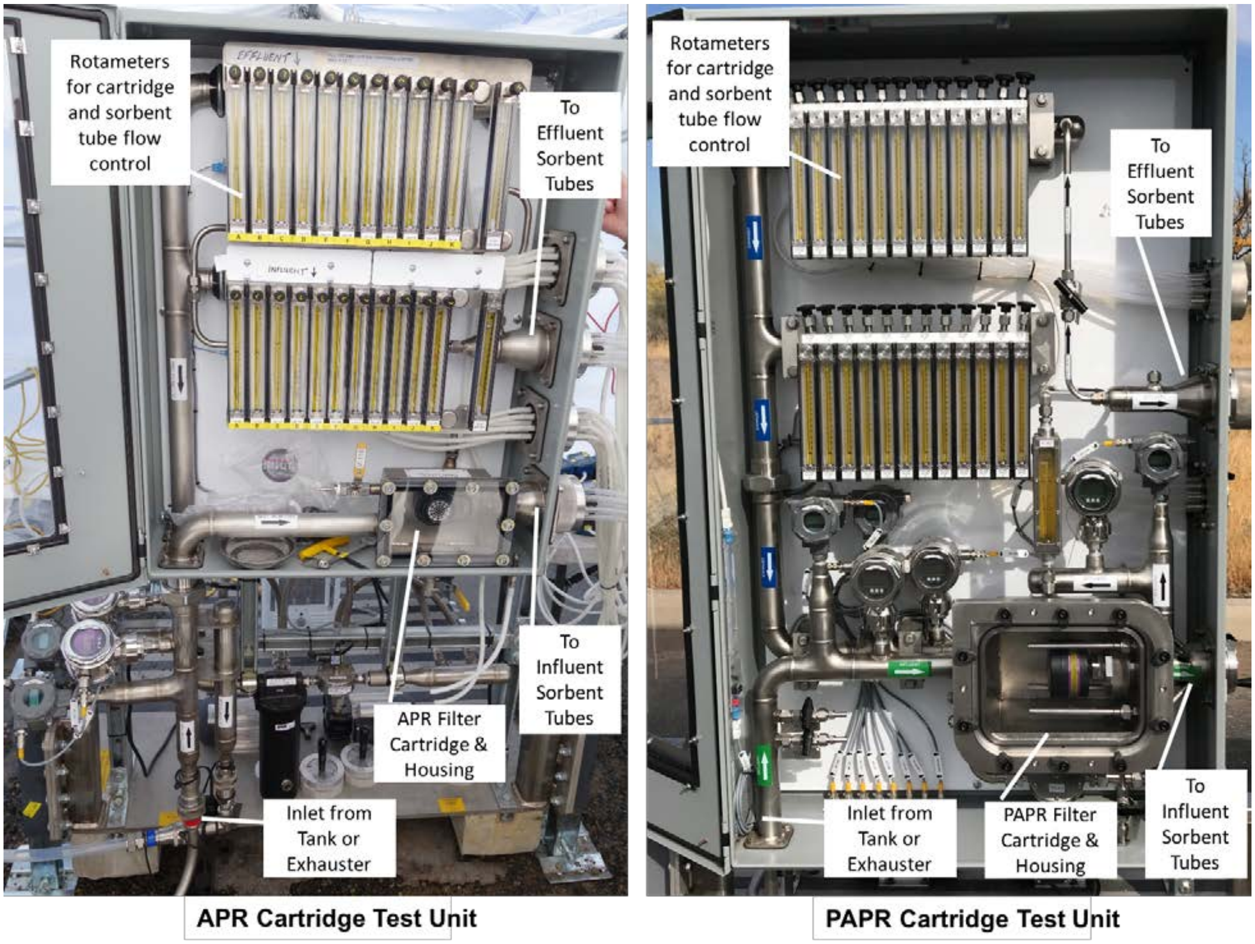


Figure A.2. Photographs of the APR (left) and PAPR (right) Cartridge Test Equipment

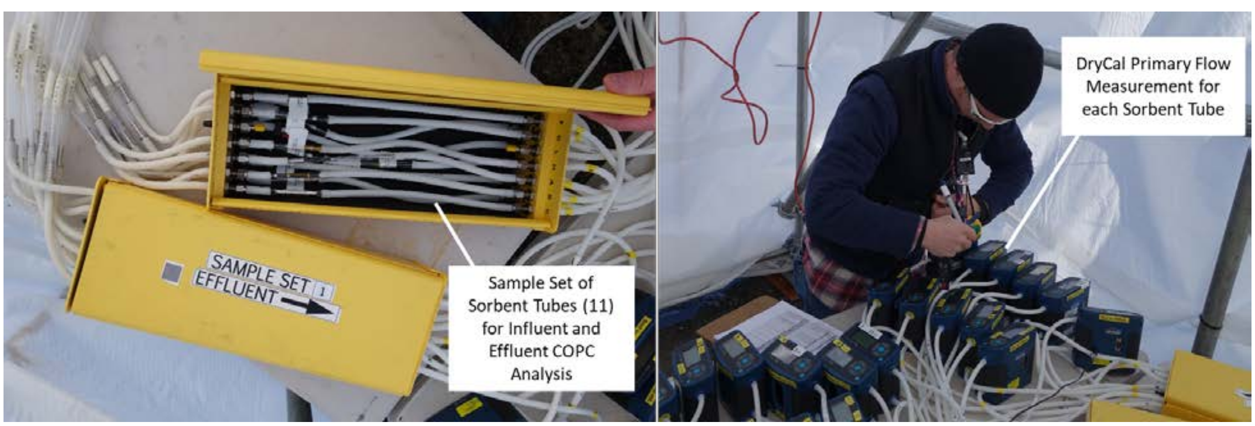


Figure A.3. Photographs of the Sorbent Tube Sampling Test Equipment

Appendix B

Analytical Testing

Appendix B

Analytical Testing

The Sampling and Analysis Plan was developed under the direction and oversight of the Industrial Hygienist in conjunction with the Tank Farms Operations Contractor Retrieval and Closure, and Tank Farms Project and/or Production Operations Project Management Team.

Chemical compounds in the tank samples were analyzed using approved Industrial Hygiene methods or methods approved by the National Institute of Occupational Safety and Health for quantifying hazardous airborne contaminants in the tank farm vapors. Methods including gas chromatography/ mass spectrometry were used as the primary analytical techniques for identifying hazardous airborne contaminants (see Table B.1).

Table B.1. Information on Sorbent Media used to Capture Contaminants, Flow Rates Used, Methods used to Extract Analyte from Sorbent Media, and Methods used to Quantify or Estimate the Concentrations of Hazardous Contaminant

Analyte Category	Media	Flow Rate (mL/min)	Analytical Method[a]	Instrument Used[b]	Analysis Location[c]
Acetonitrile	Charcoal Tube, SKC-226-09	100	NIOSH 1606	GC–FID	ALS
Acetonitrile	Carbotrap 300 TDU Tube	33	EPA TO-17 Modified	GC/MS	WRPS
Furans	TDU Tenax TA	50	EPA TO-17 Modified	GC/MS	WRPS
Semivolatile Organic Compounds	Carbotrap 150 TDU Tube	33	EPA TO-17 Modified	GC/MS	WRPS
Volatile Organic Compounds	Carbotrap 300 TDU tube	33	EPA TO-17 Modified	GC/MS	WRPS
Mercury	Anasorb C300, SKC-226-17-1A	250	NIOSH-6009	CVAA	WHL
Methanol	Silica Gel, SKC-226-51	33	NIOSH-2000	GC–FID	ALS
Ammonia	Anasorb 747 (sulfuric acid), SKC-226-29	200	OSHA-ID-188	IC	WHL
1,3-butadiene	Charcoal, SKC-226-37, (Parts A and B)	200	NIOSH-1024	GC–FID	ALS
Aldehyde	DNPH Treated Silica Gel, SKC-226-119	200	EPA TO-11A	HPLC	ALS
Pyridine	Coconut Shell Charcoal, SKC-226-01	1000	NIOSH-1613	GC–FID	ALS

Analyte Category	Media	Flow Rate (mL/min)	Analytical Method[a]	Instrument Used[b]	Analysis Location[c]
Nitrosamines	Thermosorb/N	2000	NIOSH-2522 Modified	GC–TEA	CBAL
Ethylamine	XAD-7 (NBD) Chloride), SKC 226-96	100	OSHA-ID-34, 36, 40,and 41	HPLC–UV	ALS

[a] Analytical Method
NIOSH: National Institute of Occupation Safety and Health
EPA: U.S. Environmental Protection Agency
OSHA: Occupational Safety and Health Administration

[b] Instrument Used
GC–FID: Gas Chromatography–Flame Ionization Detector
GC/MS: Gas Chromatography–Mass Spectrometry
CVAA: Cold Vapor Atomic Absorption
IC: Ion Chromatography
HPLC: High Performance Liquid Chromatography
GC–TEA: Gas Chromatography–Thermal Energy Analyzer
HPLC–UV: High Performance Liquid Chromatography–Ultraviolet Detector

[c] Analysis Location
ALS: ALS Environmental Salt Lake City
WRPS-222S: Washington River Protection Solutions, Organic Studies Group
WHL-222S: Wastren Hanford Laboratory
CBAL: Columbia Basin Analytical Laboratory, part of the RJ Lee Group

Appendix C

Raw Analytical Data

Appendix C

Raw Analytical Data

In previously published cartridge reports, raw data for all contaminants analyzed during testing were provided in Appendix C to the document. However, the extensive amount of data (over 900 pages for this report) resulted in unwieldy document file sizes. To solve this problem, the raw data are provided in a separate Volume 2. Appendix C in this document (Volume 1) still provides introductory information regarding the content of Volume 2, but to review the complete raw data set, readers are referred to Volume 2.

C.1 Description

This appendix includes raw data of flow rate, temperature, pressure, and humidity, as well as analytical data for the BY-108 and BY-110 tank headspaces. Calculations using these data are given in Appendix D.

Raw analytical data are included only in Volume 2. Washington River Protection Solutions (WRPS) converted the data into Excel data spreadsheets that were transmitted to Pacific Northwest National Laboratory. Comments on that conversion are provided below.

The analytical measurements listed in Results spreadsheet columns were transferred from entries labeled 'result' in the raw analytical .pdf files. Where a results entry was given as 'ND' in the .pdf, a '<' symbol was used. Where a detection limit (DL)/reporting limit (RL) was listed as 'n/a,' the result entry in the spreadsheet was set at the DL or RL.

The use of the RL or a DL varied among analytical laboratories. The term RL (equivalent to a limit of quantification) was used instead of a DL by ALS Environmental Salt Lake City, Columbia Basin Analytical Laboratory, and 222S–Wastren Hanford Laboratory (see Tables F.1 and F.2 in Appendix F for a complete correlation of which Chemicals of Potential Concern used an RL or a DL). The WRPS laboratory provided a DL rather an RL. Neither RLs nor DLs were provided for Tentatively Identified Compounds (TIC).

Chain of custody information is provided clearly in the raw analytical data .pdf files, including analyte name, sample numbers, and laboratory-assigned numbers. Chemical Abstract Service numbers were provided by the respective analytical laboratory.

The nomenclature of the sample identification (ID) is the same for every set of chemicals. It is generally composed of a survey number, tank farm ID, test location, sample line, and tube bundle ID. Descriptions of these nomenclatures follows

'BL' means blank measurements obtained from sorbent tubes that have not had any vapor stream passed through them. 'BA' with either 'IN' or 'EF' means measurements obtained for ambient air (i.e., fresh air rather than tank vapor) running through the test system from the inlet (IN) or effluent (EF) locations before initiation of tank vapor testing.

'SD1' designations correspond to testing with the SCOTT 7422-SD1 respirator cartridge, 'SC1' designations correspond to testing with the SCOTT 7422-SC1 respirator cartridge, 'TL1' designations correspond to testing with the MSA Optifilter TL respirator cartridge, and 'TL2' designations correspond to testing with the 3M FR-57 respirator cartridge. The unique survey number also is assigned, identifying the year and a five-digit ID for each of the cartridges tested. For the tank BY-108 headspace, the survey IDs included 18-01496 for TL1 and 18-01497 for TL2. For the tank BY-110 headspace, the survey IDs included 18-01494 for SD1 and 18-01495 for SC1.

Position designations ‘IN’ with ‘1’ and ‘EF’ with ‘1’ correspond to the respirator cartridge inlet and outlet measurements, respectively, at 0- to 2-hour time intervals. Position designations ‘2’ through ‘8’ correspond to the subsequent 2-hour measurements for inlet (IN) and outlet (EF): ‘2’ (2 to 4 hours), ‘3’ (4 to 6 hours), ‘4’ (6 to 8 hours), ‘5’ (8 to 10 hours), ‘6’ (10 to 12 hours), ‘7’ (12 to 14 hours), and ‘8’ (14 to 16 hours).

The sample IDs embed the information given above. For example, sample ID 18-01497-8-TL2-IN-1 corresponds to a particular cartridge survey (18-01497) identified as the 3M FR-57 cartridge with the (TL2), sample media line 8, influent (IN) sample bundle, and the first (0 to 2 hours) sample (1).

The target flow rate passing through the respirator cartridge was 30 L/min for the APR tests, and 95 L/min for the powered air-purifying respirator (PAPR) tests. The target sampling flow rates through the sorption tubes ranged between 30 and 2000 mL/min for different chemicals that were being collected. WRPS provided these flow rates as Excel files according to Table C.1.

Table C.1. Filenames of Sample Media Volumes Provided by WRPS

Tank	Cartridge	Filename
BY-110 Headspace	SCOTT 7422-SC1	BY 110 SC-1 2_24_18.xlsx
BY-110 Headspace	SCOTT 7422-SD1	BY 110 SD-1 2_23_18.xlsx
BY-108 Headspace	MSA TL	BY 108 TL 2_23_18.xlsx
BY-108 Headspace	3M FR-57	BY 108 3M FR-57 2_24_18.xlsx

WRPS provided the temperature and humidity information in files listed in Table C.2.

Table C.2. Files Containing Temperature, Pressure, Relative Humidity, and DRI Data

Tank	Cartridge	Filename
BY-110 Headspace	SCOTT 7422-SC1	BY-110 SC1 2-24-18.xlsx
BY-110 Headspace	SCOTT 7422-SD1	BY-110 SD1 2-23-18.xlsx
BY-108 Headspace	MSA TL	BY-108 TL1 GME 2-23-18.xlsx
BY-108 Headspace	3M FR-57	BY-108 TL2 FR57 2-24-18.xlsx

The information is shown in the Section C.3. Several terms used in the DRI files are described below.

- ‘Pre’ and ‘Post’ indicate the general time signature when the direct read instrument measurements were taken. ‘Pre’ refers to the beginning of the 2-hour sample duration, and ‘Post’ refers to the end of the 2-hour sample duration.
- ‘Influent’ and ‘Effluent’ indicate the location of the measurement within the test system. ‘Influent’ measurements are taken at the inlet of the system upstream of the respirator cartridge. ‘Effluent’ measurements are taken downstream of the respirator cartridge. The pressure, temperature, and humidity effluent sensors are located at the end of the test system near the vacuum pump, whereas the DRI measurements for ammonia and volatile organic compounds (VOC) are taken from a sampling location between the respirator cartridge and the effluent sorbent tube samples.

- The DRI measurements for ammonia and VOCs could not be taken while the test system sample pumps were operational. “After Sample Taken” refers to the time signature for these direct read results (e.g., Sample A DRI measurements were taken immediately after the Sample A sorbent tubes were taken and replaced with Sample B sorbent tubes).
- Columns labeled “Mach. Base 1” and “Mach. Base 2” refer to the ‘BASE’ baseline samples for influent and effluent, respectively, to verify machine cleanliness prior to experimental measurements.

The raw analytical data for chemicals in each analyte category are summarized in Section C.4. Some analytes are measured using more than one method (primary and secondary). A crosswalk of COPC to analyte category, media, and analytical method for both primary and secondary methods is provided in Table C.3. In general, the primary method was used for cartridge performance analysis except in cases for which the secondary method provides improved quantitation for the specific COPC and its concentration range during a specific test.

C.2 Miscellaneous Notes

All analytical flags assigned by each analytical laboratory are provided in Appendix D. Sample lines occasionally experienced flow control issues, and these instances are documented in Appendix D with a quality flag of ‘S*’ associated with the impacted data point.

Methanol was measured in the PAPR test rig only. A thirteenth sample media line was added to the newer PAPR test rig so methanol could be measured using a dedicated sorption tube.

C.3 Experimental Parameters

See PNNL-28334 Volume 2.

C.4 Raw Data

See PNNL-28334 Volume 2.

Table C.3. Crosswalk of COPCs with Primary and Secondary Analyte Category, Media, and Analytical Method

COPC#	Analyte Name	Primary Analysis Method (Analyte Category ǀ Media ǀ Method)	Secondary Analysis Method (Analyte Category ǀ Media ǀ Method)
1	Ammonia	Ammonia ǀ Anasorb 747 ǀ OSHA-ID-188	
2	Nitrous Oxide	Not Measured	
3	Mercury	Mercury ǀ Anasorb C300 ǀ NIOSH-6009	
4	1,3-Butadiene	1,3-butadiene ǀ Charcoal ǀ NIOSH 1024	
5	Benzene	VOC ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
6	Biphenyl	SVOC ǀ Carbotrap 150 ǀ EPA TO-17 Mod	
7	1-Butanol	VOC ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
8	Methanol	Methanol ǀ Silica Gel ǀ NIOSH 2000	
9	2-Hexanone	VOC ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
10	3-Methyl-3-butene-2-one	VOCTIC[a] ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
11	4-Methyl-2-hexanone	VOC ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
12	6-Methyl-2-heptanone	VOCTIC[a] ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
13	3-Buten-2-one	VOC ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
14	Formaldehyde	Aldehyde ǀ DNPH Treated Silica Gel ǀ EPA TO-11A	
15	Acetaldehyde	Aldehyde ǀ DNPH Treated Silica Gel ǀ EPA TO-11A	
16	Butanal/Butyraldehyde	VOC ǀ Carbotrap 300 ǀ EPA TO-17 Mod	Aldehyde ǀ DNPH Treated Silica Gel ǀ EPA TO-11A
17	2-Methyl-2-butenal	VOCTIC[a] ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
18	2-Ethyl-hex-2-enal	VOCTIC[a] ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
New	2-Propenal/Acrolein	Aldehyde ǀ DNPH Treated Silica Gel ǀ EPA TO-11A	
19	Furan[b]	VOC ǀ Carbotrap 300ǀ EPA TO-17 Mod	Furans ǀ Tenax TA ǀ EPA TO-17 Mod
20	2,3-Dihydrofuran	Furans ǀ Tenax TA ǀ EPA TO-17 Mod	
21	2,5-Dihydrofuran[b]	VOC ǀ Carbotrap 300ǀ EPA TO-17 Mod	Furans ǀ Tenax TA ǀ EPA TO-17 Mod
22	2-Methylfuran[b]	VOC ǀ Carbotrap 300ǀ EPA TO-17 Mod	Furans ǀ Tenax TA ǀ EPA TO-17 Mod
23	2,5-Dimethylfuran	Furans ǀ Tenax TA ǀ EPA TO-17 Mod	
24	2-Ethyl-5-methylfuran	VOCTIC[a] ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
25	4-(1-Methylpropyl)-2,3-dihydrofuran	VOCTIC[a] ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
26	3-(1,1-Dimethylethyl)-2,3-dihydrofuran	VOCTIC[a] ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
27	2-Pentylfuran	Furans ǀ Tenax TA ǀ EPA TO-17 Mod	
28	2-Heptylfuran	Furans ǀ Tenax TA ǀ EPA TO-17 Mod	
29	2-Propylfuran	Furans ǀ Tenax TA ǀ EPA TO-17 Mod	
30	2-Octylfuran	VOCTIC[a] ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
31	2-(3-Oxo-3-phenylprop-1-enyl)furan	VOCTIC[a] ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
32	2-(2-Methyl-6-oxoheptyl) furan	VOCTIC[a] ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
33	Diethylphthalate	SVOC ǀ Carbotrap 150 ǀ EPA TO-17 Mod	
34	Acetonitrile	VOC ǀ Carbotrap 300 ǀ EPA TO-17 Mod	Acetonitrile ǀ Charcoal ǀ NIOSH 1606
35	Propanenitrile	VOC ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
36	Butanenitrile	VOC ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
37	Pentanenitrile	VOC ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
38	Hexanenitrile	VOC ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
39	Heptanenitrile	VOCTIC[a] ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
40	2-Methylene butanenitrile	VOCTIC[a] ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
41	2,4-Pentadienenitrile	VOCTIC[a] ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
42	Ethylamine	Ethylamine ǀ XAD-7 ǀ OSHA-ID-34,36,40,41	
43	N-nitrosodimethylamine	Nitrosamines ǀ Thermasorb/N ǀ NIOSH-2522 Mod	
44	N-nitrosodiethylamine	Nitrosamines ǀ Thermasorb/N ǀ NIOSH-2522 Mod	
45	N-nitrosomethylethylamine	Nitrosamines ǀ Thermasorb/N ǀ NIOSH-2522 Mod	
46	N-nitrosomorpholine	Nitrosamines ǀ Thermasorb/N ǀ	

COPC#	Analyte Name	Primary Analysis Method (Analyte Category ǀ Media ǀ Method)	Secondary Analysis Method (Analyte Category ǀ Media ǀ Method)
		NIOSH-2522 Mod	
47	Tributyl phosphate	SVOC ǀ Carbotrap 150 ǀ EPA TO-17 Mod	
48	Dibutyl butylphosphonate	SVOC ǀ Carbotrap 150 ǀ EPA TO-17 Mod	
49	Chlorinated Biphenyls	VOCTIC[a] ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
50	2-Fluoropropene	VOCTIC[a] ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
51	Pyridine	VOC ǀ Carbotrap 300 ǀ EPA TO-17 Mod	Pyridines ǀ Coconut Shell Charcoal ǀ NIOSH-1613
52	2,4-Dimethylpyridine	VOC ǀ Carbotrap 300 ǀ EPA TO-17 Mod	Pyridines ǀ Coconut Shell Charcoal ǀ NIOSH-1613
53	Methyl nitrite	VOCTIC[a] ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
54	Butyl nitrite	VOCTIC[a] ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
55	Butyl nitrate	VOC ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
56	1,4-Butanediol, dinitrate	VOCTIC[a] ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
57	2-Nitro-2-methylpropane	VOCTIC ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
58	1,2,3-Propanetriol, 1,3-dinitrate	VOCTIC[a] ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
59	Methyl Isocyanate	VOCTIC[a] ǀ Carbotrap 300 ǀ EPA TO-17 Mod	
New	Dimethyl Mercury	Not Measured	

[a] A TIC designation indicates that a mass spectrometry "peak" not associated with calibrated compounds has been tentatively assigned to a compound based on an adequate match to the analytical methods reference library. Reference standards for the compound are not available to accurately quantify, assign an analytical DL, or definitively confirm the identity of the TIC. TICs are reported when the peak area is sufficiently large, estimated as ≥5 nanograms of TIC mass, and other analytical criteria are met. For the respirator cartridge testing, this mass of TIC represents an approximate concentration of <1.0 ppb, based on the average of all TICs in the COPC list. TIC compounds are measured through both the Carbotrap 300: EPA TO-17 and Carbotrap 150: EPA TO-17 modified methods. A few compounds are measured in the TIC analysis and another analytical technique. In these cases, the TIC analysis results were not retained because they are qualitative only and inferior to the other calibrated method.

[b] Furan, 2,5-dihydrofuran, and 2-methylfuran are quantified using the Carbotrap 300 TDU method, as the original primary method (Furans) was determined to perform inadequately for these lower-boiling-point furan compounds.

Appendix D

Data Reduction Steps

Appendix D

Data Reduction Steps

D.1 Test Data Processing

1. Only chemicals in the current Chemicals of Potential Concern (COPC) list were included in the calculated data (Tables D.1 and D.2). Nitrous oxide and dimethyl mercury were not measured in the study, while methanol was measured only on the powered air-purifying respirator (PAPR) test apparatus. Any other missing COPCs were analyzed as "Tentatively Identified Compounds" (TIC).
2. The COPCs are ranked in the order of their COPC number. Within the data section for each COPC, data are sorted by cartridge (SD1 followed by SC1, MSA TL followed by 3M FR-57).[22] Within every survey, data are ranked in the order of inlet and outlet and following the time sequence. Within every survey, data are ranked in the order of inlet (IN) and outlet (EF) and following the time sequence (A though H indicate 2-hour intervals that end at 2 through 16 hours).
3. COPC concentrations were calculated as parts per million (ppm) using their molecular weights and corresponding reported standard volume using the following equation:

$$C = 24.14\frac{r}{M\,V}$$

   where C is the concentration of COPC in ppmv; r is the analytical result with units of µg/sample; V is the volume of sample gas passed through the given media tube in liters; M is the species molecular weight in g/mol. When the ratio between concentration and the corresponding Occupational Exposure Limit (OEL) is larger than 10%, the result is displayed in red font. COPC-specific reported concentrations are provided in identical units to the COPC-specific OELs. For select compounds, this required conversions from ppm_v to either ppb_v, mg/m^3, or $\mu g/m^3$.
4. The reported volume measurements in Appendix C were made using DryCal devices placed downstream of each sample media tube. This allowed for precise volume measurements through each of the tubes. The DryCal devices were set to convert the measured values to standard flow conditions. The standard flow conditions are user-defined at 70°F and 1 atm pressure.
5. The analytical detection limit (DL)—or reporting limit (RL) in some cases—for every COPC was obtained from the analytical data. Here, the average flow rate was used to calculate the approximate analytical DL as the percentage of the OEL for each COPC. Because the flow rates vary, the calculated concentrations were different for each point, even though some of the results are less than the DL in the original reading. The last columns in Tables D.1 and D.2 indicate if the original readings were less than the DL or not.
   - For ammonia and mercury, only the results obtained from the total vapors of ammonia and mercury were used.

[22] The position numbers that start with SD1 are for the SCOTT 7422-SD1 model of cartridge, and the position numbers that start with SC1 are for the SCOTT 7422-SC1 model of cartridge. The position numbers that start with TL1 are for the MSA TL model of cartridge, and the position numbers that start with TL2 are for 3M FR-57 model of cartridge.

- For furan, 2,5-dihydrofuran, and 2-methylfuran, results from the Carbotrap 300 TDU tube were used rather than results from the furan analyte tube. For acetonitrile, results from the Carbotrap 300 TDU tube were used. For butanal, results from the Carbotrap 300 TDU tube instead of the aldehydes tube were used. For 2,4-dimethylpyridine and pyridine, results from the Carbotrap 300 TDU tube were used.
- For N-nitrosodimethylamine and other nitrosamines, data values above analytical DLs for the same time and position were added together because the original sample was diluted into three samples for measurements. This same rule applies to 1,3-butadiene. The results in the plots and tables reflect the sum of results.

6. Analytical results frequently have data qualifier flags documented for specific sample analyses. Depending on the data qualifier, specific data may be considered for deletion or removal from the analysis, or results described with appropriate clarifying language to indicate whether there are possible limitations to the data. Flags identified below were found to be associated with at least one of the COPC compounds analyzed through this effort. Here, key qualifier codes are given, along with their definitions and how they are being handled with the cartridge-testing analysis. The list does not include all flags that the analytical team may assign, but it does include the flags associated with the data set compiled within this report. In addition, specific samples were identified at the time of sampling as potentially suspect by the test operator due to potential sample volume or sample tube media issues. These samples have been flagged with a project-specific qualifier code in the data set.

Action	Flag	Flag Description
Retain (Result is treated in the analysis as a valid data point)	J	The "J" flag is applied to results that are considered estimates. Some examples of when a "J" flag are applied include (but are not limited to): • *Results with concentrations* <u>*greater than or equal to the method DL*</u> *but less than the RL. When results are reported based on the RL, the "J" is removed from the reported data.* • *Unknown constituents—Tentatively Identified Compounds or positively identified compounds.*
	E	The "E" flag is applied to each analyte that exceeded the calibration range of the instrument.
	U	The "U" flag is applied to analytes that were analyzed for, but were not detected, or were detected below the method DL. If results are reported based on RL, this flag is removed from the reported data.
	N	The "N" flag is applied to compounds identified based on MS Library search. TICs (or PICs) are not target compounds and are only an estimate and not quantitative.
	T	The "T" flag is applied to TIC compounds identified by MS Library search or identified as unknowns after an MS library search. The results are only estimates.
	H	The "H" flag is applied to all analytes in a sample where the holding time from the end of sampling to the beginning of sample analysis has been exceeded.
	D	The "D" flag is applied to all analytes in a sample that were diluted prior to analysis.

<table>
<tr><td rowspan="7">Retain/Evaluate (Result is treated in the analysis as a valid data point, but evaluated on a case-by-case basis to determine whether clarification is needed in the analysis report to document the uncertainty or potential limitations of the data)</td><td>L</td><td>The “L” flag is applied to analyte results (both detected and not detected) within a sample batch that included a low-level standard with a percent recovery for that analyte that was outside the analytical method specified range.</td></tr>
<tr><td>Y</td><td>The “Y” flag is a user-defined flag and is applied to results that require written descriptions or qualifying comments. This flag is used by the chemist, PC, or other technical authority to identify data that is questionable or may be inaccurate because of interferences, sampling problems, sample collection media (e.g., tubes or summa canisters) certification failures, or instrumentation limitations.</td></tr>
<tr><td>S*</td><td>The “S*” flag is a project-specific user-defined flag applied to samples that were identified by the test operator as suspect due to potentially low sample volume/flow rate issues, or other sample tube media problems</td></tr>
<tr><td>a</td><td>The “a” flag is applied to all results (both detected and not detected) within a sample batch that included a laboratory control sample (LCS) with a percent recovery for that analyte that was outside the customer or analytical method specified range. The “a” flag is not applied based on laboratory control sample duplicates (LCSD) results.</td></tr>
<tr><td>B</td><td>The "B" flag is applied to each analyte in a batch where that analyte concentration is greater than or equal to the method detection limit (MDL) (or in the case of TDU GC/MS analysis, greater than or equal to 2× the MDL or greater than or equal to the RL, whichever is less) in the preparation blank/method blank and is greater than or equal to the reporting limit (RL) in the sample. If sample results are reported based on the MDL, then all analyte results greater than or equal to the MDL would be flagged with a “B”, provided that analyte was detected (≥MDL) in the associated blank. Samples that are “B” flagged include the blank, all field samples with the analyte present, LCS, LCSD, and low-level standards.</td></tr>
<tr><td>c</td><td>The “c” flag is applied to analyte results (both detected and not detected) within a sample batch where the relative percent difference between duplicate samples (DUP) (subsample aliquots carried through the sample preparation and analysis), LCSDs or MSDs was greater than the customer or analytical method defined range. For field samples (DUP or MSD) this flag is applied only to the samples that were duplicated or spiked. For LCSD relative percent difference failure, all samples within the batch are flagged.</td></tr>
<tr><td>Q</td><td>The “Q” flag is applied to results that are considered to be qualitative based on instrument and analyte specific calibration or calibration verification issues. The “Q” flag is applied to all samples contained within the analytical batch (i.e., field samples, LCS, LCSD, LLS, and method/preparation blank).
<table>
<tr><th></th><th><MDL</th><th>MDL≤X<RL</th><th>≥RL</th></tr>
<tr><td>% RSD failure</td><td>Q</td><td>Q</td><td>Q</td></tr>
<tr><td>ICV failure</td><td>Q</td><td>Q</td><td>Q</td></tr>
<tr><td>High CCV/%D</td><td></td><td>Q[1]</td><td>Q</td></tr>
<tr><td>Low CCV/%D</td><td>Q</td><td>Q</td><td>Q</td></tr>
<tr><td>High I.S. recovery</td><td>Q</td><td>Q</td><td>Q</td></tr>
<tr><td>Low I.S. recovery</td><td>Q</td><td>Q</td><td>Q</td></tr>
</table>
1. Q flag is not required when results are reported to the RL, rather than the MDL.</td></tr>
<tr><td>Delete (Result is seriously suspect and should be screened out and not reported)</td><td>N/A</td><td></td></tr>
</table>

D.2 Calculated Concentrations

Tables D.1 and D.2 show the calculated concentrations for each of the COPC measurements conducted in this study. Red highlighted values reflect measurements that were >10% of the respective OEL values. COPCs with these highlights are plotted and shown in Section 5.0. Orange highlighted values reflect measurements in the 2 to 10% of the OEL range. COPCs with these highlights (only) are plotted and/or discussed in Appendix E. The three elements of position (the fourth column) include the survey, inlet (IN) or outlet (EF), and the time sequence (A though H indicate 2-hour intervals corresponding to 2 through 16 hours similar to the third column). Calculated results from the primary analytical methods are listed first in each table. A red line (bar) in each table indicates the beginning of analytical results from the secondary methods, when available.

Table D.1. APR Cartridge Testing (BY-110) Calculated Data

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
1	Ammonia	2	SD1-IN-A	2.0E+02	25	817%			2.29%
1	Ammonia	4	SD1-IN-B	1.0E+02	25	412%			2.29%
1	Ammonia	6	SD1-IN-C	9.5E+01	25	381%			2.29%
1	Ammonia	8	SD1-IN-D	3.3E+01	25	130%			2.29%
1	Ammonia	10	SD1-IN-E	5.6E+01	25	223%			2.29%
1	Ammonia	12	SD1-IN-F	1.3E+02	25	510%			2.29%
1	Ammonia	14	SD1-IN-G	6.7E+01	25	270%			2.29%
1	Ammonia	16	SD1-IN-H	9.0E+01	25	360%			2.29%
1	Ammonia	2	SD1-EF-A	5.7E-01	25	2.29%	YES		2.29%
1	Ammonia	4	SD1-EF-B	6.5E+00	25	25.9%			2.29%
1	Ammonia	6	SD1-EF-C	4.8E+01	25	191%			2.29%
1	Ammonia	8	SD1-EF-D	1.1E+02	25	441%			2.29%
1	Ammonia	10	SD1-EF-E	1.7E+02	25	665%			2.29%
1	Ammonia	12	SD1-EF-F	2.2E+02	25	898%			2.29%
1	Ammonia	14	SD1-EF-G	5.7E-01	25	2.26%	YES		2.29%
1	Ammonia	16	SD1-EF-H	2.6E+02	25	1043%			2.29%
1	Ammonia	2	SC1-IN-A	2.8E+01	25	112%			2.29%
1	Ammonia	4	SC1-IN-B	2.3E+02	25	928%			2.29%
1	Ammonia	6	SC1-IN-C	2.2E+02	25	874%			2.29%
1	Ammonia	8	SC1-IN-D	2.0E+02	25	817%			2.29%
1	Ammonia	10	SC1-IN-E	2.3E+02	25	936%			2.29%
1	Ammonia	12	SC1-IN-F	2.4E+02	25	943%			2.29%
1	Ammonia	14	SC1-IN-G	1.9E+02	25	761%			2.29%
1	Ammonia	16	SC1-IN-H	1.7E+02	25	666%			2.29%
1	Ammonia	2	SC1-EF-A	9.5E+00	25	38.1%			2.29%
1	Ammonia	4	SC1-EF-B	1.3E+02	25	509%			2.29%
1	Ammonia	6	SC1-EF-C	1.8E+02	25	710%			2.29%
1	Ammonia	8	SC1-EF-D	1.8E+02	25	739%			2.29%
1	Ammonia	10	SC1-EF-E	2.2E+02	25	890%			2.29%
1	Ammonia	12	SC1-EF-F	2.3E+02	25	922%			2.29%
1	Ammonia	14	SC1-EF-G	2.1E+02	25	833%			2.29%
1	Ammonia	16	SC1-EF-H	2.1E+02	25	825%			2.29%
3	Mercury	2	SD1-IN-A	2.0E-04	0.003	6.53%	YES		8.09%
3	Mercury	4	SD1-IN-B	2.0E-04	0.003	6.63%	YES		8.09%
3	Mercury	6	SD1-IN-C	2.0E-04	0.003	6.67%	YES		8.09%
3	Mercury	8	SD1-IN-D	2.0E-04	0.003	6.71%	YES		8.09%
3	Mercury	10	SD1-IN-E	2.0E-04	0.003	6.75%	YES		8.09%
3	Mercury	12	SD1-IN-F	2.0E-04	0.003	6.77%	YES		8.09%
3	Mercury	14	SD1-IN-G	2.0E-04	0.003	6.69%	YES		8.09%
3	Mercury	16	SD1-IN-H	2.0E-04	0.003	6.70%	YES		8.09%
3	Mercury	2	SD1-EF-A	2.1E-04	0.003	6.81%	YES		8.09%
3	Mercury	4	SD1-EF-B	2.0E-04	0.003	6.63%	YES		8.09%
3	Mercury	6	SD1-EF-C	2.0E-04	0.003	6.72%	YES		8.09%
3	Mercury	8	SD1-EF-D	2.1E-04	0.003	6.82%	YES		8.09%
3	Mercury	10	SD1-EF-E	2.1E-04	0.003	6.96%	YES		8.09%
3	Mercury	12	SD1-EF-F		0.003				8.09%
3	Mercury	14	SD1-EF-G	2.0E-04	0.003	6.59%	YES		8.09%
3	Mercury	16	SD1-EF-H	2.0E-04	0.003	6.62%	YES		8.09%
3	Mercury	2	SC1-IN-A	1.9E-04	0.003	6.31%	YES		8.09%
3	Mercury	4	SC1-IN-B	2.1E-04	0.003	6.86%	YES		8.09%
3	Mercury	6	SC1-IN-C	2.1E-04	0.003	6.85%	YES		8.09%
3	Mercury	8	SC1-IN-D	2.1E-04	0.003	6.89%	YES		8.09%
3	Mercury	10	SC1-IN-E	2.1E-04	0.003	7.04%	YES		8.09%
3	Mercury	12	SC1-IN-F	2.1E-04	0.003	6.91%	YES		8.09%
3	Mercury	14	SC1-IN-G	2.0E-04	0.003	6.79%	YES		8.09%
3	Mercury	16	SC1-IN-H	2.4E-04	0.003	8.09%	YES		8.09%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
3	Mercury	2	SC1-EF-A	2.0E-04	0.003	6.55%	YES		8.09%
3	Mercury	4	SC1-EF-B	1.9E-04	0.003	6.31%	YES		8.09%
3	Mercury	6	SC1-EF-C	1.9E-04	0.003	6.35%	YES		8.09%
3	Mercury	8	SC1-EF-D	1.9E-04	0.003	6.44%	YES		8.09%
3	Mercury	10	SC1-EF-E	2.0E-04	0.003	6.51%	YES		8.09%
3	Mercury	12	SC1-EF-F	2.1E-04	0.003	6.88%	YES		8.09%
3	Mercury	14	SC1-EF-G	2.1E-04	0.003	6.94%	YES		8.09%
3	Mercury	16	SC1-EF-H	2.0E-04	0.003	6.72%	YES		8.09%
4	1,3-Butadiene	2	SD1-IN-A	3.534E-02	1.0	3.53%	YES		3.87%
4	1,3-Butadiene	4	SD1-IN-B	3.549E-02	1.0	3.55%	YES		3.87%
4	1,3-Butadiene	6	SD1-IN-C	3.589E-02	1.0	3.59%	YES		3.87%
4	1,3-Butadiene	8	SD1-IN-D	3.627E-02	1.0	3.63%	YES		3.87%
4	1,3-Butadiene	10	SD1-IN-E	3.704E-02	1.0	3.70%	YES		3.87%
4	1,3-Butadiene	12	SD1-IN-F	3.725E-02	1.0	3.73%	YES		3.87%
4	1,3-Butadiene	14	SD1-IN-G	3.673E-02	1.0	3.67%	YES		3.87%
4	1,3-Butadiene	16	SD1-IN-H	3.649E-02	1.0	3.65%	YES		3.87%
4	1,3-Butadiene	2	SD1-EF-A	1.822E-02	1.0	1.82%	YES		3.87%
4	1,3-Butadiene	4	SD1-EF-B	1.826E-02	1.0	1.83%	YES		3.87%
4	1,3-Butadiene	6	SD1-EF-C	1.835E-02	1.0	1.84%	YES		3.87%
4	1,3-Butadiene	8	SD1-EF-D	1.822E-02	1.0	1.82%	YES		3.87%
4	1,3-Butadiene	10	SD1-EF-E	1.877E-02	1.0	1.88%	YES		3.87%
4	1,3-Butadiene	12	SD1-EF-F	1.895E-02	1.0	1.90%	YES		3.87%
4	1,3-Butadiene	14	SD1-EF-G	1.873E-02	1.0	1.87%	YES		3.87%
4	1,3-Butadiene	16	SD1-EF-H	1.880E-02	1.0	1.88%	YES		3.87%
4	1,3-Butadiene	2	SC1-IN-A	3.8E-02	1.0	3.85%	YES		3.87%
4	1,3-Butadiene	4	SC1-IN-B	3.8E-02	1.0	3.75%	YES		3.87%
4	1,3-Butadiene	6	SC1-IN-C	3.7E-02	1.0	3.75%	YES		3.87%
4	1,3-Butadiene	8	SC1-IN-D	3.8E-02	1.0	3.78%	YES		3.87%
4	1,3-Butadiene	10	SC1-IN-E	3.9E-02	1.0	3.87%	YES		3.87%
4	1,3-Butadiene	12	SC1-IN-F	3.9E-02	1.0	3.87%	YES		3.87%
4	1,3-Butadiene	14	SC1-IN-G	3.7E-02	1.0	3.73%	YES		3.87%
4	1,3-Butadiene	16	SC1-IN-H	3.8E-02	1.0	3.77%	YES		3.87%
4	1,3-Butadiene	2	SC1-EF-A	1.8E-02	1.0	1.84%	YES		3.87%
4	1,3-Butadiene	4	SC1-EF-B	1.8E-02	1.0	1.77%	YES		3.87%
4	1,3-Butadiene	6	SC1-EF-C	1.8E-02	1.0	1.78%	YES		3.87%
4	1,3-Butadiene	8	SC1-EF-D	1.8E-02	1.0	1.79%	YES		3.87%
4	1,3-Butadiene	10	SC1-EF-E	1.8E-02	1.0	1.83%	YES		3.87%
4	1,3-Butadiene	12	SC1-EF-F	3.7E-02	1.0	3.72%	YES		3.87%
4	1,3-Butadiene	14	SC1-EF-G	3.8E-02	1.0	3.81%	YES		3.87%
4	1,3-Butadiene	16	SC1-EF-H	3.9E-02	1.0	3.85%	YES		3.87%
5	Benzene	2	SD1-IN-A	1.1E-04	0.50	0.021%	YES	U	0.0216%
5	Benzene	4	SD1-IN-B	1.1E-04	0.50	0.022%		J	0.0216%
5	Benzene	6	SD1-IN-C	1.0E-04	0.50	0.020%	YES	U	0.0216%
5	Benzene	8	SD1-IN-D	1.0E-04	0.50	0.021%	YES	U	0.0216%
5	Benzene	10	SD1-IN-E	1.0E-04	0.50	0.021%	YES	U	0.0216%
5	Benzene	12	SD1-IN-F	1.0E-04	0.50	0.020%	YES	U	0.0216%
5	Benzene	14	SD1-IN-G	9.4E-05	0.50	0.019%	YES	U	0.0216%
5	Benzene	16	SD1-IN-H	1.1E-04	0.50	0.021%	YES	U	0.0216%
5	Benzene	2	SD1-EF-A	3.6E-04	0.50	0.072%		J	0.0216%
5	Benzene	4	SD1-EF-B	1.0E-04	0.50	0.020%	YES	U	0.0216%
5	Benzene	6	SD1-EF-C	2.2E-04	0.50	0.045%		J	0.0216%
5	Benzene	8	SD1-EF-D	1.6E-04	0.50	0.032%		J	0.0216%
5	Benzene	10	SD1-EF-E	7.5E-04	0.50	0.150%		J	0.0216%
5	Benzene	12	SD1-EF-F	6.3E-04	0.50	0.125%		J	0.0216%
5	Benzene	14	SD1-EF-G	5.2E-04	0.50	0.105%		J	0.0216%
5	Benzene	16	SD1-EF-H	1.9E-04	0.50	0.038%		J	0.0216%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
5	Benzene	2	SC1-IN-A	1.6E-03	0.50	0.320%			0.0216%
5	Benzene	4	SC1-IN-B	1.7E-03	0.50	0.345%			0.0216%
5	Benzene	6	SC1-IN-C	1.3E-03	0.50	0.269%			0.0216%
5	Benzene	8	SC1-IN-D	1.1E-04	0.50	0.022%	YES	U	0.0216%
5	Benzene	10	SC1-IN-E	6.8E-04	0.50	0.136%		J	0.0216%
5	Benzene	12	SC1-IN-F	1.0E-04	0.50	0.021%	YES	U	0.0216%
5	Benzene	14	SC1-IN-G	7.0E-04	0.50	0.140%		J	0.0216%
5	Benzene	16	SC1-IN-H	6.8E-04	0.50	0.136%		J	0.0216%
5	Benzene	2	SC1-EF-A	5.3E-04	0.50	0.106%		J	0.0216%
5	Benzene	4	SC1-EF-B	5.0E-04	0.50	0.101%		J	0.0216%
5	Benzene	6	SC1-EF-C	6.3E-04	0.50	0.126%		J	0.0216%
5	Benzene	8	SC1-EF-D	5.2E-04	0.50	0.104%		J	0.0216%
5	Benzene	10	SC1-EF-E	5.0E-04	0.50	0.100%		J	0.0216%
5	Benzene	12	SC1-EF-F	4.1E-04	0.50	0.082%		J	0.0216%
5	Benzene	14	SC1-EF-G	4.5E-04	0.50	0.089%		J	0.0216%
5	Benzene	16	SC1-EF-H	4.3E-04	0.50	0.087%		J	0.0216%
6	Biphenyl	2	SD1-IN-A	5.1E-05	0.20	0.025%	YES	U	0.0257%
6	Biphenyl	4	SD1-IN-B	5.1E-05	0.20	0.026%	YES	U	0.0257%
6	Biphenyl	6	SD1-IN-C	4.9E-05	0.20	0.025%	YES	U	0.0257%
6	Biphenyl	8	SD1-IN-D	4.9E-05	0.20	0.025%	YES	U	0.0257%
6	Biphenyl	10	SD1-IN-E	5.1E-05	0.20	0.025%	YES	U	0.0257%
6	Biphenyl	12	SD1-IN-F	5.1E-05	0.20	0.026%	YES	U	0.0257%
6	Biphenyl	14	SD1-IN-G	5.1E-05	0.20	0.026%	YES	U	0.0257%
6	Biphenyl	16	SD1-IN-H	4.8E-05	0.20	0.024%	YES	U	0.0257%
6	Biphenyl	2	SD1-EF-A	4.7E-05	0.20	0.023%	YES	U	0.0257%
6	Biphenyl	4	SD1-EF-B	4.6E-05	0.20	0.023%	YES	U	0.0257%
6	Biphenyl	6	SD1-EF-C	4.7E-05	0.20	0.023%	YES	U	0.0257%
6	Biphenyl	8	SD1-EF-D		0.20				0.0257%
6	Biphenyl	10	SD1-EF-E	4.7E-05	0.20	0.024%	YES	U	0.0257%
6	Biphenyl	12	SD1-EF-F	4.7E-05	0.20	0.024%	YES	U,S*	0.0257%
6	Biphenyl	14	SD1-EF-G	4.6E-05	0.20	0.023%	YES	U	0.0257%
6	Biphenyl	16	SD1-EF-H	4.7E-05	0.20	0.024%	YES	U	0.0257%
6	Biphenyl	2	SC1-IN-A	4.8E-05	0.20	0.024%	YES	U	0.0257%
6	Biphenyl	4	SC1-IN-B	5.0E-05	0.20	0.025%	YES	U	0.0257%
6	Biphenyl	6	SC1-IN-C	4.7E-05	0.20	0.023%	YES	U	0.0257%
6	Biphenyl	8	SC1-IN-D	4.2E-05	0.20	0.021%	YES	U	0.0257%
6	Biphenyl	10	SC1-IN-E	5.0E-05	0.20	0.025%	YES	U	0.0257%
6	Biphenyl	12	SC1-IN-F	4.8E-05	0.20	0.024%	YES	U	0.0257%
6	Biphenyl	14	SC1-IN-G	4.7E-05	0.20	0.023%	YES	U	0.0257%
6	Biphenyl	16	SC1-IN-H	5.1E-05	0.20	0.025%	YES	U	0.0257%
6	Biphenyl	2	SC1-EF-A	5.1E-05	0.20	0.026%	YES	U	0.0257%
6	Biphenyl	4	SC1-EF-B	4.4E-05	0.20	0.022%	YES	U	0.0257%
6	Biphenyl	6	SC1-EF-C	4.4E-05	0.20	0.022%	YES	U	0.0257%
6	Biphenyl	8	SC1-EF-D	4.8E-05	0.20	0.024%	YES	U	0.0257%
6	Biphenyl	10	SC1-EF-E	4.7E-05	0.20	0.024%	YES	U	0.0257%
6	Biphenyl	12	SC1-EF-F	4.7E-05	0.20	0.023%	YES	U,S*	0.0257%
6	Biphenyl	14	SC1-EF-G	5.0E-05	0.20	0.025%	YES	U	0.0257%
6	Biphenyl	16	SC1-EF-H	4.7E-05	0.20	0.024%	YES	U	0.0257%
7	1-Butanol	2	SD1-IN-A	6.7E-04	20	0.003%	YES	LQUYac	0.00341%
7	1-Butanol	4	SD1-IN-B	6.5E-04	20	0.003%	YES	LQUYac	0.00341%
7	1-Butanol	6	SD1-IN-C	6.2E-04	20	0.003%	YES	LQUYa	0.00341%
7	1-Butanol	8	SD1-IN-D	6.4E-04	20	0.003%	YES	LQUYa	0.00341%
7	1-Butanol	10	SD1-IN-E	6.4E-04	20	0.003%	YES	LQUYa	0.00341%
7	1-Butanol	12	SD1-IN-F	6.3E-04	20	0.003%	YES	LQUYa	0.00341%
7	1-Butanol	14	SD1-IN-G	5.9E-04	20	0.003%	YES	LQUYa	0.00341%
7	1-Butanol	16	SD1-IN-H	6.7E-04	20	0.003%	YES	LQUYac	0.00341%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
7	1-Butanol	2	SD1-EF-A	6.4E-04	20	0.003%	YES	LQUYac	0.00341%
7	1-Butanol	4	SD1-EF-B	6.2E-04	20	0.003%	YES	LQUYac	0.00341%
7	1-Butanol	6	SD1-EF-C	6.8E-04	20	0.003%	YES	LQUYac	0.00341%
7	1-Butanol	8	SD1-EF-D	6.8E-04	20	0.003%	YES	LQUYac	0.00341%
7	1-Butanol	10	SD1-EF-E	6.1E-04	20	0.003%	YES	LQUYac	0.00341%
7	1-Butanol	12	SD1-EF-F	5.9E-04	20	0.003%	YES	LQUYac	0.00341%
7	1-Butanol	14	SD1-EF-G	6.3E-04	20	0.003%	YES	LQUYac	0.00341%
7	1-Butanol	16	SD1-EF-H	6.7E-04	20	0.003%	YES	LQUYac	0.00341%
7	1-Butanol	2	SC1-IN-A	3.4E-01	20	1.69%		ELQYa	0.00341%
7	1-Butanol	4	SC1-IN-B	6.4E-04	20	0.003%	YES	LQUYa	0.00341%
7	1-Butanol	6	SC1-IN-C	6.4E-04	20	0.003%	YES	LQUYa	0.00341%
7	1-Butanol	8	SC1-IN-D	6.7E-04	20	0.003%	YES	LQUYa	0.00341%
7	1-Butanol	10	SC1-IN-E	6.5E-04	20	0.003%	YES	LQUYa	0.00341%
7	1-Butanol	12	SC1-IN-F	6.5E-04	20	0.003%	YES	LQUYa	0.00341%
7	1-Butanol	14	SC1-IN-G	6.5E-04	20	0.003%	YES	LQUYa	0.00341%
7	1-Butanol	16	SC1-IN-H	6.3E-04	20	0.003%	YES	LQa	0.00341%
7	1-Butanol	2	SC1-EF-A	6.1E-04	20	0.003%	YES	LQa	0.00341%
7	1-Butanol	4	SC1-EF-B	5.9E-04	20	0.003%	YES	LQa	0.00341%
7	1-Butanol	6	SC1-EF-C	6.5E-04	20	0.003%	YES	LQa	0.00341%
7	1-Butanol	8	SC1-EF-D	6.4E-04	20	0.003%	YES	LQa	0.00341%
7	1-Butanol	10	SC1-EF-E	6.5E-04	20	0.003%	YES	LQa	0.00341%
7	1-Butanol	12	SC1-EF-F	6.4E-04	20	0.003%	YES	LQa	0.00341%
7	1-Butanol	14	SC1-EF-G	6.7E-04	20	0.003%	YES	LQa	0.00341%
7	1-Butanol	16	SC1-EF-H	6.4E-04	20	0.003%	YES	LQa	0.00341%
9	2-Hexanone	2	SD1-IN-A	7.1E-05	5.0	0.001%	YES	U	0.00144%
9	2-Hexanone	4	SD1-IN-B	6.8E-05	5.0	0.001%	YES	U	0.00144%
9	2-Hexanone	6	SD1-IN-C	6.6E-05	5.0	0.001%	YES	U	0.00144%
9	2-Hexanone	8	SD1-IN-D	6.8E-05	5.0	0.001%	YES	U	0.00144%
9	2-Hexanone	10	SD1-IN-E	6.8E-05	5.0	0.001%	YES	U	0.00144%
9	2-Hexanone	12	SD1-IN-F	6.6E-05	5.0	0.001%	YES	U	0.00144%
9	2-Hexanone	14	SD1-IN-G	6.2E-05	5.0	0.001%	YES	U	0.00144%
9	2-Hexanone	16	SD1-IN-H	7.0E-05	5.0	0.001%	YES	U	0.00144%
9	2-Hexanone	2	SD1-EF-A	6.7E-05	5.0	0.001%	YES	U	0.00144%
9	2-Hexanone	4	SD1-EF-B	6.6E-05	5.0	0.001%	YES	U	0.00144%
9	2-Hexanone	6	SD1-EF-C	7.1E-05	5.0	0.001%	YES	U	0.00144%
9	2-Hexanone	8	SD1-EF-D	7.2E-05	5.0	0.001%	YES	U	0.00144%
9	2-Hexanone	10	SD1-EF-E	6.4E-05	5.0	0.001%	YES	U	0.00144%
9	2-Hexanone	12	SD1-EF-F	6.2E-05	5.0	0.001%	YES	U	0.00144%
9	2-Hexanone	14	SD1-EF-G	6.6E-05	5.0	0.001%	YES	U	0.00144%
9	2-Hexanone	16	SD1-EF-H	7.1E-05	5.0	0.001%	YES	U	0.00144%
9	2-Hexanone	2	SC1-IN-A	7.1E-03	5.0	0.141%			0.00144%
9	2-Hexanone	4	SC1-IN-B	2.6E-03	5.0	0.051%			0.00144%
9	2-Hexanone	6	SC1-IN-C	2.5E-03	5.0	0.051%			0.00144%
9	2-Hexanone	8	SC1-IN-D	7.1E-05	5.0	0.001%	YES	U	0.00144%
9	2-Hexanone	10	SC1-IN-E	6.9E-04	5.0	0.014%		J	0.00144%
9	2-Hexanone	12	SC1-IN-F	6.9E-05	5.0	0.001%	YES	U	0.00144%
9	2-Hexanone	14	SC1-IN-G	4.5E-04	5.0	0.009%		J	0.00144%
9	2-Hexanone	16	SC1-IN-H	9.6E-04	5.0	0.019%			0.00144%
9	2-Hexanone	2	SC1-EF-A	6.5E-05	5.0	0.001%	YES		0.00144%
9	2-Hexanone	4	SC1-EF-B	6.3E-05	5.0	0.001%	YES		0.00144%
9	2-Hexanone	6	SC1-EF-C	6.8E-05	5.0	0.001%	YES		0.00144%
9	2-Hexanone	8	SC1-EF-D	6.7E-05	5.0	0.001%	YES		0.00144%
9	2-Hexanone	10	SC1-EF-E	6.8E-05	5.0	0.001%	YES		0.00144%
9	2-Hexanone	12	SC1-EF-F	6.8E-05	5.0	0.001%	YES		0.00144%
9	2-Hexanone	14	SC1-EF-G	7.1E-05	5.0	0.001%	YES		0.00144%
9	2-Hexanone	16	SC1-EF-H	6.8E-05	5.0	0.001%	YES		0.00144%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
11	4-Methyl-2-hexanone	2	SD1-IN-A	7.9E-05	0.50	0.016%	YES	U	0.0161%
11	4-Methyl-2-hexanone	4	SD1-IN-B	7.6E-05	0.50	0.015%	YES	U	0.0161%
11	4-Methyl-2-hexanone	6	SD1-IN-C	7.4E-05	0.50	0.015%	YES	U	0.0161%
11	4-Methyl-2-hexanone	8	SD1-IN-D	7.6E-05	0.50	0.015%	YES	U	0.0161%
11	4-Methyl-2-hexanone	10	SD1-IN-E	7.6E-05	0.50	0.015%	YES	U	0.0161%
11	4-Methyl-2-hexanone	12	SD1-IN-F	7.4E-05	0.50	0.015%	YES	U	0.0161%
11	4-Methyl-2-hexanone	14	SD1-IN-G	6.9E-05	0.50	0.014%	YES	U	0.0161%
11	4-Methyl-2-hexanone	16	SD1-IN-H	7.9E-05	0.50	0.016%	YES	U	0.0161%
11	4-Methyl-2-hexanone	2	SD1-EF-A	7.5E-05	0.50	0.015%	YES	U	0.0161%
11	4-Methyl-2-hexanone	4	SD1-EF-B	7.4E-05	0.50	0.015%	YES	U	0.0161%
11	4-Methyl-2-hexanone	6	SD1-EF-C	8.0E-05	0.50	0.016%	YES	U	0.0161%
11	4-Methyl-2-hexanone	8	SD1-EF-D	8.0E-05	0.50	0.016%	YES	U	0.0161%
11	4-Methyl-2-hexanone	10	SD1-EF-E	7.2E-05	0.50	0.014%	YES	U	0.0161%
11	4-Methyl-2-hexanone	12	SD1-EF-F	7.0E-05	0.50	0.014%	YES	U	0.0161%
11	4-Methyl-2-hexanone	14	SD1-EF-G	7.4E-05	0.50	0.015%	YES	U	0.0161%
11	4-Methyl-2-hexanone	16	SD1-EF-H	7.9E-05	0.50	0.016%	YES	U	0.0161%
11	4-Methyl-2-hexanone	2	SC1-IN-A	6.2E-04	0.50	0.124%			0.0161%
11	4-Methyl-2-hexanone	4	SC1-IN-B	1.3E-04	0.50	0.026%		J	0.0161%
11	4-Methyl-2-hexanone	6	SC1-IN-C	1.7E-04	0.50	0.034%		J	0.0161%
11	4-Methyl-2-hexanone	8	SC1-IN-D	7.9E-05	0.50	0.016%	YES	U	0.0161%
11	4-Methyl-2-hexanone	10	SC1-IN-E	7.7E-05	0.50	0.015%	YES	U	0.0161%
11	4-Methyl-2-hexanone	12	SC1-IN-F	7.7E-05	0.50	0.015%	YES	U	0.0161%
11	4-Methyl-2-hexanone	14	SC1-IN-G	7.7E-05	0.50	0.015%	YES	U	0.0161%
11	4-Methyl-2-hexanone	16	SC1-IN-H	7.4E-05	0.50	0.015%	YES		0.0161%
11	4-Methyl-2-hexanone	2	SC1-EF-A	7.2E-05	0.50	0.014%	YES		0.0161%
11	4-Methyl-2-hexanone	4	SC1-EF-B	7.0E-05	0.50	0.014%	YES		0.0161%
11	4-Methyl-2-hexanone	6	SC1-EF-C	7.6E-05	0.50	0.015%	YES		0.0161%
11	4-Methyl-2-hexanone	8	SC1-EF-D	7.5E-05	0.50	0.015%	YES		0.0161%
11	4-Methyl-2-hexanone	10	SC1-EF-E	7.6E-05	0.50	0.015%	YES		0.0161%
11	4-Methyl-2-hexanone	12	SC1-EF-F	7.6E-05	0.50	0.015%	YES		0.0161%
11	4-Methyl-2-hexanone	14	SC1-EF-G	7.9E-05	0.50	0.016%	YES		0.0161%
11	4-Methyl-2-hexanone	16	SC1-EF-H	7.5E-05	0.50	0.015%	YES		0.0161%
13	3-Buten-2-one	2	SD1-IN-A	1.4E-04	0.20	0.069%	YES	U	0.0702%
13	3-Buten-2-one	4	SD1-IN-B	1.4E-04	0.20	0.071%		J	0.0702%
13	3-Buten-2-one	6	SD1-IN-C	1.3E-04	0.20	0.064%	YES	U	0.0702%
13	3-Buten-2-one	8	SD1-IN-D	1.3E-04	0.20	0.066%	YES	U	0.0702%
13	3-Buten-2-one	10	SD1-IN-E	1.3E-04	0.20	0.066%	YES	U	0.0702%
13	3-Buten-2-one	12	SD1-IN-F	1.3E-04	0.20	0.065%	YES	U	0.0702%
13	3-Buten-2-one	14	SD1-IN-G	1.2E-04	0.20	0.060%	YES	U	0.0702%
13	3-Buten-2-one	16	SD1-IN-H	1.4E-04	0.20	0.069%	YES	U	0.0702%
13	3-Buten-2-one	2	SD1-EF-A	1.5E-04	0.20	0.074%		J	0.0702%
13	3-Buten-2-one	4	SD1-EF-B	1.6E-04	0.20	0.082%		J	0.0702%
13	3-Buten-2-one	6	SD1-EF-C	1.5E-04	0.20	0.074%		J	0.0702%
13	3-Buten-2-one	8	SD1-EF-D	1.4E-04	0.20	0.070%	YES	U	0.0702%
13	3-Buten-2-one	10	SD1-EF-E	1.5E-04	0.20	0.075%		J	0.0702%
13	3-Buten-2-one	12	SD1-EF-F	1.2E-04	0.20	0.061%	YES	U	0.0702%
13	3-Buten-2-one	14	SD1-EF-G	1.8E-04	0.20	0.090%		J	0.0702%
13	3-Buten-2-one	16	SD1-EF-H	1.4E-04	0.20	0.069%	YES	U	0.0702%
13	3-Buten-2-one	2	SC1-IN-A	4.9E-03	0.20	2.45%			0.0702%
13	3-Buten-2-one	4	SC1-IN-B	3.2E-03	0.20	1.62%			0.0702%
13	3-Buten-2-one	6	SC1-IN-C	2.6E-03	0.20	1.32%			0.0702%
13	3-Buten-2-one	8	SC1-IN-D	1.4E-04	0.20	0.069%	YES	U	0.0702%
13	3-Buten-2-one	10	SC1-IN-E	5.1E-03	0.20	2.54%			0.0702%
13	3-Buten-2-one	12	SC1-IN-F	1.3E-04	0.20	0.067%	YES	U	0.0702%
13	3-Buten-2-one	14	SC1-IN-G	2.0E-03	0.20	0.984%			0.0702%
13	3-Buten-2-one	16	SC1-IN-H	4.6E-03	0.20	2.32%			0.0702%
13	3-Buten-2-one	2	SC1-EF-A	1.3E-04	0.20	0.067%		J	0.0702%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
13	3-Buten-2-one	4	SC1-EF-B	1.4E-04	0.20	0.069%		J	0.0702%
13	3-Buten-2-one	6	SC1-EF-C	1.3E-04	0.20	0.066%	YES		0.0702%
13	3-Buten-2-one	8	SC1-EF-D	1.5E-04	0.20	0.074%		J	0.0702%
13	3-Buten-2-one	10	SC1-EF-E	2.7E-04	0.20	0.133%		J	0.0702%
13	3-Buten-2-one	12	SC1-EF-F	1.6E-04	0.20	0.079%		J	0.0702%
13	3-Buten-2-one	14	SC1-EF-G	1.7E-04	0.20	0.083%		J	0.0702%
13	3-Buten-2-one	16	SC1-EF-H	1.8E-04	0.20	0.092%		J	0.0702%
14	Formaldehyde	2	SD1-IN-A	3.2E-03	0.30	1.08%			0.571%
14	Formaldehyde	4	SD1-IN-B	2.0E-03	0.30	0.669%			0.571%
14	Formaldehyde	6	SD1-IN-C	2.1E-03	0.30	0.707%			0.571%
14	Formaldehyde	8	SD1-IN-D	2.6E-03	0.30	0.866%			0.571%
14	Formaldehyde	10	SD1-IN-E	2.1E-03	0.30	0.694%			0.571%
14	Formaldehyde	12	SD1-IN-F	2.8E-03	0.30	0.947%			0.571%
14	Formaldehyde	14	SD1-IN-G	1.6E-03	0.30	0.549%			0.571%
14	Formaldehyde	16	SD1-IN-H	2.7E-03	0.30	0.890%			0.571%
14	Formaldehyde	2	SD1-EF-A	2.4E-03	0.30	0.803%			0.571%
14	Formaldehyde	4	SD1-EF-B	2.4E-03	0.30	0.785%			0.571%
14	Formaldehyde	6	SD1-EF-C	1.7E-03	0.30	0.557%			0.571%
14	Formaldehyde	8	SD1-EF-D	1.7E-03	0.30	0.556%	YES		0.571%
14	Formaldehyde	10	SD1-EF-E	1.7E-03	0.30	0.569%	YES		0.571%
14	Formaldehyde	12	SD1-EF-F	1.7E-03	0.30	0.571%	YES		0.571%
14	Formaldehyde	14	SD1-EF-G	2.1E-03	0.30	0.710%			0.571%
14	Formaldehyde	16	SD1-EF-H	1.7E-03	0.30	0.564%			0.571%
14	Formaldehyde	2	SC1-IN-A	4.5E-03	0.30	1.51%			0.571%
14	Formaldehyde	4	SC1-IN-B	3.7E-03	0.30	1.24%			0.571%
14	Formaldehyde	6	SC1-IN-C	4.1E-03	0.30	1.35%			0.571%
14	Formaldehyde	8	SC1-IN-D	3.8E-03	0.30	1.26%			0.571%
14	Formaldehyde	10	SC1-IN-E	6.3E-03	0.30	2.08%			0.571%
14	Formaldehyde	12	SC1-IN-F	3.3E-03	0.30	1.10%			0.571%
14	Formaldehyde	14	SC1-IN-G	3.4E-03	0.30	1.13%			0.571%
14	Formaldehyde	16	SC1-IN-H	3.3E-03	0.30	1.10%			0.571%
14	Formaldehyde	2	SC1-EF-A	3.5E-03	0.30	1.17%			0.571%
14	Formaldehyde	4	SC1-EF-B	2.5E-03	0.30	0.824%			0.571%
14	Formaldehyde	6	SC1-EF-C	2.7E-03	0.30	0.912%			0.571%
14	Formaldehyde	8	SC1-EF-D	4.2E-03	0.30	1.40%			0.571%
14	Formaldehyde	10	SC1-EF-E	3.3E-03	0.30	1.10%			0.571%
14	Formaldehyde	12	SC1-EF-F	2.8E-03	0.30	0.939%			0.571%
14	Formaldehyde	14	SC1-EF-G	3.0E-03	0.30	1.01%			0.571%
14	Formaldehyde	16	SC1-EF-H	4.3E-03	0.30	1.45%			0.571%
15	Acetaldehyde	2	SD1-IN-A	9.6E-02	25	0.383%			0.00487%
15	Acetaldehyde	4	SD1-IN-B	8.5E-02	25	0.341%			0.00487%
15	Acetaldehyde	6	SD1-IN-C	8.4E-02	25	0.334%			0.00487%
15	Acetaldehyde	8	SD1-IN-D	3.0E-02	25	0.118%			0.00487%
15	Acetaldehyde	10	SD1-IN-E	9.1E-02	25	0.363%			0.00487%
15	Acetaldehyde	12	SD1-IN-F	8.0E-02	25	0.321%			0.00487%
15	Acetaldehyde	14	SD1-IN-G	7.2E-02	25	0.289%			0.00487%
15	Acetaldehyde	16	SD1-IN-H	9.0E-02	25	0.359%			0.00487%
15	Acetaldehyde	2	SD1-EF-A	1.8E-03	25	0.007%			0.00487%
15	Acetaldehyde	4	SD1-EF-B	6.5E-03	25	0.026%			0.00487%
15	Acetaldehyde	6	SD1-EF-C	4.2E-03	25	0.017%			0.00487%
15	Acetaldehyde	8	SD1-EF-D	4.1E-03	25	0.016%			0.00487%
15	Acetaldehyde	10	SD1-EF-E	4.4E-03	25	0.018%			0.00487%
15	Acetaldehyde	12	SD1-EF-F	5.1E-03	25	0.021%			0.00487%
15	Acetaldehyde	14	SD1-EF-G	5.7E-03	25	0.023%			0.00487%
15	Acetaldehyde	16	SD1-EF-H	5.9E-03	25	0.024%			0.00487%
15	Acetaldehyde	2	SC1-IN-A	9.0E-02	25	0.360%			0.00487%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
15	Acetaldehyde	4	SC1-IN-B	8.7E-02	25	0.350%			0.00487%
15	Acetaldehyde	6	SC1-IN-C	8.1E-02	25	0.323%			0.00487%
15	Acetaldehyde	8	SC1-IN-D	8.0E-02	25	0.319%			0.00487%
15	Acetaldehyde	10	SC1-IN-E	8.3E-02	25	0.332%			0.00487%
15	Acetaldehyde	12	SC1-IN-F	7.8E-02	25	0.314%			0.00487%
15	Acetaldehyde	14	SC1-IN-G	8.0E-02	25	0.318%			0.00487%
15	Acetaldehyde	16	SC1-IN-H	8.0E-02	25	0.322%			0.00487%
15	Acetaldehyde	2	SC1-EF-A	7.9E-03	25	0.032%			0.00487%
15	Acetaldehyde	4	SC1-EF-B	1.4E-02	25	0.057%			0.00487%
15	Acetaldehyde	6	SC1-EF-C	1.6E-02	25	0.064%			0.00487%
15	Acetaldehyde	8	SC1-EF-D	1.8E-02	25	0.071%			0.00487%
15	Acetaldehyde	10	SC1-EF-E	1.8E-02	25	0.073%			0.00487%
15	Acetaldehyde	12	SC1-EF-F	2.2E-02	25	0.088%			0.00487%
15	Acetaldehyde	14	SC1-EF-G	2.5E-02	25	0.100%			0.00487%
15	Acetaldehyde	16	SC1-EF-H	2.7E-02	25	0.109%			0.00487%
16	Butanal/Butyraldehyde	2	SD1-IN-A	3.9E-04	25	0.002%	YES	LQUY	0.00160%
16	Butanal/Butyraldehyde	4	SD1-IN-B	3.8E-04	25	0.002%	YES	LQUY	0.00160%
16	Butanal/Butyraldehyde	6	SD1-IN-C	3.7E-04	25	0.001%	YES	QUY	0.00160%
16	Butanal/Butyraldehyde	8	SD1-IN-D	3.8E-04	25	0.002%	YES	QUY	0.00160%
16	Butanal/Butyraldehyde	10	SD1-IN-E	3.8E-04	25	0.002%	YES	QUY	0.00160%
16	Butanal/Butyraldehyde	12	SD1-IN-F	3.7E-04	25	0.001%	YES	QUY	0.00160%
16	Butanal/Butyraldehyde	14	SD1-IN-G	3.4E-04	25	0.001%	YES	QUY	0.00160%
16	Butanal/Butyraldehyde	16	SD1-IN-H	3.9E-04	25	0.002%	YES	LQUY	0.00160%
16	Butanal/Butyraldehyde	2	SD1-EF-A	3.7E-04	25	0.001%	YES	LQY	0.00160%
16	Butanal/Butyraldehyde	4	SD1-EF-B	3.7E-04	25	0.001%	YES	LQUY	0.00160%
16	Butanal/Butyraldehyde	6	SD1-EF-C	4.0E-04	25	0.002%	YES	LQUY	0.00160%
16	Butanal/Butyraldehyde	8	SD1-EF-D	4.0E-04	25	0.002%	YES	LQUY	0.00160%
16	Butanal/Butyraldehyde	10	SD1-EF-E	3.6E-04	25	0.001%	YES	LQY	0.00160%
16	Butanal/Butyraldehyde	12	SD1-EF-F	3.5E-04	25	0.001%	YES	LQY	0.00160%
16	Butanal/Butyraldehyde	14	SD1-EF-G	3.7E-04	25	0.001%	YES	LQY	0.00160%
16	Butanal/Butyraldehyde	16	SD1-EF-H	3.9E-04	25	0.002%	YES	LQUY	0.00160%
16	Butanal/Butyraldehyde	2	SC1-IN-A	1.4E-01	25	0.573%		Ec	0.00160%
16	Butanal/Butyraldehyde	4	SC1-IN-B	1.2E-03	25	0.005%		LQY	0.00160%
16	Butanal/Butyraldehyde	6	SC1-IN-C	1.4E-03	25	0.005%		LQY	0.00160%
16	Butanal/Butyraldehyde	8	SC1-IN-D	4.0E-04	25	0.002%	YES	LUY	0.00160%
16	Butanal/Butyraldehyde	10	SC1-IN-E	2.0E-03	25	0.008%		LQY	0.00160%
16	Butanal/Butyraldehyde	12	SC1-IN-F	3.8E-04	25	0.002%	YES	LUY	0.00160%
16	Butanal/Butyraldehyde	14	SC1-IN-G	1.1E-03	25	0.005%		LQY	0.00160%
16	Butanal/Butyraldehyde	16	SC1-IN-H	1.4E-03	25	0.006%		c	0.00160%
16	Butanal/Butyraldehyde	2	SC1-EF-A	3.6E-04	25	0.001%	YES	c	0.00160%
16	Butanal/Butyraldehyde	4	SC1-EF-B	3.5E-04	25	0.001%	YES	c	0.00160%
16	Butanal/Butyraldehyde	6	SC1-EF-C	3.8E-04	25	0.002%	YES	c	0.00160%
16	Butanal/Butyraldehyde	8	SC1-EF-D	3.7E-04	25	0.001%	YES	c	0.00160%
16	Butanal/Butyraldehyde	10	SC1-EF-E	3.8E-04	25	0.002%	YES	c	0.00160%
16	Butanal/Butyraldehyde	12	SC1-EF-F	3.8E-04	25	0.002%	YES	c	0.00160%
16	Butanal/Butyraldehyde	14	SC1-EF-G	3.9E-04	25	0.002%	YES	c	0.00160%
16	Butanal/Butyraldehyde	16	SC1-EF-H	3.8E-04	25	0.002%	YES	c	0.00160%
19	2-Propenal/Acrolein	2	SD1-IN-A	8.7E-04	0.100	0.875%	YES		0.957%
19	2-Propenal/Acrolein	4	SD1-IN-B	8.8E-04	0.100	0.881%	YES		0.957%
19	2-Propenal/Acrolein	6	SD1-IN-C	8.9E-04	0.100	0.888%	YES		0.957%
19	2-Propenal/Acrolein	8	SD1-IN-D	8.9E-04	0.100	0.892%	YES		0.957%
19	2-Propenal/Acrolein	10	SD1-IN-E	9.1E-04	0.100	0.913%	YES		0.957%
19	2-Propenal/Acrolein	12	SD1-IN-F	9.3E-04	0.100	0.928%	YES		0.957%
19	2-Propenal/Acrolein	14	SD1-IN-G	7.9E-04	0.100	0.788%	YES		0.957%
19	2-Propenal/Acrolein	16	SD1-IN-H	9.0E-04	0.100	0.905%	YES		0.957%
19	2-Propenal/Acrolein	2	SD1-EF-A	8.6E-04	0.100	0.860%	YES		0.957%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
19	2-Propenal/Acrolein	4	SD1-EF-B	8.8E-04	0.100	0.876%	YES		0.957%
19	2-Propenal/Acrolein	6	SD1-EF-C	8.8E-04	0.100	0.877%	YES		0.957%
19	2-Propenal/Acrolein	8	SD1-EF-D	8.9E-04	0.100	0.894%	YES		0.957%
19	2-Propenal/Acrolein	10	SD1-EF-E	9.1E-04	0.100	0.914%	YES		0.957%
19	2-Propenal/Acrolein	12	SD1-EF-F	9.2E-04	0.100	0.918%	YES		0.957%
19	2-Propenal/Acrolein	14	SD1-EF-G	8.9E-04	0.100	0.891%	YES		0.957%
19	2-Propenal/Acrolein	16	SD1-EF-H	8.9E-04	0.100	0.889%	YES		0.957%
19	2-Propenal/Acrolein	2	SC1-IN-A	9.3E-04	0.100	0.932%	YES		0.957%
19	2-Propenal/Acrolein	4	SC1-IN-B	9.0E-04	0.100	0.904%	YES		0.957%
19	2-Propenal/Acrolein	6	SC1-IN-C	9.1E-04	0.100	0.905%	YES		0.957%
19	2-Propenal/Acrolein	8	SC1-IN-D	9.2E-04	0.100	0.922%	YES		0.957%
19	2-Propenal/Acrolein	10	SC1-IN-E	9.3E-04	0.100	0.931%	YES		0.957%
19	2-Propenal/Acrolein	12	SC1-IN-F	9.3E-04	0.100	0.934%	YES		0.957%
19	2-Propenal/Acrolein	14	SC1-IN-G	9.5E-04	0.100	0.948%	YES		0.957%
19	2-Propenal/Acrolein	16	SC1-IN-H	9.6E-04	0.100	0.957%	YES		0.957%
19	2-Propenal/Acrolein	2	SC1-EF-A	9.4E-04	0.100	0.944%	YES		0.957%
19	2-Propenal/Acrolein	4	SC1-EF-B	9.1E-04	0.100	0.907%	YES		0.957%
19	2-Propenal/Acrolein	6	SC1-EF-C	9.3E-04	0.100	0.927%	YES		0.957%
19	2-Propenal/Acrolein	8	SC1-EF-D	9.4E-04	0.100	0.938%	YES		0.957%
19	2-Propenal/Acrolein	10	SC1-EF-E	8.8E-04	0.100	0.881%	YES		0.957%
19	2-Propenal/Acrolein	12	SC1-EF-F	8.7E-04	0.100	0.867%	YES		0.957%
19	2-Propenal/Acrolein	14	SC1-EF-G	8.9E-04	0.100	0.892%	YES		0.957%
19	2-Propenal/Acrolein	16	SC1-EF-H	9.0E-04	0.100	0.895%	YES		0.957%
20	Furan	2	SD1-IN-A	1.3E-04	0.001	13.3%	YES	U	13.5%
20	Furan	4	SD1-IN-B	1.3E-04	0.001	12.8%	YES	U	13.5%
20	Furan	6	SD1-IN-C	1.2E-04	0.001	12.3%	YES	U	13.5%
20	Furan	8	SD1-IN-D	1.3E-04	0.001	12.8%	YES	U	13.5%
20	Furan	10	SD1-IN-E	1.3E-04	0.001	12.7%	YES	U	13.5%
20	Furan	12	SD1-IN-F	1.2E-04	0.001	12.4%	YES	U	13.5%
20	Furan	14	SD1-IN-G	1.2E-04	0.001	11.6%	YES	U	13.5%
20	Furan	16	SD1-IN-H	1.3E-04	0.001	13.2%	YES	U	13.5%
20	Furan	2	SD1-EF-A	1.3E-04	0.001	12.6%	YES	U	13.5%
20	Furan	4	SD1-EF-B	1.2E-04	0.001	12.4%	YES	U	13.5%
20	Furan	6	SD1-EF-C	1.3E-04	0.001	13.4%	YES	U	13.5%
20	Furan	8	SD1-EF-D	1.3E-04	0.001	13.5%	YES	U	13.5%
20	Furan	10	SD1-EF-E	1.2E-04	0.001	12.0%	YES	U	13.5%
20	Furan	12	SD1-EF-F	1.2E-04	0.001	11.7%	YES	U	13.5%
20	Furan	14	SD1-EF-G	1.2E-04	0.001	12.4%	YES	U	13.5%
20	Furan	16	SD1-EF-H	1.3E-04	0.001	13.2%	YES	U	13.5%
20	Furan	2	SC1-IN-A	1.7E-03	0.001	168%			13.5%
20	Furan	4	SC1-IN-B	6.4E-04	0.001	63.9%		J	13.5%
20	Furan	6	SC1-IN-C	6.2E-04	0.001	61.7%		J	13.5%
20	Furan	8	SC1-IN-D	1.3E-04	0.001	13.3%	YES	U	13.5%
20	Furan	10	SC1-IN-E	2.2E-04	0.001	22.1%		J	13.5%
20	Furan	12	SC1-IN-F	1.3E-04	0.001	12.9%	YES		13.5%
20	Furan	14	SC1-IN-G	2.8E-04	0.001	27.6%		J	13.5%
20	Furan	16	SC1-IN-H	4.0E-04	0.001	39.9%		J	13.5%
20	Furan	2	SC1-EF-A	1.2E-04	0.001	12.1%	YES		13.5%
20	Furan	4	SC1-EF-B	1.2E-04	0.001	11.8%	YES		13.5%
20	Furan	6	SC1-EF-C	1.3E-04	0.001	12.8%	YES		13.5%
20	Furan	8	SC1-EF-D	1.3E-04	0.001	12.6%	YES		13.5%
20	Furan	10	SC1-EF-E	1.3E-04	0.001	12.8%	YES		13.5%
20	Furan	12	SC1-EF-F	1.3E-04	0.001	12.7%	YES		13.5%
20	Furan	14	SC1-EF-G	1.3E-04	0.001	13.3%	YES		13.5%
20	Furan	16	SC1-EF-H	1.3E-04	0.001	12.7%	YES		13.5%
21	2,3-Dihydrofuran	2	SD1-IN-A	2.9E-05	0.001	2.95%	YES	U	3.34%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
21	2,3-Dihydrofuran	4	SD1-IN-B	2.9E-05	0.001	2.88%	YES	U	3.34%
21	2,3-Dihydrofuran	6	SD1-IN-C	3.1E-05	0.001	3.05%	YES	U	3.34%
21	2,3-Dihydrofuran	8	SD1-IN-D	3.1E-05	0.001	3.06%	YES		3.34%
21	2,3-Dihydrofuran	10	SD1-IN-E	3.2E-05	0.001	3.18%	YES	U	3.34%
21	2,3-Dihydrofuran	12	SD1-IN-F	2.9E-05	0.001	2.87%	YES	U	3.34%
21	2,3-Dihydrofuran	14	SD1-IN-G	2.9E-05	0.001	2.94%	YES	U	3.34%
21	2,3-Dihydrofuran	16	SD1-IN-H	3.2E-05	0.001	3.23%	YES	U	3.34%
21	2,3-Dihydrofuran	2	SD1-EF-A	2.9E-05	0.001	2.90%	YES	U	3.34%
21	2,3-Dihydrofuran	4	SD1-EF-B	3.1E-05	0.001	3.08%	YES	U	3.34%
21	2,3-Dihydrofuran	6	SD1-EF-C	2.9E-05	0.001	2.86%	YES	U	3.34%
21	2,3-Dihydrofuran	8	SD1-EF-D	3.0E-05	0.001	2.97%	YES	U	3.34%
21	2,3-Dihydrofuran	10	SD1-EF-E	3.1E-05	0.001	3.11%	YES	U	3.34%
21	2,3-Dihydrofuran	12	SD1-EF-F	3.1E-05	0.001	3.06%	YES	U	3.34%
21	2,3-Dihydrofuran	14	SD1-EF-G		0.001				3.34%
21	2,3-Dihydrofuran	16	SD1-EF-H	3.1E-05	0.001	3.10%	YES	U	3.34%
21	2,3-Dihydrofuran	2	SC1-IN-A	2.7E-05	0.001	2.75%	YES	U	3.34%
21	2,3-Dihydrofuran	4	SC1-IN-B	3.3E-05	0.001	3.34%	YES	U	3.34%
21	2,3-Dihydrofuran	6	SC1-IN-C	3.1E-05	0.001	3.13%	YES	U	3.34%
21	2,3-Dihydrofuran	8	SC1-IN-D	3.3E-05	0.001	3.29%	YES	U	3.34%
21	2,3-Dihydrofuran	10	SC1-IN-E	2.9E-05	0.001	2.88%	YES	U	3.34%
21	2,3-Dihydrofuran	12	SC1-IN-F	3.2E-05	0.001	3.21%	YES	U	3.34%
21	2,3-Dihydrofuran	14	SC1-IN-G	3.0E-05	0.001	2.98%	YES	U	3.34%
21	2,3-Dihydrofuran	16	SC1-IN-H	3.2E-05	0.001	3.19%	YES	U	3.34%
21	2,3-Dihydrofuran	2	SC1-EF-A	3.3E-05	0.001	3.31%	YES	U	3.34%
21	2,3-Dihydrofuran	4	SC1-EF-B	3.0E-05	0.001	2.99%	YES	U	3.34%
21	2,3-Dihydrofuran	6	SC1-EF-C	3.0E-05	0.001	3.01%	YES	U	3.34%
21	2,3-Dihydrofuran	8	SC1-EF-D	3.0E-05	0.001	3.01%	YES	U	3.34%
21	2,3-Dihydrofuran	10	SC1-EF-E	3.1E-05	0.001	3.05%	YES	U	3.34%
21	2,3-Dihydrofuran	12	SC1-EF-F	3.1E-05	0.001	3.11%	YES	U	3.34%
21	2,3-Dihydrofuran	14	SC1-EF-G	3.1E-05	0.001	3.09%	YES	U	3.34%
21	2,3-Dihydrofuran	16	SC1-EF-H	3.1E-05	0.001	3.12%	YES	U	3.34%
22	2,5-Dihydrofuran	2	SD1-IN-A	2.3E-04	0.001	23.0%	YES	U	23.4%
22	2,5-Dihydrofuran	4	SD1-IN-B	2.2E-04	0.001	22.2%	YES	U	23.4%
22	2,5-Dihydrofuran	6	SD1-IN-C	2.1E-04	0.001	21.4%	YES	U	23.4%
22	2,5-Dihydrofuran	8	SD1-IN-D	2.2E-04	0.001	22.1%	YES	U	23.4%
22	2,5-Dihydrofuran	10	SD1-IN-E	2.2E-04	0.001	22.0%	YES	U	23.4%
22	2,5-Dihydrofuran	12	SD1-IN-F	2.2E-04	0.001	21.5%	YES	U	23.4%
22	2,5-Dihydrofuran	14	SD1-IN-G	2.0E-04	0.001	20.1%	YES	U	23.4%
22	2,5-Dihydrofuran	16	SD1-IN-H	2.3E-04	0.001	22.9%	YES	U	23.4%
22	2,5-Dihydrofuran	2	SD1-EF-A	4.4E-04	0.001	43.8%		J	23.4%
22	2,5-Dihydrofuran	4	SD1-EF-B	2.1E-04	0.001	21.5%	YES	U	23.4%
22	2,5-Dihydrofuran	6	SD1-EF-C	2.3E-04	0.001	23.2%	YES	U	23.4%
22	2,5-Dihydrofuran	8	SD1-EF-D	2.3E-04	0.001	23.4%	YES	U	23.4%
22	2,5-Dihydrofuran	10	SD1-EF-E	2.1E-04	0.001	20.8%	YES	U	23.4%
22	2,5-Dihydrofuran	12	SD1-EF-F	2.0E-04	0.001	20.3%	YES	U	23.4%
22	2,5-Dihydrofuran	14	SD1-EF-G	4.2E-04	0.001	42.1%		J	23.4%
22	2,5-Dihydrofuran	16	SD1-EF-H	2.3E-04	0.001	23.0%	YES	U	23.4%
22	2,5-Dihydrofuran	2	SC1-IN-A	1.9E-04	0.001	19.4%	YES		23.4%
22	2,5-Dihydrofuran	4	SC1-IN-B	2.2E-04	0.001	21.9%	YES	U	23.4%
22	2,5-Dihydrofuran	6	SC1-IN-C	2.2E-04	0.001	22.0%	YES	U	23.4%
22	2,5-Dihydrofuran	8	SC1-IN-D	2.3E-04	0.001	23.1%	YES	U	23.4%
22	2,5-Dihydrofuran	10	SC1-IN-E	2.2E-04	0.001	22.3%	YES	U	23.4%
22	2,5-Dihydrofuran	12	SC1-IN-F	2.2E-04	0.001	22.4%	YES	U	23.4%
22	2,5-Dihydrofuran	14	SC1-IN-G	2.2E-04	0.001	22.4%	YES	U	23.4%
22	2,5-Dihydrofuran	16	SC1-IN-H	2.2E-04	0.001	21.5%	YES		23.4%
22	2,5-Dihydrofuran	2	SC1-EF-A	2.1E-04	0.001	21.1%	YES		23.4%
22	2,5-Dihydrofuran	4	SC1-EF-B	2.0E-04	0.001	20.4%	YES		23.4%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
22	2,5-Dihydrofuran	6	SC1-EF-C	2.2E-04	0.001	22.2%	YES		23.4%
22	2,5-Dihydrofuran	8	SC1-EF-D	2.2E-04	0.001	21.9%	YES		23.4%
22	2,5-Dihydrofuran	10	SC1-EF-E	2.2E-04	0.001	22.2%	YES		23.4%
22	2,5-Dihydrofuran	12	SC1-EF-F	2.2E-04	0.001	22.0%	YES		23.4%
22	2,5-Dihydrofuran	14	SC1-EF-G	2.3E-04	0.001	23.0%	YES		23.4%
22	2,5-Dihydrofuran	16	SC1-EF-H	2.2E-04	0.001	22.0%	YES		23.4%
23	2-Methylfuran	2	SD1-IN-A	8.6E-05	0.001	8.65%	YES	U	8.78%
23	2-Methylfuran	4	SD1-IN-B	8.3E-05	0.001	8.32%	YES	U	8.78%
23	2-Methylfuran	6	SD1-IN-C	8.0E-05	0.001	8.05%	YES	U	8.78%
23	2-Methylfuran	8	SD1-IN-D	8.3E-05	0.001	8.31%	YES	U	8.78%
23	2-Methylfuran	10	SD1-IN-E	8.3E-05	0.001	8.27%	YES	U	8.78%
23	2-Methylfuran	12	SD1-IN-F	8.1E-05	0.001	8.08%	YES	U	8.78%
23	2-Methylfuran	14	SD1-IN-G	7.5E-05	0.001	7.55%	YES	U	8.78%
23	2-Methylfuran	16	SD1-IN-H	8.6E-05	0.001	8.60%	YES	U	8.78%
23	2-Methylfuran	2	SD1-EF-A	8.2E-05	0.001	8.22%	YES	U	8.78%
23	2-Methylfuran	4	SD1-EF-B	8.1E-05	0.001	8.06%	YES	U	8.78%
23	2-Methylfuran	6	SD1-EF-C	8.7E-05	0.001	8.71%	YES	U	8.78%
23	2-Methylfuran	8	SD1-EF-D	8.8E-05	0.001	8.78%	YES	U	8.78%
23	2-Methylfuran	10	SD1-EF-E	7.8E-05	0.001	7.82%	YES	U	8.78%
23	2-Methylfuran	12	SD1-EF-F	7.6E-05	0.001	7.61%	YES	U	8.78%
23	2-Methylfuran	14	SD1-EF-G	8.1E-05	0.001	8.07%	YES	U	8.78%
23	2-Methylfuran	16	SD1-EF-H	8.6E-05	0.001	8.62%	YES	U	8.78%
23	2-Methylfuran	2	SC1-IN-A	1.1E-04	0.001	10.6%		J	8.78%
23	2-Methylfuran	4	SC1-IN-B	8.2E-05	0.001	8.21%	YES	U	8.78%
23	2-Methylfuran	6	SC1-IN-C	8.3E-05	0.001	8.28%	YES	U	8.78%
23	2-Methylfuran	8	SC1-IN-D	8.7E-05	0.001	8.68%	YES	U	8.78%
23	2-Methylfuran	10	SC1-IN-E	8.4E-05	0.001	8.38%	YES	U	8.78%
23	2-Methylfuran	12	SC1-IN-F	8.4E-05	0.001	8.41%	YES	U	8.78%
23	2-Methylfuran	14	SC1-IN-G	8.4E-05	0.001	8.40%	YES	U	8.78%
23	2-Methylfuran	16	SC1-IN-H	8.1E-05	0.001	8.08%	YES		8.78%
23	2-Methylfuran	2	SC1-EF-A	7.9E-05	0.001	7.91%	YES		8.78%
23	2-Methylfuran	4	SC1-EF-B	7.7E-05	0.001	7.66%	YES		8.78%
23	2-Methylfuran	6	SC1-EF-C	8.3E-05	0.001	8.32%	YES		8.78%
23	2-Methylfuran	8	SC1-EF-D	8.2E-05	0.001	8.22%	YES		8.78%
23	2-Methylfuran	10	SC1-EF-E	8.3E-05	0.001	8.33%	YES		8.78%
23	2-Methylfuran	12	SC1-EF-F	8.3E-05	0.001	8.28%	YES		8.78%
23	2-Methylfuran	14	SC1-EF-G	8.7E-05	0.001	8.65%	YES		8.78%
23	2-Methylfuran	16	SC1-EF-H	8.2E-05	0.001	8.25%	YES		8.78%
24	2,5-Dimethylfuran	2	SD1-IN-A	2.8E-05	0.001	2.77%	YES	U	3.14%
24	2,5-Dimethylfuran	4	SD1-IN-B	2.7E-05	0.001	2.70%	YES	U	3.14%
24	2,5-Dimethylfuran	6	SD1-IN-C	2.9E-05	0.001	2.87%	YES	U	3.14%
24	2,5-Dimethylfuran	8	SD1-IN-D	2.9E-05	0.001	2.87%	YES		3.14%
24	2,5-Dimethylfuran	10	SD1-IN-E	3.0E-05	0.001	2.99%	YES	U	3.14%
24	2,5-Dimethylfuran	12	SD1-IN-F	2.7E-05	0.001	2.70%	YES	U	3.14%
24	2,5-Dimethylfuran	14	SD1-IN-G	2.8E-05	0.001	2.77%	YES	U	3.14%
24	2,5-Dimethylfuran	16	SD1-IN-H	3.0E-05	0.001	3.04%	YES	U	3.14%
24	2,5-Dimethylfuran	2	SD1-EF-A	2.7E-05	0.001	2.73%	YES	U	3.14%
24	2,5-Dimethylfuran	4	SD1-EF-B	2.9E-05	0.001	2.90%	YES	U	3.14%
24	2,5-Dimethylfuran	6	SD1-EF-C	2.7E-05	0.001	2.69%	YES	U	3.14%
24	2,5-Dimethylfuran	8	SD1-EF-D	2.8E-05	0.001	2.79%	YES	U	3.14%
24	2,5-Dimethylfuran	10	SD1-EF-E	2.9E-05	0.001	2.92%	YES	U	3.14%
24	2,5-Dimethylfuran	12	SD1-EF-F	2.9E-05	0.001	2.88%	YES	U	3.14%
24	2,5-Dimethylfuran	14	SD1-EF-G		0.001				3.14%
24	2,5-Dimethylfuran	16	SD1-EF-H	2.9E-05	0.001	2.91%	YES	U	3.14%
24	2,5-Dimethylfuran	2	SC1-IN-A	2.6E-05	0.001	2.58%	YES	U	3.14%
24	2,5-Dimethylfuran	4	SC1-IN-B	3.1E-05	0.001	3.14%	YES	U	3.14%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
24	2,5-Dimethylfuran	6	SC1-IN-C	2.9E-05	0.001	2.94%	YES	U	3.14%
24	2,5-Dimethylfuran	8	SC1-IN-D	3.1E-05	0.001	3.09%	YES	U	3.14%
24	2,5-Dimethylfuran	10	SC1-IN-E	2.7E-05	0.001	2.70%	YES	U	3.14%
24	2,5-Dimethylfuran	12	SC1-IN-F	3.0E-05	0.001	3.01%	YES	U	3.14%
24	2,5-Dimethylfuran	14	SC1-IN-G	2.8E-05	0.001	2.80%	YES	U	3.14%
24	2,5-Dimethylfuran	16	SC1-IN-H	3.0E-05	0.001	3.00%	YES	U	3.14%
24	2,5-Dimethylfuran	2	SC1-EF-A	3.1E-05	0.001	3.11%	YES	U	3.14%
24	2,5-Dimethylfuran	4	SC1-EF-B	2.8E-05	0.001	2.81%	YES	U	3.14%
24	2,5-Dimethylfuran	6	SC1-EF-C	2.8E-05	0.001	2.83%	YES	U	3.14%
24	2,5-Dimethylfuran	8	SC1-EF-D	2.8E-05	0.001	2.83%	YES	U	3.14%
24	2,5-Dimethylfuran	10	SC1-EF-E	2.9E-05	0.001	2.87%	YES	U	3.14%
24	2,5-Dimethylfuran	12	SC1-EF-F	2.9E-05	0.001	2.92%	YES	U	3.14%
24	2,5-Dimethylfuran	14	SC1-EF-G	2.9E-05	0.001	2.90%	YES	U	3.14%
24	2,5-Dimethylfuran	16	SC1-EF-H	2.9E-05	0.001	2.93%	YES	U	3.14%
28	2-Pentylfuran	2	SD1-IN-A	2.8E-05	0.001	2.79%	YES	U	3.16%
28	2-Pentylfuran	4	SD1-IN-B	2.7E-05	0.001	2.72%	YES	U	3.16%
28	2-Pentylfuran	6	SD1-IN-C	2.9E-05	0.001	2.89%	YES	U	3.16%
28	2-Pentylfuran	8	SD1-IN-D	2.9E-05	0.001	2.89%	YES		3.16%
28	2-Pentylfuran	10	SD1-IN-E	3.0E-05	0.001	3.01%	YES	U	3.16%
28	2-Pentylfuran	12	SD1-IN-F	2.7E-05	0.001	2.72%	YES	U	3.16%
28	2-Pentylfuran	14	SD1-IN-G	2.8E-05	0.001	2.78%	YES	U	3.16%
28	2-Pentylfuran	16	SD1-IN-H	3.1E-05	0.001	3.06%	YES	U	3.16%
28	2-Pentylfuran	2	SD1-EF-A	2.7E-05	0.001	2.75%	YES	U	3.16%
28	2-Pentylfuran	4	SD1-EF-B	2.9E-05	0.001	2.92%	YES	U	3.16%
28	2-Pentylfuran	6	SD1-EF-C	2.7E-05	0.001	2.71%	YES	U	3.16%
28	2-Pentylfuran	8	SD1-EF-D	2.8E-05	0.001	2.81%	YES	U	3.16%
28	2-Pentylfuran	10	SD1-EF-E	2.9E-05	0.001	2.94%	YES	U	3.16%
28	2-Pentylfuran	12	SD1-EF-F	2.9E-05	0.001	2.90%	YES	U	3.16%
28	2-Pentylfuran	14	SD1-EF-G		0.001				3.16%
28	2-Pentylfuran	16	SD1-EF-H	2.9E-05	0.001	2.93%	YES	U	3.16%
28	2-Pentylfuran	2	SC1-IN-A	2.6E-05	0.001	2.60%	YES	U	3.16%
28	2-Pentylfuran	4	SC1-IN-B	3.2E-05	0.001	3.16%	YES	U	3.16%
28	2-Pentylfuran	6	SC1-IN-C	3.0E-05	0.001	2.96%	YES	U	3.16%
28	2-Pentylfuran	8	SC1-IN-D	3.1E-05	0.001	3.11%	YES	U	3.16%
28	2-Pentylfuran	10	SC1-IN-E	2.7E-05	0.001	2.72%	YES	U	3.16%
28	2-Pentylfuran	12	SC1-IN-F	3.0E-05	0.001	3.03%	YES	U	3.16%
28	2-Pentylfuran	14	SC1-IN-G	2.8E-05	0.001	2.81%	YES	U	3.16%
28	2-Pentylfuran	16	SC1-IN-H	3.0E-05	0.001	3.02%	YES	U	3.16%
28	2-Pentylfuran	2	SC1-EF-A	3.1E-05	0.001	3.14%	YES	U	3.16%
28	2-Pentylfuran	4	SC1-EF-B	2.8E-05	0.001	2.83%	YES	U	3.16%
28	2-Pentylfuran	6	SC1-EF-C	2.9E-05	0.001	2.85%	YES	U	3.16%
28	2-Pentylfuran	8	SC1-EF-D	2.8E-05	0.001	2.85%	YES	U	3.16%
28	2-Pentylfuran	10	SC1-EF-E	2.9E-05	0.001	2.89%	YES	U	3.16%
28	2-Pentylfuran	12	SC1-EF-F	2.9E-05	0.001	2.94%	YES	U	3.16%
28	2-Pentylfuran	14	SC1-EF-G	2.9E-05	0.001	2.92%	YES	U	3.16%
28	2-Pentylfuran	16	SC1-EF-H	2.9E-05	0.001	2.95%	YES	U	3.16%
29	2-Heptylfuran	2	SD1-IN-A	2.6E-05	0.001	2.63%	YES	U	2.98%
29	2-Heptylfuran	4	SD1-IN-B	2.6E-05	0.001	2.57%	YES	U	2.98%
29	2-Heptylfuran	6	SD1-IN-C	2.7E-05	0.001	2.72%	YES	U	2.98%
29	2-Heptylfuran	8	SD1-IN-D	2.7E-05	0.001	2.73%	YES		2.98%
29	2-Heptylfuran	10	SD1-IN-E	2.8E-05	0.001	2.83%	YES	U	2.98%
29	2-Heptylfuran	12	SD1-IN-F	2.6E-05	0.001	2.56%	YES	U	2.98%
29	2-Heptylfuran	14	SD1-IN-G	2.6E-05	0.001	2.63%	YES	U	2.98%
29	2-Heptylfuran	16	SD1-IN-H	2.9E-05	0.001	2.88%	YES	U	2.98%
29	2-Heptylfuran	2	SD1-EF-A	2.6E-05	0.001	2.59%	YES	U	2.98%
29	2-Heptylfuran	4	SD1-EF-B	2.7E-05	0.001	2.75%	YES	U	2.98%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
29	2-Heptylfuran	6	SD1-EF-C	2.6E-05	0.001	2.55%	YES	U	2.98%
29	2-Heptylfuran	8	SD1-EF-D	2.6E-05	0.001	2.65%	YES	U	2.98%
29	2-Heptylfuran	10	SD1-EF-E	2.8E-05	0.001	2.77%	YES	U	2.98%
29	2-Heptylfuran	12	SD1-EF-F	2.7E-05	0.001	2.73%	YES	U	2.98%
29	2-Heptylfuran	14	SD1-EF-G		0.001				2.98%
29	2-Heptylfuran	16	SD1-EF-H	2.8E-05	0.001	2.76%	YES	U	2.98%
29	2-Heptylfuran	2	SC1-IN-A	2.4E-05	0.001	2.45%	YES	U	2.98%
29	2-Heptylfuran	4	SC1-IN-B	3.0E-05	0.001	2.98%	YES	U	2.98%
29	2-Heptylfuran	6	SC1-IN-C	2.8E-05	0.001	2.79%	YES	U	2.98%
29	2-Heptylfuran	8	SC1-IN-D	2.9E-05	0.001	2.93%	YES	U	2.98%
29	2-Heptylfuran	10	SC1-IN-E	2.6E-05	0.001	2.57%	YES	U	2.98%
29	2-Heptylfuran	12	SC1-IN-F	2.9E-05	0.001	2.86%	YES	U	2.98%
29	2-Heptylfuran	14	SC1-IN-G	2.7E-05	0.001	2.65%	YES	U	2.98%
29	2-Heptylfuran	16	SC1-IN-H	2.8E-05	0.001	2.85%	YES	U	2.98%
29	2-Heptylfuran	2	SC1-EF-A	3.0E-05	0.001	2.96%	YES	U	2.98%
29	2-Heptylfuran	4	SC1-EF-B	2.7E-05	0.001	2.67%	YES	U	2.98%
29	2-Heptylfuran	6	SC1-EF-C	2.7E-05	0.001	2.69%	YES	U	2.98%
29	2-Heptylfuran	8	SC1-EF-D	2.7E-05	0.001	2.69%	YES	U	2.98%
29	2-Heptylfuran	10	SC1-EF-E	2.7E-05	0.001	2.72%	YES	U	2.98%
29	2-Heptylfuran	12	SC1-EF-F	2.8E-05	0.001	2.78%	YES	U	2.98%
29	2-Heptylfuran	14	SC1-EF-G	2.8E-05	0.001	2.75%	YES	U	2.98%
29	2-Heptylfuran	16	SC1-EF-H	2.8E-05	0.001	2.78%	YES	U	2.98%
30	2-Propylfuran	2	SD1-IN-A	1.7E-05	0.001	1.66%	YES	U	1.88%
30	2-Propylfuran	4	SD1-IN-B	1.6E-05	0.001	1.62%	YES	U	1.88%
30	2-Propylfuran	6	SD1-IN-C	1.7E-05	0.001	1.72%	YES	U	1.88%
30	2-Propylfuran	8	SD1-IN-D	1.7E-05	0.001	1.72%	YES		1.88%
30	2-Propylfuran	10	SD1-IN-E	1.8E-05	0.001	1.79%	YES	U	1.88%
30	2-Propylfuran	12	SD1-IN-F	1.6E-05	0.001	1.62%	YES	U	1.88%
30	2-Propylfuran	14	SD1-IN-G	1.7E-05	0.001	1.66%	YES	U	1.88%
30	2-Propylfuran	16	SD1-IN-H	1.8E-05	0.001	1.82%	YES	U	1.88%
30	2-Propylfuran	2	SD1-EF-A	1.6E-05	0.001	1.64%	YES	U	1.88%
30	2-Propylfuran	4	SD1-EF-B	1.7E-05	0.001	1.74%	YES	U	1.88%
30	2-Propylfuran	6	SD1-EF-C	1.6E-05	0.001	1.61%	YES	U	1.88%
30	2-Propylfuran	8	SD1-EF-D	1.7E-05	0.001	1.67%	YES	U	1.88%
30	2-Propylfuran	10	SD1-EF-E	1.7E-05	0.001	1.75%	YES	U	1.88%
30	2-Propylfuran	12	SD1-EF-F	1.7E-05	0.001	1.72%	YES	U	1.88%
30	2-Propylfuran	14	SD1-EF-G		0.001				1.88%
30	2-Propylfuran	16	SD1-EF-H	1.7E-05	0.001	1.74%	YES	U	1.88%
30	2-Propylfuran	2	SC1-IN-A	1.5E-05	0.001	1.55%	YES	U	1.88%
30	2-Propylfuran	4	SC1-IN-B	1.9E-05	0.001	1.88%	YES	U	1.88%
30	2-Propylfuran	6	SC1-IN-C	1.8E-05	0.001	1.76%	YES	U	1.88%
30	2-Propylfuran	8	SC1-IN-D	1.9E-05	0.001	1.85%	YES	U	1.88%
30	2-Propylfuran	10	SC1-IN-E	1.6E-05	0.001	1.62%	YES	U	1.88%
30	2-Propylfuran	12	SC1-IN-F	1.8E-05	0.001	1.80%	YES	U	1.88%
30	2-Propylfuran	14	SC1-IN-G	1.7E-05	0.001	1.67%	YES	U	1.88%
30	2-Propylfuran	16	SC1-IN-H	1.8E-05	0.001	1.80%	YES	U	1.88%
30	2-Propylfuran	2	SC1-EF-A	1.9E-05	0.001	1.87%	YES	U	1.88%
30	2-Propylfuran	4	SC1-EF-B	1.7E-05	0.001	1.68%	YES	U	1.88%
30	2-Propylfuran	6	SC1-EF-C	1.7E-05	0.001	1.70%	YES	U	1.88%
30	2-Propylfuran	8	SC1-EF-D	1.7E-05	0.001	1.70%	YES	U	1.88%
30	2-Propylfuran	10	SC1-EF-E	1.7E-05	0.001	1.72%	YES	U	1.88%
30	2-Propylfuran	12	SC1-EF-F	1.8E-05	0.001	1.75%	YES	U	1.88%
30	2-Propylfuran	14	SC1-EF-G	1.7E-05	0.001	1.74%	YES	U	1.88%
30	2-Propylfuran	16	SC1-EF-H	1.8E-05	0.001	1.75%	YES	U	1.88%
34	Diethylphthalate	2	SD1-IN-A	5.9E-05	0.54	0.011%	YES	U	0.0109%
34	Diethylphthalate	4	SD1-IN-B	8.9E-05	0.54	0.016%		J	0.0109%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
34	Diethylphthalate	6	SD1-IN-C	5.7E-05	0.54	0.011%	YES	U	0.0109%
34	Diethylphthalate	8	SD1-IN-D	5.7E-05	0.54	0.010%	YES	U	0.0109%
34	Diethylphthalate	10	SD1-IN-E	5.8E-05	0.54	0.011%	YES	U	0.0109%
34	Diethylphthalate	12	SD1-IN-F	5.9E-05	0.54	0.011%	YES	U	0.0109%
34	Diethylphthalate	14	SD1-IN-G	6.0E-05	0.54	0.011%		J	0.0109%
34	Diethylphthalate	16	SD1-IN-H	5.6E-05	0.54	0.010%	YES	U	0.0109%
34	Diethylphthalate	2	SD1-EF-A	5.4E-05	0.54	0.010%	YES	U	0.0109%
34	Diethylphthalate	4	SD1-EF-B	8.0E-05	0.54	0.015%		J	0.0109%
34	Diethylphthalate	6	SD1-EF-C	9.8E-05	0.54	0.018%		J	0.0109%
34	Diethylphthalate	8	SD1-EF-D		0.54				0.0109%
34	Diethylphthalate	10	SD1-EF-E	9.5E-05	0.54	0.018%		J	0.0109%
34	Diethylphthalate	12	SD1-EF-F	5.5E-05	0.54	0.010%	YES	U,S*	0.0109%
34	Diethylphthalate	14	SD1-EF-G	6.7E-05	0.54	0.012%		J	0.0109%
34	Diethylphthalate	16	SD1-EF-H	6.3E-05	0.54	0.012%		J	0.0109%
34	Diethylphthalate	2	SC1-IN-A	5.5E-05	0.54	0.010%	YES	U	0.0109%
34	Diethylphthalate	4	SC1-IN-B	5.8E-05	0.54	0.011%	YES	U	0.0109%
34	Diethylphthalate	6	SC1-IN-C	5.4E-05	0.54	0.010%	YES	U	0.0109%
34	Diethylphthalate	8	SC1-IN-D	5.4E-05	0.54	0.010%		J	0.0109%
34	Diethylphthalate	10	SC1-IN-E	7.8E-05	0.54	0.014%		J	0.0109%
34	Diethylphthalate	12	SC1-IN-F	5.6E-05	0.54	0.010%	YES	U	0.0109%
34	Diethylphthalate	14	SC1-IN-G	7.0E-05	0.54	0.013%		J	0.0109%
34	Diethylphthalate	16	SC1-IN-H	5.8E-05	0.54	0.011%	YES	U	0.0109%
34	Diethylphthalate	2	SC1-EF-A	1.9E-04	0.54	0.035%		J	0.0109%
34	Diethylphthalate	4	SC1-EF-B	5.1E-05	0.54	0.009%	YES	U	0.0109%
34	Diethylphthalate	6	SC1-EF-C	5.1E-05	0.54	0.009%	YES	U	0.0109%
34	Diethylphthalate	8	SC1-EF-D	1.2E-04	0.54	0.022%		J	0.0109%
34	Diethylphthalate	10	SC1-EF-E	5.4E-05	0.54	0.010%	YES	U	0.0109%
34	Diethylphthalate	12	SC1-EF-F	5.4E-05	0.54	0.010%	YES	U,S*	0.0109%
34	Diethylphthalate	14	SC1-EF-G	9.5E-05	0.54	0.018%		J	0.0109%
34	Diethylphthalate	16	SC1-EF-H	8.2E-05	0.54	0.015%		J	0.0109%
35	Acetonitrile	2	SD1-IN-A	2.2E-03	20	0.011%			0.000958%
35	Acetonitrile	4	SD1-IN-B	2.9E-02	20	0.144%			0.000958%
35	Acetonitrile	6	SD1-IN-C	6.4E-03	20	0.032%			0.000958%
35	Acetonitrile	8	SD1-IN-D	1.0E-02	20	0.050%			0.000958%
35	Acetonitrile	10	SD1-IN-E	8.0E-04	20	0.004%		J	0.000958%
35	Acetonitrile	12	SD1-IN-F	1.3E-03	20	0.006%		J	0.000958%
35	Acetonitrile	14	SD1-IN-G	8.6E-04	20	0.004%		J	0.000958%
35	Acetonitrile	16	SD1-IN-H	2.0E-03	20	0.010%			0.000958%
35	Acetonitrile	2	SD1-EF-A	1.2E-03	20	0.006%		J	0.000958%
35	Acetonitrile	4	SD1-EF-B	8.8E-03	20	0.044%			0.000958%
35	Acetonitrile	6	SD1-EF-C	1.2E-03	20	0.006%		J	0.000958%
35	Acetonitrile	8	SD1-EF-D	8.0E-04	20	0.004%		J	0.000958%
35	Acetonitrile	10	SD1-EF-E	4.6E-04	20	0.002%		J	0.000958%
35	Acetonitrile	12	SD1-EF-F	2.4E-03	20	0.012%			0.000958%
35	Acetonitrile	14	SD1-EF-G	2.8E-03	20	0.014%			0.000958%
35	Acetonitrile	16	SD1-EF-H	8.8E-04	20	0.004%		J	0.000958%
35	Acetonitrile	2	SC1-IN-A	8.1E-02	20	0.404%		E	0.000958%
35	Acetonitrile	4	SC1-IN-B	2.2E-01	20	1.12%		EY	0.000958%
35	Acetonitrile	6	SC1-IN-C	6.5E-02	20	0.324%		E	0.000958%
35	Acetonitrile	8	SC1-IN-D	2.1E-02	20	0.103%			0.000958%
35	Acetonitrile	10	SC1-IN-E	8.2E-02	20	0.412%		E	0.000958%
35	Acetonitrile	12	SC1-IN-F	1.7E-02	20	0.084%			0.000958%
35	Acetonitrile	14	SC1-IN-G	6.0E-02	20	0.298%			0.000958%
35	Acetonitrile	16	SC1-IN-H	4.8E-02	20	0.242%			0.000958%
35	Acetonitrile	2	SC1-EF-A	7.6E-03	20	0.038%			0.000958%
35	Acetonitrile	4	SC1-EF-B	9.3E-03	20	0.047%			0.000958%
35	Acetonitrile	6	SC1-EF-C	9.1E-03	20	0.045%			0.000958%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
35	Acetonitrile	8	SC1-EF-D	1.0E-02	20	0.050%			0.000958%
35	Acetonitrile	10	SC1-EF-E	1.1E-02	20	0.054%			0.000958%
35	Acetonitrile	12	SC1-EF-F	7.8E-01	20	3.91%		EY	0.000958%
35	Acetonitrile	14	SC1-EF-G	9.0E-03	20	0.045%			0.000958%
35	Acetonitrile	16	SC1-EF-H	2.1E-02	20	0.105%			0.000958%
36	Propanenitrile	2	SD1-IN-A	1.5E-04	6.0	0.003%	YES	U	0.00258%
36	Propanenitrile	4	SD1-IN-B	1.5E-04	6.0	0.002%	YES	U	0.00258%
36	Propanenitrile	6	SD1-IN-C	1.4E-04	6.0	0.002%	YES	U	0.00258%
36	Propanenitrile	8	SD1-IN-D	1.5E-04	6.0	0.002%	YES	U	0.00258%
36	Propanenitrile	10	SD1-IN-E	1.5E-04	6.0	0.002%	YES	U	0.00258%
36	Propanenitrile	12	SD1-IN-F	1.4E-04	6.0	0.002%	YES	U	0.00258%
36	Propanenitrile	14	SD1-IN-G	1.3E-04	6.0	0.002%	YES	U	0.00258%
36	Propanenitrile	16	SD1-IN-H	1.5E-04	6.0	0.003%	YES	U	0.00258%
36	Propanenitrile	2	SD1-EF-A	1.4E-04	6.0	0.002%	YES	U	0.00258%
36	Propanenitrile	4	SD1-EF-B	1.4E-04	6.0	0.002%	YES	U	0.00258%
36	Propanenitrile	6	SD1-EF-C	1.5E-04	6.0	0.003%	YES	U	0.00258%
36	Propanenitrile	8	SD1-EF-D	1.5E-04	6.0	0.003%	YES	U	0.00258%
36	Propanenitrile	10	SD1-EF-E	1.4E-04	6.0	0.002%	YES	U	0.00258%
36	Propanenitrile	12	SD1-EF-F	1.3E-04	6.0	0.002%	YES	U	0.00258%
36	Propanenitrile	14	SD1-EF-G	1.4E-04	6.0	0.002%	YES	U	0.00258%
36	Propanenitrile	16	SD1-EF-H	1.5E-04	6.0	0.003%	YES	U	0.00258%
36	Propanenitrile	2	SC1-IN-A	3.0E-03	6.0	0.049%			0.00258%
36	Propanenitrile	4	SC1-IN-B	3.0E-03	6.0	0.050%			0.00258%
36	Propanenitrile	6	SC1-IN-C	1.8E-03	6.0	0.030%			0.00258%
36	Propanenitrile	8	SC1-IN-D	1.5E-04	6.0	0.003%	YES	U	0.00258%
36	Propanenitrile	10	SC1-IN-E	1.2E-03	6.0	0.021%		J	0.00258%
36	Propanenitrile	12	SC1-IN-F	1.5E-04	6.0	0.002%	YES	U	0.00258%
36	Propanenitrile	14	SC1-IN-G	1.5E-03	6.0	0.025%			0.00258%
36	Propanenitrile	16	SC1-IN-H	1.0E-03	6.0	0.017%		J	0.00258%
36	Propanenitrile	2	SC1-EF-A	1.4E-04	6.0	0.002%	YES		0.00258%
36	Propanenitrile	4	SC1-EF-B	1.3E-04	6.0	0.002%	YES		0.00258%
36	Propanenitrile	6	SC1-EF-C	1.5E-04	6.0	0.002%	YES		0.00258%
36	Propanenitrile	8	SC1-EF-D	1.4E-04	6.0	0.002%	YES		0.00258%
36	Propanenitrile	10	SC1-EF-E	1.5E-04	6.0	0.002%	YES		0.00258%
36	Propanenitrile	12	SC1-EF-F	1.5E-04	6.0	0.002%	YES		0.00258%
36	Propanenitrile	14	SC1-EF-G	1.5E-04	6.0	0.003%	YES		0.00258%
36	Propanenitrile	16	SC1-EF-H	1.5E-04	6.0	0.002%	YES		0.00258%
37	Butanenitrile	2	SD1-IN-A	1.2E-04	8.0	0.002%		J	0.00111%
37	Butanenitrile	4	SD1-IN-B	2.6E-04	8.0	0.003%		J	0.00111%
37	Butanenitrile	6	SD1-IN-C	8.6E-05	8.0	0.001%	YES	U	0.00111%
37	Butanenitrile	8	SD1-IN-D	8.9E-05	8.0	0.001%	YES	U	0.00111%
37	Butanenitrile	10	SD1-IN-E	8.8E-05	8.0	0.001%	YES	U	0.00111%
37	Butanenitrile	12	SD1-IN-F	8.6E-05	8.0	0.001%	YES	U	0.00111%
37	Butanenitrile	14	SD1-IN-G	1.2E-04	8.0	0.002%		J	0.00111%
37	Butanenitrile	16	SD1-IN-H	1.1E-04	8.0	0.001%		J	0.00111%
37	Butanenitrile	2	SD1-EF-A	5.2E-04	8.0	0.006%		J	0.00111%
37	Butanenitrile	4	SD1-EF-B	1.2E-04	8.0	0.002%		J	0.00111%
37	Butanenitrile	6	SD1-EF-C	3.9E-04	8.0	0.005%		J	0.00111%
37	Butanenitrile	8	SD1-EF-D	2.7E-04	8.0	0.003%		J	0.00111%
37	Butanenitrile	10	SD1-EF-E	3.2E-04	8.0	0.004%		J	0.00111%
37	Butanenitrile	12	SD1-EF-F	3.1E-04	8.0	0.004%		J	0.00111%
37	Butanenitrile	14	SD1-EF-G	3.1E-04	8.0	0.004%		J	0.00111%
37	Butanenitrile	16	SD1-EF-H	2.0E-04	8.0	0.003%		J	0.00111%
37	Butanenitrile	2	SC1-IN-A	1.2E-02	8.0	0.148%			0.00111%
37	Butanenitrile	4	SC1-IN-B	5.1E-03	8.0	0.064%			0.00111%
37	Butanenitrile	6	SC1-IN-C	4.9E-03	8.0	0.061%			0.00111%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
37	Butanenitrile	8	SC1-IN-D	1.2E-04	8.0	0.002%		J	0.00111%
37	Butanenitrile	10	SC1-IN-E	1.8E-03	8.0	0.023%			0.00111%
37	Butanenitrile	12	SC1-IN-F	1.6E-04	8.0	0.002%		J	0.00111%
37	Butanenitrile	14	SC1-IN-G	1.6E-03	8.0	0.020%			0.00111%
37	Butanenitrile	16	SC1-IN-H	1.9E-03	8.0	0.024%			0.00111%
37	Butanenitrile	2	SC1-EF-A	4.1E-04	8.0	0.005%		J	0.00111%
37	Butanenitrile	4	SC1-EF-B	4.2E-04	8.0	0.005%		J	0.00111%
37	Butanenitrile	6	SC1-EF-C	4.4E-04	8.0	0.006%		J	0.00111%
37	Butanenitrile	8	SC1-EF-D	5.0E-04	8.0	0.006%		J	0.00111%
37	Butanenitrile	10	SC1-EF-E	8.9E-05	8.0	0.001%	YES		0.00111%
37	Butanenitrile	12	SC1-EF-F	3.4E-04	8.0	0.004%		J	0.00111%
37	Butanenitrile	14	SC1-EF-G	2.5E-04	8.0	0.003%		J	0.00111%
37	Butanenitrile	16	SC1-EF-H	2.5E-04	8.0	0.003%		J	0.00111%
38	Pentanenitrile	2	SD1-IN-A	9.3E-05	6.0	0.002%	YES	U	0.00158%
38	Pentanenitrile	4	SD1-IN-B	9.0E-05	6.0	0.001%	YES	U	0.00158%
38	Pentanenitrile	6	SD1-IN-C	8.7E-05	6.0	0.001%	YES	U	0.00158%
38	Pentanenitrile	8	SD1-IN-D	9.0E-05	6.0	0.001%	YES	U	0.00158%
38	Pentanenitrile	10	SD1-IN-E	8.9E-05	6.0	0.001%	YES	U	0.00158%
38	Pentanenitrile	12	SD1-IN-F	8.7E-05	6.0	0.001%	YES	U	0.00158%
38	Pentanenitrile	14	SD1-IN-G	8.1E-05	6.0	0.001%	YES	U	0.00158%
38	Pentanenitrile	16	SD1-IN-H	9.3E-05	6.0	0.002%	YES	U	0.00158%
38	Pentanenitrile	2	SD1-EF-A	8.9E-05	6.0	0.001%	YES	U	0.00158%
38	Pentanenitrile	4	SD1-EF-B	8.7E-05	6.0	0.001%	YES	U	0.00158%
38	Pentanenitrile	6	SD1-EF-C	9.4E-05	6.0	0.002%	YES	U	0.00158%
38	Pentanenitrile	8	SD1-EF-D	9.5E-05	6.0	0.002%	YES	U	0.00158%
38	Pentanenitrile	10	SD1-EF-E	8.4E-05	6.0	0.001%	YES	U	0.00158%
38	Pentanenitrile	12	SD1-EF-F	8.2E-05	6.0	0.001%	YES	U	0.00158%
38	Pentanenitrile	14	SD1-EF-G	8.7E-05	6.0	0.001%	YES	U	0.00158%
38	Pentanenitrile	16	SD1-EF-H	9.3E-05	6.0	0.002%	YES	U	0.00158%
38	Pentanenitrile	2	SC1-IN-A	1.5E-03	6.0	0.025%			0.00158%
38	Pentanenitrile	4	SC1-IN-B	8.8E-04	6.0	0.015%		J	0.00158%
38	Pentanenitrile	6	SC1-IN-C	8.9E-04	6.0	0.015%		J	0.00158%
38	Pentanenitrile	8	SC1-IN-D	9.3E-05	6.0	0.002%	YES	U	0.00158%
38	Pentanenitrile	10	SC1-IN-E	2.6E-04	6.0	0.004%		J	0.00158%
38	Pentanenitrile	12	SC1-IN-F	9.1E-05	6.0	0.002%	YES	U	0.00158%
38	Pentanenitrile	14	SC1-IN-G	2.5E-04	6.0	0.004%		J	0.00158%
38	Pentanenitrile	16	SC1-IN-H	3.4E-04	6.0	0.006%		J	0.00158%
38	Pentanenitrile	2	SC1-EF-A	8.5E-05	6.0	0.001%	YES		0.00158%
38	Pentanenitrile	4	SC1-EF-B	8.2E-05	6.0	0.001%	YES		0.00158%
38	Pentanenitrile	6	SC1-EF-C	9.0E-05	6.0	0.001%	YES		0.00158%
38	Pentanenitrile	8	SC1-EF-D	8.9E-05	6.0	0.001%	YES		0.00158%
38	Pentanenitrile	10	SC1-EF-E	9.0E-05	6.0	0.001%	YES		0.00158%
38	Pentanenitrile	12	SC1-EF-F	8.9E-05	6.0	0.001%	YES		0.00158%
38	Pentanenitrile	14	SC1-EF-G	9.3E-05	6.0	0.002%	YES		0.00158%
38	Pentanenitrile	16	SC1-EF-H	8.9E-05	6.0	0.001%	YES		0.00158%
39	Hexanenitrile	2	SD1-IN-A	6.6E-05	6.0	0.001%	YES	U	0.00112%
39	Hexanenitrile	4	SD1-IN-B	6.4E-05	6.0	0.001%	YES	U	0.00112%
39	Hexanenitrile	6	SD1-IN-C	6.2E-05	6.0	0.001%	YES	U	0.00112%
39	Hexanenitrile	8	SD1-IN-D	6.4E-05	6.0	0.001%	YES	U	0.00112%
39	Hexanenitrile	10	SD1-IN-E	6.4E-05	6.0	0.001%	YES	U	0.00112%
39	Hexanenitrile	12	SD1-IN-F	6.2E-05	6.0	0.001%	YES	U	0.00112%
39	Hexanenitrile	14	SD1-IN-G	5.8E-05	6.0	0.001%	YES	U	0.00112%
39	Hexanenitrile	16	SD1-IN-H	6.6E-05	6.0	0.001%	YES	U	0.00112%
39	Hexanenitrile	2	SD1-EF-A	6.3E-05	6.0	0.001%	YES	U	0.00112%
39	Hexanenitrile	4	SD1-EF-B	6.2E-05	6.0	0.001%	YES	U	0.00112%
39	Hexanenitrile	6	SD1-EF-C	6.7E-05	6.0	0.001%	YES	U	0.00112%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
39	Hexanenitrile	8	SD1-EF-D	6.7E-05	6.0	0.001%	YES	U	0.00112%
39	Hexanenitrile	10	SD1-EF-E	6.0E-05	6.0	0.001%	YES	U	0.00112%
39	Hexanenitrile	12	SD1-EF-F	5.8E-05	6.0	0.001%	YES	U	0.00112%
39	Hexanenitrile	14	SD1-EF-G	6.2E-05	6.0	0.001%	YES	U	0.00112%
39	Hexanenitrile	16	SD1-EF-H	6.6E-05	6.0	0.001%	YES	U	0.00112%
39	Hexanenitrile	2	SC1-IN-A	1.0E-03	6.0	0.017%			0.00112%
39	Hexanenitrile	4	SC1-IN-B	1.3E-04	6.0	0.002%		J	0.00112%
39	Hexanenitrile	6	SC1-IN-C	2.2E-04	6.0	0.004%		J	0.00112%
39	Hexanenitrile	8	SC1-IN-D	6.7E-05	6.0	0.001%	YES	U	0.00112%
39	Hexanenitrile	10	SC1-IN-E	6.4E-05	6.0	0.001%	YES	U	0.00112%
39	Hexanenitrile	12	SC1-IN-F	6.5E-05	6.0	0.001%	YES	U	0.00112%
39	Hexanenitrile	14	SC1-IN-G	6.4E-05	6.0	0.001%	YES	U	0.00112%
39	Hexanenitrile	16	SC1-IN-H	6.2E-05	6.0	0.001%	YES		0.00112%
39	Hexanenitrile	2	SC1-EF-A	6.1E-05	6.0	0.001%	YES		0.00112%
39	Hexanenitrile	4	SC1-EF-B	5.9E-05	6.0	0.001%	YES		0.00112%
39	Hexanenitrile	6	SC1-EF-C	6.4E-05	6.0	0.001%	YES		0.00112%
39	Hexanenitrile	8	SC1-EF-D	6.3E-05	6.0	0.001%	YES		0.00112%
39	Hexanenitrile	10	SC1-EF-E	6.4E-05	6.0	0.001%	YES		0.00112%
39	Hexanenitrile	12	SC1-EF-F	6.4E-05	6.0	0.001%	YES		0.00112%
39	Hexanenitrile	14	SC1-EF-G	6.6E-05	6.0	0.001%	YES		0.00112%
39	Hexanenitrile	16	SC1-EF-H	6.3E-05	6.0	0.001%	YES		0.00112%
43	Ethylamine	2	SD1-IN-A	2.6E-02	5.0	0.518%			0.0922%
43	Ethylamine	4	SD1-IN-B	2.9E-02	5.0	0.572%			0.0922%
43	Ethylamine	6	SD1-IN-C	3.0E-02	5.0	0.591%			0.0922%
43	Ethylamine	8	SD1-IN-D	3.3E-02	5.0	0.652%			0.0922%
43	Ethylamine	10	SD1-IN-E	4.4E-02	5.0	0.880%			0.0922%
43	Ethylamine	12	SD1-IN-F		5.0				0.0922%
43	Ethylamine	14	SD1-IN-G	4.2E-03	5.0	0.083%	YES		0.0922%
43	Ethylamine	16	SD1-IN-H	3.4E-02	5.0	0.672%			0.0922%
43	Ethylamine	2	SD1-EF-A	4.3E-03	5.0	0.086%	YES		0.0922%
43	Ethylamine	4	SD1-EF-B	1.4E-02	5.0	0.273%			0.0922%
43	Ethylamine	6	SD1-EF-C	1.7E-02	5.0	0.349%			0.0922%
43	Ethylamine	8	SD1-EF-D	2.6E-02	5.0	0.529%			0.0922%
43	Ethylamine	10	SD1-EF-E	2.6E-02	5.0	0.528%			0.0922%
43	Ethylamine	12	SD1-EF-F	2.2E-02	5.0	0.441%			0.0922%
43	Ethylamine	14	SD1-EF-G	2.5E-02	5.0	0.509%			0.0922%
43	Ethylamine	16	SD1-EF-H	2.2E-02	5.0	0.442%			0.0922%
43	Ethylamine	2	SC1-IN-A	4.6E-03	5.0	0.092%	YES		0.0922%
43	Ethylamine	4	SC1-IN-B	3.5E-02	5.0	0.705%			0.0922%
43	Ethylamine	6	SC1-IN-C	2.3E-02	5.0	0.461%			0.0922%
43	Ethylamine	8	SC1-IN-D	1.5E-02	5.0	0.298%			0.0922%
43	Ethylamine	10	SC1-IN-E	2.7E-02	5.0	0.545%			0.0922%
43	Ethylamine	12	SC1-IN-F	3.2E-02	5.0	0.631%			0.0922%
43	Ethylamine	14	SC1-IN-G	2.5E-02	5.0	0.491%			0.0922%
43	Ethylamine	16	SC1-IN-H	3.6E-02	5.0	0.726%			0.0922%
43	Ethylamine	2	SC1-EF-A	1.5E-02	5.0	0.302%			0.0922%
43	Ethylamine	4	SC1-EF-B	2.1E-02	5.0	0.422%			0.0922%
43	Ethylamine	6	SC1-EF-C	2.8E-02	5.0	0.555%			0.0922%
43	Ethylamine	8	SC1-EF-D	2.3E-02	5.0	0.456%			0.0922%
43	Ethylamine	10	SC1-EF-E	2.5E-02	5.0	0.492%			0.0922%
43	Ethylamine	12	SC1-EF-F	2.2E-02	5.0	0.442%			0.0922%
43	Ethylamine	14	SC1-EF-G	2.4E-02	5.0	0.486%			0.0922%
43	Ethylamine	16	SC1-EF-H	2.3E-02	5.0	0.459%			0.0922%
44	N-Nitrosodimethylamine	2	SD1-IN-A	2.2E-03	0.000	721%		DL	5.15%
44	N-Nitrosodimethylamine	4	SD1-IN-B	2.4E-03	0.000	797%		DL	5.15%
44	N-Nitrosodimethylamine	6	SD1-IN-C	2.6E-03	0.000	853%		DL	5.15%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
44	N-Nitrosodimethylamine	8	SD1-IN-D	1.2E-03	0.000	392%		L	5.15%
44	N-Nitrosodimethylamine	10	SD1-IN-E	2.3E-03	0.000	764%		DL	5.15%
44	N-Nitrosodimethylamine	12	SD1-IN-F	2.8E-03	0.000	921%		DL	5.15%
44	N-Nitrosodimethylamine	14	SD1-IN-G	2.6E-03	0.000	851%		DL	5.15%
44	N-Nitrosodimethylamine	16	SD1-IN-H	5.6E-03	0.000	1874%		DEL	5.15%
44	N-Nitrosodimethylamine	2	SD1-EF-A	1.2E-05	0.000	4.02%	YES		5.15%
44	N-Nitrosodimethylamine	4	SD1-EF-B	1.2E-05	0.000	4.00%	YES		5.15%
44	N-Nitrosodimethylamine	6	SD1-EF-C	1.2E-05	0.000	4.09%	YES		5.15%
44	N-Nitrosodimethylamine	8	SD1-EF-D	1.2E-05	0.000	4.07%	YES		5.15%
44	N-Nitrosodimethylamine	10	SD1-EF-E	1.2E-05	0.000	4.04%	YES		5.15%
44	N-Nitrosodimethylamine	12	SD1-EF-F	1.3E-05	0.000	4.21%	YES		5.15%
44	N-Nitrosodimethylamine	14	SD1-EF-G	1.2E-05	0.000	4.05%	YES	L	5.15%
44	N-Nitrosodimethylamine	16	SD1-EF-H	2.6E-05	0.000	8.58%		L	5.15%
44	N-Nitrosodimethylamine	2	SC1-IN-A	2.9E-03	0.000	970%		BL	5.15%
44	N-Nitrosodimethylamine	4	SC1-IN-B	2.8E-03	0.000	944%		BL	5.15%
44	N-Nitrosodimethylamine	6	SC1-IN-C	2.7E-03	0.000	896%		BL	5.15%
44	N-Nitrosodimethylamine	8	SC1-IN-D	2.8E-03	0.000	919%		BL	5.15%
44	N-Nitrosodimethylamine	10	SC1-IN-E	2.7E-03	0.000	903%		BL	5.15%
44	N-Nitrosodimethylamine	12	SC1-IN-F	2.7E-03	0.000	901%		BL	5.15%
44	N-Nitrosodimethylamine	14	SC1-IN-G	2.4E-03	0.000	786%		BL	5.15%
44	N-Nitrosodimethylamine	16	SC1-IN-H	2.5E-03	0.000	825%		BL	5.15%
44	N-Nitrosodimethylamine	2	SC1-EF-A	1.3E-05	0.000	4.21%	YES	L	5.15%
44	N-Nitrosodimethylamine	4	SC1-EF-B	1.3E-05	0.000	4.21%	YES	L	5.15%
44	N-Nitrosodimethylamine	6	SC1-EF-C	1.3E-05	0.000	4.27%	YES	L	5.15%
44	N-Nitrosodimethylamine	8	SC1-EF-D	1.3E-05	0.000	4.24%	YES	L	5.15%
44	N-Nitrosodimethylamine	10	SC1-EF-E	1.3E-05	0.000	4.22%	YES	L	5.15%
44	N-Nitrosodimethylamine	12	SC1-EF-F	1.2E-05	0.000	4.15%	YES	L	5.15%
44	N-Nitrosodimethylamine	14	SC1-EF-G	1.5E-05	0.000	5.15%	YES		5.15%
44	N-Nitrosodimethylamine	16	SC1-EF-H	1.5E-05	0.000	5.13%	YES		5.15%
45	N-Nitrosodiethylamine	2	SD1-IN-A	1.3E-04	0.000	126%			10.3%
45	N-Nitrosodiethylamine	4	SD1-IN-B	1.3E-04	0.000	130%			10.3%
45	N-Nitrosodiethylamine	6	SD1-IN-C	1.2E-04	0.000	116%			10.3%
45	N-Nitrosodiethylamine	8	SD1-IN-D	4.1E-05	0.000	40.9%			10.3%
45	N-Nitrosodiethylamine	10	SD1-IN-E	1.1E-04	0.000	108%			10.3%
45	N-Nitrosodiethylamine	12	SD1-IN-F	1.5E-04	0.000	150%			10.3%
45	N-Nitrosodiethylamine	14	SD1-IN-G	1.4E-04	0.000	138%			10.3%
45	N-Nitrosodiethylamine	16	SD1-IN-H	1.4E-04	0.000	143%			10.3%
45	N-Nitrosodiethylamine	2	SD1-EF-A	8.8E-06	0.000	8.76%	YES		10.3%
45	N-Nitrosodiethylamine	4	SD1-EF-B	8.7E-06	0.000	8.71%	YES		10.3%
45	N-Nitrosodiethylamine	6	SD1-EF-C	8.9E-06	0.000	8.91%	YES		10.3%
45	N-Nitrosodiethylamine	8	SD1-EF-D	8.9E-06	0.000	8.86%	YES		10.3%
45	N-Nitrosodiethylamine	10	SD1-EF-E	8.8E-06	0.000	8.80%	YES		10.3%
45	N-Nitrosodiethylamine	12	SD1-EF-F	9.2E-06	0.000	9.16%	YES		10.3%
45	N-Nitrosodiethylamine	14	SD1-EF-G	8.8E-06	0.000	8.82%	YES		10.3%
45	N-Nitrosodiethylamine	16	SD1-EF-H	8.8E-06	0.000	8.84%	YES		10.3%
45	N-Nitrosodiethylamine	2	SC1-IN-A	1.2E-04	0.000	124%			10.3%
45	N-Nitrosodiethylamine	4	SC1-IN-B	1.4E-04	0.000	136%			10.3%
45	N-Nitrosodiethylamine	6	SC1-IN-C	4.2E-05	0.000	42.0%			10.3%
45	N-Nitrosodiethylamine	8	SC1-IN-D	1.2E-04	0.000	119%			10.3%
45	N-Nitrosodiethylamine	10	SC1-IN-E	1.0E-05	0.000	10.1%	YES		10.3%
45	N-Nitrosodiethylamine	12	SC1-IN-F	1.2E-04	0.000	117%			10.3%
45	N-Nitrosodiethylamine	14	SC1-IN-G	9.4E-05	0.000	94.2%			10.3%
45	N-Nitrosodiethylamine	16	SC1-IN-H	1.1E-04	0.000	105%			10.3%
45	N-Nitrosodiethylamine	2	SC1-EF-A	1.0E-05	0.000	10.2%	YES		10.3%
45	N-Nitrosodiethylamine	4	SC1-EF-B	1.0E-05	0.000	10.2%	YES		10.3%
45	N-Nitrosodiethylamine	6	SC1-EF-C	1.0E-05	0.000	10.3%	YES		10.3%
45	N-Nitrosodiethylamine	8	SC1-EF-D	1.0E-05	0.000	10.3%	YES		10.3%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
45	N-Nitrosodiethylamine	10	SC1-EF-E	1.0E-05	0.000	10.2%	YES		10.3%
45	N-Nitrosodiethylamine	12	SC1-EF-F	1.0E-05	0.000	10.0%	YES		10.3%
45	N-Nitrosodiethylamine	14	SC1-EF-G	1.0E-05	0.000	10.2%	YES		10.3%
45	N-Nitrosodiethylamine	16	SC1-EF-H	1.0E-05	0.000	10.2%	YES		10.3%
46	N-Nitrosomethylethylamine	2	SD1-IN-A	5.4E-04	0.000	179%			3.98%
46	N-Nitrosomethylethylamine	4	SD1-IN-B	6.7E-04	0.000	222%			3.98%
46	N-Nitrosomethylethylamine	6	SD1-IN-C	5.8E-04	0.000	192%			3.98%
46	N-Nitrosomethylethylamine	8	SD1-IN-D	3.3E-04	0.000	111%			3.98%
46	N-Nitrosomethylethylamine	10	SD1-IN-E	6.3E-04	0.000	211%			3.98%
46	N-Nitrosomethylethylamine	12	SD1-IN-F	7.6E-04	0.000	252%			3.98%
46	N-Nitrosomethylethylamine	14	SD1-IN-G	6.7E-04	0.000	224%			3.98%
46	N-Nitrosomethylethylamine	16	SD1-IN-H	7.4E-04	0.000	248%			3.98%
46	N-Nitrosomethylethylamine	2	SD1-EF-A	1.0E-05	0.000	3.38%	YES		3.98%
46	N-Nitrosomethylethylamine	4	SD1-EF-B	2.0E-05	0.000	6.73%			3.98%
46	N-Nitrosomethylethylamine	6	SD1-EF-C	1.0E-05	0.000	3.44%	YES		3.98%
46	N-Nitrosomethylethylamine	8	SD1-EF-D	1.0E-05	0.000	3.42%	YES		3.98%
46	N-Nitrosomethylethylamine	10	SD1-EF-E	1.0E-05	0.000	3.40%	YES		3.98%
46	N-Nitrosomethylethylamine	12	SD1-EF-F	1.1E-05	0.000	3.54%	YES		3.98%
46	N-Nitrosomethylethylamine	14	SD1-EF-G	1.1E-05	0.000	3.79%	YES		3.98%
46	N-Nitrosomethylethylamine	16	SD1-EF-H	1.1E-05	0.000	3.80%	YES		3.98%
46	N-Nitrosomethylethylamine	2	SC1-IN-A	5.6E-04	0.000	188%			3.98%
46	N-Nitrosomethylethylamine	4	SC1-IN-B	4.0E-04	0.000	132%			3.98%
46	N-Nitrosomethylethylamine	6	SC1-IN-C	5.2E-04	0.000	173%			3.98%
46	N-Nitrosomethylethylamine	8	SC1-IN-D	4.0E-04	0.000	133%			3.98%
46	N-Nitrosomethylethylamine	10	SC1-IN-E	3.9E-04	0.000	129%			3.98%
46	N-Nitrosomethylethylamine	12	SC1-IN-F	3.8E-04	0.000	125%			3.98%
46	N-Nitrosomethylethylamine	14	SC1-IN-G	3.3E-04	0.000	108%			3.98%
46	N-Nitrosomethylethylamine	16	SC1-IN-H	3.4E-04	0.000	112%			3.98%
46	N-Nitrosomethylethylamine	2	SC1-EF-A	1.2E-05	0.000	3.93%	YES		3.98%
46	N-Nitrosomethylethylamine	4	SC1-EF-B	1.2E-05	0.000	3.93%	YES		3.98%
46	N-Nitrosomethylethylamine	6	SC1-EF-C	1.2E-05	0.000	3.98%	YES		3.98%
46	N-Nitrosomethylethylamine	8	SC1-EF-D	1.2E-05	0.000	3.96%	YES		3.98%
46	N-Nitrosomethylethylamine	10	SC1-EF-E	1.2E-05	0.000	3.94%	YES		3.98%
46	N-Nitrosomethylethylamine	12	SC1-EF-F	1.2E-05	0.000	3.87%	YES		3.98%
46	N-Nitrosomethylethylamine	14	SC1-EF-G	1.2E-05	0.000	3.93%	YES		3.98%
46	N-Nitrosomethylethylamine	16	SC1-EF-H	1.2E-05	0.000	3.92%	YES		3.98%
47	N-Nitrosomorpholine	2	SD1-IN-A	8.6E-06	0.001	1.44%			1.66%
47	N-Nitrosomorpholine	4	SD1-IN-B	8.6E-06	0.001	1.44%	YES		1.66%
47	N-Nitrosomorpholine	6	SD1-IN-C	8.7E-06	0.001	1.45%	YES		1.66%
47	N-Nitrosomorpholine	8	SD1-IN-D	8.8E-06	0.001	1.46%	YES		1.66%
47	N-Nitrosomorpholine	10	SD1-IN-E	8.7E-06	0.001	1.45%	YES		1.66%
47	N-Nitrosomorpholine	12	SD1-IN-F	8.7E-06	0.001	1.45%	YES		1.66%
47	N-Nitrosomorpholine	14	SD1-IN-G	8.7E-06	0.001	1.44%	YES		1.66%
47	N-Nitrosomorpholine	16	SD1-IN-H	8.7E-06	0.001	1.45%	YES		1.66%
47	N-Nitrosomorpholine	2	SD1-EF-A	8.6E-06	0.001	1.43%	YES		1.66%
47	N-Nitrosomorpholine	4	SD1-EF-B	8.5E-06	0.001	1.42%	YES		1.66%
47	N-Nitrosomorpholine	6	SD1-EF-C	8.7E-06	0.001	1.45%	YES		1.66%
47	N-Nitrosomorpholine	8	SD1-EF-D	8.7E-06	0.001	1.44%	YES		1.66%
47	N-Nitrosomorpholine	10	SD1-EF-E	8.6E-06	0.001	1.43%	YES		1.66%
47	N-Nitrosomorpholine	12	SD1-EF-F	9.0E-06	0.001	1.49%	YES		1.66%
47	N-Nitrosomorpholine	14	SD1-EF-G	8.6E-06	0.001	1.44%	YES		1.66%
47	N-Nitrosomorpholine	16	SD1-EF-H	8.6E-06	0.001	1.44%	YES		1.66%
47	N-Nitrosomorpholine	2	SC1-IN-A	9.7E-06	0.001	1.62%	YES		1.66%
47	N-Nitrosomorpholine	4	SC1-IN-B	9.5E-06	0.001	1.58%	YES		1.66%
47	N-Nitrosomorpholine	6	SC1-IN-C	9.7E-06	0.001	1.61%	YES		1.66%
47	N-Nitrosomorpholine	8	SC1-IN-D	9.8E-06	0.001	1.64%	YES		1.66%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
47	N-Nitrosomorpholine	10	SC1-IN-E	9.7E-06	0.001	1.62%	YES		1.66%
47	N-Nitrosomorpholine	12	SC1-IN-F	9.8E-06	0.001	1.63%	YES		1.66%
47	N-Nitrosomorpholine	14	SC1-IN-G	9.8E-06	0.001	1.63%	YES		1.66%
47	N-Nitrosomorpholine	16	SC1-IN-H	1.0E-05	0.001	1.66%	YES		1.66%
47	N-Nitrosomorpholine	2	SC1-EF-A	9.0E-06	0.001	1.49%	YES		1.66%
47	N-Nitrosomorpholine	4	SC1-EF-B	9.0E-06	0.001	1.49%	YES		1.66%
47	N-Nitrosomorpholine	6	SC1-EF-C	9.1E-06	0.001	1.51%	YES		1.66%
47	N-Nitrosomorpholine	8	SC1-EF-D	9.0E-06	0.001	1.50%	YES		1.66%
47	N-Nitrosomorpholine	10	SC1-EF-E	9.0E-06	0.001	1.50%	YES		1.66%
47	N-Nitrosomorpholine	12	SC1-EF-F	8.8E-06	0.001	1.47%	YES		1.66%
47	N-Nitrosomorpholine	14	SC1-EF-G	9.8E-06	0.001	1.64%	YES		1.66%
47	N-Nitrosomorpholine	16	SC1-EF-H	9.8E-06	0.001	1.64%	YES		1.66%
48	Tributyl phosphate	2	SD1-IN-A	6.6E-05	0.20	0.033%	YES	U	0.0335%
48	Tributyl phosphate	4	SD1-IN-B	6.7E-05	0.20	0.033%	YES	U	0.0335%
48	Tributyl phosphate	6	SD1-IN-C	6.4E-05	0.20	0.032%	YES	U	0.0335%
48	Tributyl phosphate	8	SD1-IN-D	6.4E-05	0.20	0.032%	YES	U	0.0335%
48	Tributyl phosphate	10	SD1-IN-E	6.6E-05	0.20	0.033%	YES	U	0.0335%
48	Tributyl phosphate	12	SD1-IN-F	6.7E-05	0.20	0.033%	YES	U	0.0335%
48	Tributyl phosphate	14	SD1-IN-G	6.7E-05	0.20	0.034%	YES	U	0.0335%
48	Tributyl phosphate	16	SD1-IN-H	6.3E-05	0.20	0.032%	YES	U	0.0335%
48	Tributyl phosphate	2	SD1-EF-A	6.1E-05	0.20	0.031%	YES	U	0.0335%
48	Tributyl phosphate	4	SD1-EF-B	6.0E-05	0.20	0.030%	YES	U	0.0335%
48	Tributyl phosphate	6	SD1-EF-C	6.1E-05	0.20	0.031%	YES	U	0.0335%
48	Tributyl phosphate	8	SD1-EF-D		0.20				0.0335%
48	Tributyl phosphate	10	SD1-EF-E	6.1E-05	0.20	0.031%	YES	U	0.0335%
48	Tributyl phosphate	12	SD1-EF-F	6.2E-05	0.20	0.031%	YES	U,S*	0.0335%
48	Tributyl phosphate	14	SD1-EF-G	6.1E-05	0.20	0.030%	YES	U	0.0335%
48	Tributyl phosphate	16	SD1-EF-H	6.1E-05	0.20	0.031%	YES	U	0.0335%
48	Tributyl phosphate	2	SC1-IN-A	6.2E-05	0.20	0.031%	YES	U	0.0335%
48	Tributyl phosphate	4	SC1-IN-B	6.6E-05	0.20	0.033%	YES	U	0.0335%
48	Tributyl phosphate	6	SC1-IN-C	6.1E-05	0.20	0.030%	YES	U	0.0335%
48	Tributyl phosphate	8	SC1-IN-D	5.5E-05	0.20	0.028%	YES	U	0.0335%
48	Tributyl phosphate	10	SC1-IN-E	6.5E-05	0.20	0.032%	YES	U	0.0335%
48	Tributyl phosphate	12	SC1-IN-F	6.3E-05	0.20	0.031%	YES	U	0.0335%
48	Tributyl phosphate	14	SC1-IN-G	6.1E-05	0.20	0.031%	YES	U	0.0335%
48	Tributyl phosphate	16	SC1-IN-H	6.6E-05	0.20	0.033%	YES	U	0.0335%
48	Tributyl phosphate	2	SC1-EF-A	6.7E-05	0.20	0.033%	YES	U	0.0335%
48	Tributyl phosphate	4	SC1-EF-B	5.8E-05	0.20	0.029%	YES	U	0.0335%
48	Tributyl phosphate	6	SC1-EF-C	5.7E-05	0.20	0.028%	YES	U	0.0335%
48	Tributyl phosphate	8	SC1-EF-D	6.3E-05	0.20	0.031%	YES	U	0.0335%
48	Tributyl phosphate	10	SC1-EF-E	6.1E-05	0.20	0.031%	YES	U	0.0335%
48	Tributyl phosphate	12	SC1-EF-F	6.1E-05	0.20	0.031%	YES	U,S*	0.0335%
48	Tributyl phosphate	14	SC1-EF-G	6.5E-05	0.20	0.033%	YES	U	0.0335%
48	Tributyl phosphate	16	SC1-EF-H	6.2E-05	0.20	0.031%	YES	U	0.0335%
49	Dibutyl butylphosphonate	2	SD1-IN-A	2.5E-05	0.007	0.358%	YES	U	0.377%
49	Dibutyl butylphosphonate	4	SD1-IN-B	2.5E-05	0.007	0.359%	YES	U	0.377%
49	Dibutyl butylphosphonate	6	SD1-IN-C	2.4E-05	0.007	0.348%	YES	U	0.377%
49	Dibutyl butylphosphonate	8	SD1-IN-D	2.4E-05	0.007	0.346%	YES	U	0.377%
49	Dibutyl butylphosphonate	10	SD1-IN-E	2.5E-05	0.007	0.356%	YES	U	0.377%
49	Dibutyl butylphosphonate	12	SD1-IN-F	2.6E-05	0.007	0.377%	YES	U	0.377%
49	Dibutyl butylphosphonate	14	SD1-IN-G	2.5E-05	0.007	0.363%	YES	U	0.377%
49	Dibutyl butylphosphonate	16	SD1-IN-H	2.4E-05	0.007	0.341%	YES	U	0.377%
49	Dibutyl butylphosphonate	2	SD1-EF-A	2.3E-05	0.007	0.330%	YES	U	0.377%
49	Dibutyl butylphosphonate	4	SD1-EF-B	2.3E-05	0.007	0.324%	YES	U	0.377%
49	Dibutyl butylphosphonate	6	SD1-EF-C	2.3E-05	0.007	0.330%	YES	U	0.377%
49	Dibutyl butylphosphonate	8	SD1-EF-D		0.007				0.377%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
49	Dibutyl butylphosphonate	10	SD1-EF-E	2.3E-05	0.007	0.331%	YES	U	0.377%
49	Dibutyl butylphosphonate	12	SD1-EF-F	2.3E-05	0.007	0.333%	YES	U,S*	0.377%
49	Dibutyl butylphosphonate	14	SD1-EF-G	2.3E-05	0.007	0.327%	YES	U	0.377%
49	Dibutyl butylphosphonate	16	SD1-EF-H	2.3E-05	0.007	0.331%	YES	U	0.377%
49	Dibutyl butylphosphonate	2	SC1-IN-A	2.4E-05	0.007	0.337%	YES	U	0.377%
49	Dibutyl butylphosphonate	4	SC1-IN-B	2.5E-05	0.007	0.355%	YES	U	0.377%
49	Dibutyl butylphosphonate	6	SC1-IN-C	2.3E-05	0.007	0.329%	YES	U	0.377%
49	Dibutyl butylphosphonate	8	SC1-IN-D	2.1E-05	0.007	0.299%	YES	U	0.377%
49	Dibutyl butylphosphonate	10	SC1-IN-E	2.5E-05	0.007	0.351%	YES	U	0.377%
49	Dibutyl butylphosphonate	12	SC1-IN-F	2.4E-05	0.007	0.339%	YES	U	0.377%
49	Dibutyl butylphosphonate	14	SC1-IN-G	2.3E-05	0.007	0.330%	YES	U	0.377%
49	Dibutyl butylphosphonate	16	SC1-IN-H	2.5E-05	0.007	0.356%	YES	U	0.377%
49	Dibutyl butylphosphonate	2	SC1-EF-A	2.6E-05	0.007	0.376%	YES	U	0.377%
49	Dibutyl butylphosphonate	4	SC1-EF-B	2.2E-05	0.007	0.312%	YES	U	0.377%
49	Dibutyl butylphosphonate	6	SC1-EF-C	2.2E-05	0.007	0.308%	YES	U	0.377%
49	Dibutyl butylphosphonate	8	SC1-EF-D	2.4E-05	0.007	0.340%	YES	U	0.377%
49	Dibutyl butylphosphonate	10	SC1-EF-E	2.3E-05	0.007	0.331%	YES	U	0.377%
49	Dibutyl butylphosphonate	12	SC1-EF-F	2.3E-05	0.007	0.330%	YES	U,S*	0.377%
49	Dibutyl butylphosphonate	14	SC1-EF-G	2.5E-05	0.007	0.352%	YES	U	0.377%
49	Dibutyl butylphosphonate	16	SC1-EF-H	2.3E-05	0.007	0.333%	YES	U	0.377%
52	Pyridine	2	SD1-IN-A	7.3E-05	1.0	0.007%	YES	U	0.00738%
52	Pyridine	4	SD1-IN-B	7.0E-05	1.0	0.007%	YES	U	0.00738%
52	Pyridine	6	SD1-IN-C	6.8E-05	1.0	0.007%	YES	U	0.00738%
52	Pyridine	8	SD1-IN-D	7.0E-05	1.0	0.007%	YES	U	0.00738%
52	Pyridine	10	SD1-IN-E	6.9E-05	1.0	0.007%	YES	U	0.00738%
52	Pyridine	12	SD1-IN-F	6.8E-05	1.0	0.007%	YES	U	0.00738%
52	Pyridine	14	SD1-IN-G	6.3E-05	1.0	0.006%	YES	U	0.00738%
52	Pyridine	16	SD1-IN-H	7.2E-05	1.0	0.007%	YES	U	0.00738%
52	Pyridine	2	SD1-EF-A	6.9E-05	1.0	0.007%	YES	U	0.00738%
52	Pyridine	4	SD1-EF-B	6.8E-05	1.0	0.007%	YES	U	0.00738%
52	Pyridine	6	SD1-EF-C	7.3E-05	1.0	0.007%	YES	U	0.00738%
52	Pyridine	8	SD1-EF-D	7.4E-05	1.0	0.007%	YES	U	0.00738%
52	Pyridine	10	SD1-EF-E	6.6E-05	1.0	0.007%	YES	U	0.00738%
52	Pyridine	12	SD1-EF-F	6.4E-05	1.0	0.006%	YES	U	0.00738%
52	Pyridine	14	SD1-EF-G	6.8E-05	1.0	0.007%	YES	U	0.00738%
52	Pyridine	16	SD1-EF-H	7.2E-05	1.0	0.007%	YES	U	0.00738%
52	Pyridine	2	SC1-IN-A	1.2E-03	1.0	0.117%			0.00738%
52	Pyridine	4	SC1-IN-B	3.0E-04	1.0	0.030%		J	0.00738%
52	Pyridine	6	SC1-IN-C	3.1E-04	1.0	0.031%		J	0.00738%
52	Pyridine	8	SC1-IN-D	7.3E-05	1.0	0.007%	YES	U	0.00738%
52	Pyridine	10	SC1-IN-E	1.0E-04	1.0	0.010%		J	0.00738%
52	Pyridine	12	SC1-IN-F	7.1E-05	1.0	0.007%	YES	U	0.00738%
52	Pyridine	14	SC1-IN-G	9.5E-05	1.0	0.010%		J	0.00738%
52	Pyridine	16	SC1-IN-H	1.1E-04	1.0	0.011%		J	0.00738%
52	Pyridine	2	SC1-EF-A	6.6E-05	1.0	0.007%	YES		0.00738%
52	Pyridine	4	SC1-EF-B	6.4E-05	1.0	0.006%	YES		0.00738%
52	Pyridine	6	SC1-EF-C	7.0E-05	1.0	0.007%	YES		0.00738%
52	Pyridine	8	SC1-EF-D	6.9E-05	1.0	0.007%	YES		0.00738%
52	Pyridine	10	SC1-EF-E	7.0E-05	1.0	0.007%	YES		0.00738%
52	Pyridine	12	SC1-EF-F	7.0E-05	1.0	0.007%	YES		0.00738%
52	Pyridine	14	SC1-EF-G	7.3E-05	1.0	0.007%	YES		0.00738%
52	Pyridine	16	SC1-EF-H	6.9E-05	1.0	0.007%	YES		0.00738%
53	2,4-Dimethylpyridine	2	SD1-IN-A	4.8E-05	0.50	0.010%	YES	U	0.00979%
53	2,4-Dimethylpyridine	4	SD1-IN-B	4.6E-05	0.50	0.009%	YES	U	0.00979%
53	2,4-Dimethylpyridine	6	SD1-IN-C	4.5E-05	0.50	0.009%	YES	U	0.00979%
53	2,4-Dimethylpyridine	8	SD1-IN-D	4.6E-05	0.50	0.009%	YES	U	0.00979%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
53	2,4-Dimethylpyridine	10	SD1-IN-E	4.6E-05	0.50	0.009%	YES	U	0.00979%
53	2,4-Dimethylpyridine	12	SD1-IN-F	4.5E-05	0.50	0.009%	YES	U	0.00979%
53	2,4-Dimethylpyridine	14	SD1-IN-G	4.2E-05	0.50	0.008%	YES	U	0.00979%
53	2,4-Dimethylpyridine	16	SD1-IN-H	4.8E-05	0.50	0.010%	YES	U	0.00979%
53	2,4-Dimethylpyridine	2	SD1-EF-A	4.6E-05	0.50	0.009%	YES	U	0.00979%
53	2,4-Dimethylpyridine	4	SD1-EF-B	4.5E-05	0.50	0.009%	YES	U	0.00979%
53	2,4-Dimethylpyridine	6	SD1-EF-C	4.9E-05	0.50	0.010%	YES	U	0.00979%
53	2,4-Dimethylpyridine	8	SD1-EF-D	4.9E-05	0.50	0.010%	YES	U	0.00979%
53	2,4-Dimethylpyridine	10	SD1-EF-E	4.4E-05	0.50	0.009%	YES	U	0.00979%
53	2,4-Dimethylpyridine	12	SD1-EF-F	4.2E-05	0.50	0.008%	YES	U	0.00979%
53	2,4-Dimethylpyridine	14	SD1-EF-G	4.5E-05	0.50	0.009%	YES	U	0.00979%
53	2,4-Dimethylpyridine	16	SD1-EF-H	4.8E-05	0.50	0.010%	YES	U	0.00979%
53	2,4-Dimethylpyridine	2	SC1-IN-A	1.6E-04	0.50	0.032%		J	0.00979%
53	2,4-Dimethylpyridine	4	SC1-IN-B	4.6E-05	0.50	0.009%	YES	U	0.00979%
53	2,4-Dimethylpyridine	6	SC1-IN-C	4.6E-05	0.50	0.009%	YES	U	0.00979%
53	2,4-Dimethylpyridine	8	SC1-IN-D	4.8E-05	0.50	0.010%	YES	U	0.00979%
53	2,4-Dimethylpyridine	10	SC1-IN-E	4.7E-05	0.50	0.009%	YES	U	0.00979%
53	2,4-Dimethylpyridine	12	SC1-IN-F	4.7E-05	0.50	0.009%	YES	U	0.00979%
53	2,4-Dimethylpyridine	14	SC1-IN-G	4.7E-05	0.50	0.009%	YES	U	0.00979%
53	2,4-Dimethylpyridine	16	SC1-IN-H	4.5E-05	0.50	0.009%	YES		0.00979%
53	2,4-Dimethylpyridine	2	SC1-EF-A	4.4E-05	0.50	0.009%	YES		0.00979%
53	2,4-Dimethylpyridine	4	SC1-EF-B	4.3E-05	0.50	0.009%	YES		0.00979%
53	2,4-Dimethylpyridine	6	SC1-EF-C	4.6E-05	0.50	0.009%	YES		0.00979%
53	2,4-Dimethylpyridine	8	SC1-EF-D	4.6E-05	0.50	0.009%	YES		0.00979%
53	2,4-Dimethylpyridine	10	SC1-EF-E	4.6E-05	0.50	0.009%	YES		0.00979%
53	2,4-Dimethylpyridine	12	SC1-EF-F	4.6E-05	0.50	0.009%	YES		0.00979%
53	2,4-Dimethylpyridine	14	SC1-EF-G	4.8E-05	0.50	0.010%	YES		0.00979%
53	2,4-Dimethylpyridine	16	SC1-EF-H	4.6E-05	0.50	0.009%	YES		0.00979%
12	6-Methyl-2-heptanone	2	SD1-IN-A		8.0				
12	6-Methyl-2-heptanone	4	SD1-IN-B		8.0				
12	6-Methyl-2-heptanone	6	SD1-IN-C		8.0				
12	6-Methyl-2-heptanone	8	SD1-IN-D		8.0				
12	6-Methyl-2-heptanone	10	SD1-IN-E		8.0				
12	6-Methyl-2-heptanone	12	SD1-IN-F		8.0				
12	6-Methyl-2-heptanone	14	SD1-IN-G		8.0				
12	6-Methyl-2-heptanone	16	SD1-IN-H		8.0				
12	6-Methyl-2-heptanone	2	SD1-EF-A		8.0				
12	6-Methyl-2-heptanone	4	SD1-EF-B		8.0				
12	6-Methyl-2-heptanone	6	SD1-EF-C		8.0				
12	6-Methyl-2-heptanone	8	SD1-EF-D		8.0				
12	6-Methyl-2-heptanone	10	SD1-EF-E		8.0				
12	6-Methyl-2-heptanone	12	SD1-EF-F		8.0				
12	6-Methyl-2-heptanone	14	SD1-EF-G		8.0				
12	6-Methyl-2-heptanone	16	SD1-EF-H		8.0				
12	6-Methyl-2-heptanone	2	SC1-IN-A		8.0				
12	6-Methyl-2-heptanone	4	SC1-IN-B		8.0				
12	6-Methyl-2-heptanone	6	SC1-IN-C		8.0				
12	6-Methyl-2-heptanone	8	SC1-IN-D		8.0				
12	6-Methyl-2-heptanone	10	SC1-IN-E		8.0				
12	6-Methyl-2-heptanone	12	SC1-IN-F		8.0				
12	6-Methyl-2-heptanone	14	SC1-IN-G		8.0				
12	6-Methyl-2-heptanone	16	SC1-IN-H	2.0E-03	8.0	0.025%		JNT	
12	6-Methyl-2-heptanone	2	SC1-EF-A		8.0				
12	6-Methyl-2-heptanone	4	SC1-EF-B		8.0				
12	6-Methyl-2-heptanone	6	SC1-EF-C		8.0				
12	6-Methyl-2-heptanone	8	SC1-EF-D		8.0				

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
12	6-Methyl-2-heptanone	10	SC1-EF-E		8.0				
12	6-Methyl-2-heptanone	12	SC1-EF-F		8.0				
12	6-Methyl-2-heptanone	14	SC1-EF-G		8.0				
12	6-Methyl-2-heptanone	16	SC1-EF-H		8.0				
16	Butanal/Butyraldehyde	2	SD1-IN-A	3.8E-02	25	0.152%			0.00298%
16	Butanal/Butyraldehyde	4	SD1-IN-B	3.6E-02	25	0.143%			0.00298%
16	Butanal/Butyraldehyde	6	SD1-IN-C	3.5E-02	25	0.138%			0.00298%
16	Butanal/Butyraldehyde	8	SD1-IN-D	1.1E-02	25	0.044%			0.00298%
16	Butanal/Butyraldehyde	10	SD1-IN-E	3.6E-02	25	0.142%			0.00298%
16	Butanal/Butyraldehyde	12	SD1-IN-F	3.2E-02	25	0.127%			0.00298%
16	Butanal/Butyraldehyde	14	SD1-IN-G	2.9E-02	25	0.118%			0.00298%
16	Butanal/Butyraldehyde	16	SD1-IN-H	3.8E-02	25	0.152%			0.00298%
16	Butanal/Butyraldehyde	2	SD1-EF-A	6.7E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	4	SD1-EF-B	6.8E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	6	SD1-EF-C	6.8E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	8	SD1-EF-D	7.0E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	10	SD1-EF-E	7.1E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	12	SD1-EF-F	7.1E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	14	SD1-EF-G	6.9E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	16	SD1-EF-H	6.9E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	2	SC1-IN-A	7.2E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	4	SC1-IN-B	7.0E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	6	SC1-IN-C	7.0E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	8	SC1-IN-D	7.2E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	10	SC1-IN-E	7.2E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	12	SC1-IN-F	7.3E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	14	SC1-IN-G	7.4E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	16	SC1-IN-H	7.4E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	2	SC1-EF-A	7.3E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	4	SC1-EF-B	7.0E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	6	SC1-EF-C	7.2E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	8	SC1-EF-D	7.3E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	10	SC1-EF-E	6.9E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	12	SC1-EF-F	6.7E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	14	SC1-EF-G	6.9E-04	25	0.003%	YES		0.00298%
16	Butanal/Butyraldehyde	16	SC1-EF-H	7.0E-04	25	0.003%	YES		0.00298%
20	Furan	2	SD1-IN-A	2.3E-05	0.001	2.28%	YES	U	2.58%
20	Furan	4	SD1-IN-B	2.2E-05	0.001	2.22%	YES	U	2.58%
20	Furan	6	SD1-IN-C	2.4E-05	0.001	2.36%	YES	U	2.58%
20	Furan	8	SD1-IN-D	2.4E-05	0.001	2.36%	YES		2.58%
20	Furan	10	SD1-IN-E	2.5E-05	0.001	2.45%	YES	U	2.58%
20	Furan	12	SD1-IN-F	2.2E-05	0.001	2.22%	YES	U	2.58%
20	Furan	14	SD1-IN-G	2.3E-05	0.001	2.27%	YES	U	2.58%
20	Furan	16	SD1-IN-H	2.5E-05	0.001	2.50%	YES	U	2.58%
20	Furan	2	SD1-EF-A	2.2E-05	0.001	2.24%	YES	U	2.58%
20	Furan	4	SD1-EF-B	2.4E-05	0.001	2.38%	YES	U	2.58%
20	Furan	6	SD1-EF-C	2.2E-05	0.001	2.21%	YES	U	2.58%
20	Furan	8	SD1-EF-D	2.3E-05	0.001	2.29%	YES	U	2.58%
20	Furan	10	SD1-EF-E	2.4E-05	0.001	2.40%	YES	U	2.58%
20	Furan	12	SD1-EF-F	2.4E-05	0.001	2.37%	YES	U	2.58%
20	Furan	14	SD1-EF-G		0.001				2.58%
20	Furan	16	SD1-EF-H	2.4E-05	0.001	2.39%	YES	U	2.58%
20	Furan	2	SC1-IN-A	2.1E-05	0.001	2.12%	YES	U	2.58%
20	Furan	4	SC1-IN-B	2.6E-05	0.001	2.58%	YES	U	2.58%
20	Furan	6	SC1-IN-C	2.4E-05	0.001	2.41%	YES	U	2.58%
20	Furan	8	SC1-IN-D	2.5E-05	0.001	2.54%	YES	U	2.58%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
20	Furan	10	SC1-IN-E	2.2E-05	0.001	2.22%	YES	U	2.58%
20	Furan	12	SC1-IN-F	2.5E-05	0.001	2.48%	YES	U	2.58%
20	Furan	14	SC1-IN-G	2.3E-05	0.001	2.30%	YES	U	2.58%
20	Furan	16	SC1-IN-H	2.5E-05	0.001	2.47%	YES	U	2.58%
20	Furan	2	SC1-EF-A	2.6E-05	0.001	2.56%	YES	U	2.58%
20	Furan	4	SC1-EF-B	2.3E-05	0.001	2.31%	YES	U	2.58%
20	Furan	6	SC1-EF-C	2.3E-05	0.001	2.33%	YES	U	2.58%
20	Furan	8	SC1-EF-D	2.3E-05	0.001	2.33%	YES	U	2.58%
20	Furan	10	SC1-EF-E	2.4E-05	0.001	2.36%	YES	U	2.58%
20	Furan	12	SC1-EF-F	2.4E-05	0.001	2.40%	YES	U	2.58%
20	Furan	14	SC1-EF-G	2.4E-05	0.001	2.38%	YES	U	2.58%
20	Furan	16	SC1-EF-H	2.4E-05	0.001	2.41%	YES	U	2.58%
22	2,5-Dihydrofuran	2	SD1-IN-A	1.9E-05	0.001	1.87%	YES	U	2.12%
22	2,5-Dihydrofuran	4	SD1-IN-B	1.8E-05	0.001	1.83%	YES	U	2.12%
22	2,5-Dihydrofuran	6	SD1-IN-C	1.9E-05	0.001	1.94%	YES	U	2.12%
22	2,5-Dihydrofuran	8	SD1-IN-D	1.9E-05	0.001	1.94%	YES		2.12%
22	2,5-Dihydrofuran	10	SD1-IN-E	2.0E-05	0.001	2.02%	YES	U	2.12%
22	2,5-Dihydrofuran	12	SD1-IN-F	1.8E-05	0.001	1.82%	YES	U	2.12%
22	2,5-Dihydrofuran	14	SD1-IN-G	1.9E-05	0.001	1.87%	YES	U	2.12%
22	2,5-Dihydrofuran	16	SD1-IN-H	2.1E-05	0.001	2.05%	YES	U	2.12%
22	2,5-Dihydrofuran	2	SD1-EF-A	1.8E-05	0.001	1.84%	YES	U	2.12%
22	2,5-Dihydrofuran	4	SD1-EF-B	2.0E-05	0.001	1.96%	YES	U	2.12%
22	2,5-Dihydrofuran	6	SD1-EF-C	1.8E-05	0.001	1.82%	YES	U	2.12%
22	2,5-Dihydrofuran	8	SD1-EF-D	1.9E-05	0.001	1.88%	YES	U	2.12%
22	2,5-Dihydrofuran	10	SD1-EF-E	2.0E-05	0.001	1.97%	YES	U	2.12%
22	2,5-Dihydrofuran	12	SD1-EF-F	1.9E-05	0.001	1.94%	YES	U	2.12%
22	2,5-Dihydrofuran	14	SD1-EF-G		0.001				2.12%
22	2,5-Dihydrofuran	16	SD1-EF-H	2.0E-05	0.001	1.97%	YES	U	2.12%
22	2,5-Dihydrofuran	2	SC1-IN-A	1.7E-05	0.001	1.74%	YES	U	2.12%
22	2,5-Dihydrofuran	4	SC1-IN-B	2.1E-05	0.001	2.12%	YES	U	2.12%
22	2,5-Dihydrofuran	6	SC1-IN-C	2.0E-05	0.001	1.98%	YES	U	2.12%
22	2,5-Dihydrofuran	8	SC1-IN-D	2.1E-05	0.001	2.09%	YES	U	2.12%
22	2,5-Dihydrofuran	10	SC1-IN-E	1.8E-05	0.001	1.83%	YES	U	2.12%
22	2,5-Dihydrofuran	12	SC1-IN-F	2.0E-05	0.001	2.03%	YES	U	2.12%
22	2,5-Dihydrofuran	14	SC1-IN-G	1.9E-05	0.001	1.89%	YES	U	2.12%
22	2,5-Dihydrofuran	16	SC1-IN-H	2.0E-05	0.001	2.03%	YES	U	2.12%
22	2,5-Dihydrofuran	2	SC1-EF-A	2.1E-05	0.001	2.10%	YES	U	2.12%
22	2,5-Dihydrofuran	4	SC1-EF-B	1.9E-05	0.001	1.90%	YES	U	2.12%
22	2,5-Dihydrofuran	6	SC1-EF-C	1.9E-05	0.001	1.91%	YES	U	2.12%
22	2,5-Dihydrofuran	8	SC1-EF-D	1.9E-05	0.001	1.91%	YES	U	2.12%
22	2,5-Dihydrofuran	10	SC1-EF-E	1.9E-05	0.001	1.94%	YES	U	2.12%
22	2,5-Dihydrofuran	12	SC1-EF-F	2.0E-05	0.001	1.98%	YES	U	2.12%
22	2,5-Dihydrofuran	14	SC1-EF-G	2.0E-05	0.001	1.96%	YES	U	2.12%
22	2,5-Dihydrofuran	16	SC1-EF-H	2.0E-05	0.001	1.98%	YES	U	2.12%
23	2-Methylfuran	2	SD1-IN-A	2.0E-05	0.001	2.03%	YES	U	2.30%
23	2-Methylfuran	4	SD1-IN-B	2.0E-05	0.001	1.98%	YES	U	2.30%
23	2-Methylfuran	6	SD1-IN-C	2.1E-05	0.001	2.10%	YES	U	2.30%
23	2-Methylfuran	8	SD1-IN-D	2.1E-05	0.001	2.11%	YES		2.30%
23	2-Methylfuran	10	SD1-IN-E	2.2E-05	0.001	2.19%	YES	U	2.30%
23	2-Methylfuran	12	SD1-IN-F	2.0E-05	0.001	1.98%	YES	U	2.30%
23	2-Methylfuran	14	SD1-IN-G	2.0E-05	0.001	2.03%	YES	U	2.30%
23	2-Methylfuran	16	SD1-IN-H	2.2E-05	0.001	2.23%	YES	U	2.30%
23	2-Methylfuran	2	SD1-EF-A	2.0E-05	0.001	2.00%	YES	U	2.30%
23	2-Methylfuran	4	SD1-EF-B	2.1E-05	0.001	2.13%	YES	U	2.30%
23	2-Methylfuran	6	SD1-EF-C	2.0E-05	0.001	1.98%	YES	U	2.30%
23	2-Methylfuran	8	SD1-EF-D	2.0E-05	0.001	2.05%	YES	U	2.30%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
23	2-Methylfuran	10	SD1-EF-E	2.1E-05	0.001	2.14%	YES	U	2.30%
23	2-Methylfuran	12	SD1-EF-F	2.1E-05	0.001	2.11%	YES	U	2.30%
23	2-Methylfuran	14	SD1-EF-G		0.001				2.30%
23	2-Methylfuran	16	SD1-EF-H	2.1E-05	0.001	2.14%	YES	U	2.30%
23	2-Methylfuran	2	SC1-IN-A	1.9E-05	0.001	1.89%	YES	U	2.30%
23	2-Methylfuran	4	SC1-IN-B	2.3E-05	0.001	2.30%	YES	U	2.30%
23	2-Methylfuran	6	SC1-IN-C	2.2E-05	0.001	2.16%	YES	U	2.30%
23	2-Methylfuran	8	SC1-IN-D	2.3E-05	0.001	2.27%	YES	U	2.30%
23	2-Methylfuran	10	SC1-IN-E	2.0E-05	0.001	1.99%	YES	U	2.30%
23	2-Methylfuran	12	SC1-IN-F	2.2E-05	0.001	2.21%	YES	U	2.30%
23	2-Methylfuran	14	SC1-IN-G	2.1E-05	0.001	2.05%	YES	U	2.30%
23	2-Methylfuran	16	SC1-IN-H	2.2E-05	0.001	2.20%	YES	U	2.30%
23	2-Methylfuran	2	SC1-EF-A	2.3E-05	0.001	2.29%	YES	U	2.30%
23	2-Methylfuran	4	SC1-EF-B	2.1E-05	0.001	2.06%	YES	U	2.30%
23	2-Methylfuran	6	SC1-EF-C	2.1E-05	0.001	2.08%	YES	U	2.30%
23	2-Methylfuran	8	SC1-EF-D	2.1E-05	0.001	2.08%	YES	U	2.30%
23	2-Methylfuran	10	SC1-EF-E	2.1E-05	0.001	2.10%	YES	U	2.30%
23	2-Methylfuran	12	SC1-EF-F	2.1E-05	0.001	2.15%	YES	U	2.30%
23	2-Methylfuran	14	SC1-EF-G	2.1E-05	0.001	2.13%	YES	U	2.30%
23	2-Methylfuran	16	SC1-EF-H	2.1E-05	0.001	2.15%	YES	U	2.30%
34	Diethylphthalate	2	SD1-IN-A		0.54				
34	Diethylphthalate	4	SD1-IN-B		0.54				
34	Diethylphthalate	6	SD1-IN-C		0.54				
34	Diethylphthalate	8	SD1-IN-D		0.54				
34	Diethylphthalate	10	SD1-IN-E		0.54				
34	Diethylphthalate	12	SD1-IN-F		0.54				
34	Diethylphthalate	14	SD1-IN-G		0.54				
34	Diethylphthalate	16	SD1-IN-H		0.54				
34	Diethylphthalate	2	SD1-EF-A		0.54				
34	Diethylphthalate	4	SD1-EF-B		0.54				
34	Diethylphthalate	6	SD1-EF-C		0.54				
34	Diethylphthalate	8	SD1-EF-D		0.54				
34	Diethylphthalate	10	SD1-EF-E		0.54				
34	Diethylphthalate	12	SD1-EF-F		0.54				
34	Diethylphthalate	14	SD1-EF-G		0.54				
34	Diethylphthalate	16	SD1-EF-H		0.54				
34	Diethylphthalate	2	SC1-IN-A		0.54				
34	Diethylphthalate	4	SC1-IN-B		0.54				
34	Diethylphthalate	6	SC1-IN-C		0.54				
34	Diethylphthalate	8	SC1-IN-D		0.54				
34	Diethylphthalate	10	SC1-IN-E		0.54				
34	Diethylphthalate	12	SC1-IN-F		0.54				
34	Diethylphthalate	14	SC1-IN-G		0.54				
34	Diethylphthalate	16	SC1-IN-H	6.5E-04	0.54	0.120%		JNT	
34	Diethylphthalate	2	SC1-EF-A		0.54				
34	Diethylphthalate	4	SC1-EF-B		0.54				
34	Diethylphthalate	6	SC1-EF-C		0.54				
34	Diethylphthalate	8	SC1-EF-D		0.54				
34	Diethylphthalate	10	SC1-EF-E	2.8E-03	0.54	0.515%		JNT	
34	Diethylphthalate	12	SC1-EF-F		0.54				
34	Diethylphthalate	14	SC1-EF-G	9.6E-04	0.54	0.177%		JNT	
34	Diethylphthalate	16	SC1-EF-H		0.54				
35	Acetonitrile	2	SD1-IN-A	4.9E-01	20	2.44%	YES		2.69%
35	Acetonitrile	4	SD1-IN-B	4.9E-01	20	2.44%	YES		2.69%
35	Acetonitrile	6	SD1-IN-C	4.9E-01	20	2.47%	YES		2.69%
35	Acetonitrile	8	SD1-IN-D	4.8E-01	20	2.38%	YES		2.69%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
35	Acetonitrile	10	SD1-IN-E	5.4E-01	20	2.69%	YES		2.69%
35	Acetonitrile	12	SD1-IN-F	4.6E-01	20	2.29%	YES		2.69%
35	Acetonitrile	14	SD1-IN-G	4.6E-01	20	2.32%	YES		2.69%
35	Acetonitrile	16	SD1-IN-H	4.8E-01	20	2.38%	YES		2.69%
35	Acetonitrile	2	SD1-EF-A	4.8E-01	20	2.42%	YES		2.69%
35	Acetonitrile	4	SD1-EF-B	4.9E-01	20	2.43%	YES		2.69%
35	Acetonitrile	6	SD1-EF-C	5.0E-01	20	2.48%	YES		2.69%
35	Acetonitrile	8	SD1-EF-D	5.0E-01	20	2.50%	YES		2.69%
35	Acetonitrile	10	SD1-EF-E	5.1E-01	20	2.54%	YES		2.69%
35	Acetonitrile	12	SD1-EF-F	5.1E-01	20	2.56%	YES		2.69%
35	Acetonitrile	14	SD1-EF-G	5.0E-01	20	2.49%	YES		2.69%
35	Acetonitrile	16	SD1-EF-H	5.0E-01	20	2.50%	YES		2.69%
35	Acetonitrile	2	SC1-IN-A	4.6E-01	20	2.29%	YES		2.69%
35	Acetonitrile	4	SC1-IN-B	4.7E-01	20	2.34%	YES		2.69%
35	Acetonitrile	6	SC1-IN-C	5.1E-01	20	2.57%	YES		2.69%
35	Acetonitrile	8	SC1-IN-D	5.1E-01	20	2.53%	YES		2.69%
35	Acetonitrile	10	SC1-IN-E	4.7E-01	20	2.35%	YES		2.69%
35	Acetonitrile	12	SC1-IN-F	5.1E-01	20	2.56%	YES		2.69%
35	Acetonitrile	14	SC1-IN-G	5.1E-01	20	2.57%	YES		2.69%
35	Acetonitrile	16	SC1-IN-H	5.0E-01	20	2.52%	YES		2.69%
35	Acetonitrile	2	SC1-EF-A	5.3E-01	20	2.66%	YES		2.69%
35	Acetonitrile	4	SC1-EF-B	5.1E-01	20	2.57%	YES		2.69%
35	Acetonitrile	6	SC1-EF-C	5.1E-01	20	2.56%	YES		2.69%
35	Acetonitrile	8	SC1-EF-D	5.0E-01	20	2.51%	YES		2.69%
35	Acetonitrile	10	SC1-EF-E	4.8E-01	20	2.38%	YES		2.69%
35	Acetonitrile	12	SC1-EF-F	4.8E-01	20	2.41%	YES		2.69%
35	Acetonitrile	14	SC1-EF-G	4.9E-01	20	2.46%	YES		2.69%
35	Acetonitrile	16	SC1-EF-H	5.0E-01	20	2.50%	YES		2.69%
52	Pyridine	2	SD1-IN-A	1.3E-03	1.0	0.132%	YES	c	0.142%
52	Pyridine	4	SD1-IN-B	1.3E-03	1.0	0.130%	YES	c	0.142%
52	Pyridine	6	SD1-IN-C	1.3E-03	1.0	0.130%	YES	c	0.142%
52	Pyridine	8	SD1-IN-D	1.3E-03	1.0	0.134%	YES	c	0.142%
52	Pyridine	10	SD1-IN-E	1.3E-03	1.0	0.130%	YES	c	0.142%
52	Pyridine	12	SD1-IN-F	1.3E-03	1.0	0.131%	YES	c	0.142%
52	Pyridine	14	SD1-IN-G	1.3E-03	1.0	0.134%	YES	c	0.142%
52	Pyridine	16	SD1-IN-H	1.3E-03	1.0	0.135%	YES	c	0.142%
52	Pyridine	2	SD1-EF-A	1.2E-03	1.0	0.120%	YES	c	0.142%
52	Pyridine	4	SD1-EF-B	1.3E-03	1.0	0.127%	YES	c	0.142%
52	Pyridine	6	SD1-EF-C	1.2E-03	1.0	0.125%	YES	c	0.142%
52	Pyridine	8	SD1-EF-D	1.3E-03	1.0	0.125%	YES	c	0.142%
52	Pyridine	10	SD1-EF-E	1.2E-03	1.0	0.122%	YES	c	0.142%
52	Pyridine	12	SD1-EF-F	1.2E-03	1.0	0.123%	YES	c	0.142%
52	Pyridine	14	SD1-EF-G	1.3E-03	1.0	0.126%	YES	c	0.142%
52	Pyridine	16	SD1-EF-H	1.2E-03	1.0	0.124%	YES	c	0.142%
52	Pyridine	2	SC1-IN-A	1.4E-03	1.0	0.142%	YES		0.142%
52	Pyridine	4	SC1-IN-B	1.4E-03	1.0	0.141%	YES		0.142%
52	Pyridine	6	SC1-IN-C	1.4E-03	1.0	0.140%	YES		0.142%
52	Pyridine	8	SC1-IN-D	1.4E-03	1.0	0.136%	YES		0.142%
52	Pyridine	10	SC1-IN-E	1.3E-03	1.0	0.126%	YES		0.142%
52	Pyridine	12	SC1-IN-F	1.3E-03	1.0	0.127%	YES		0.142%
52	Pyridine	14	SC1-IN-G	1.3E-03	1.0	0.130%	YES		0.142%
52	Pyridine	16	SC1-IN-H	1.3E-03	1.0	0.130%	YES		0.142%
52	Pyridine	2	SC1-EF-A	1.4E-03	1.0	0.141%	YES		0.142%
52	Pyridine	4	SC1-EF-B	1.4E-03	1.0	0.137%	YES		0.142%
52	Pyridine	6	SC1-EF-C	1.4E-03	1.0	0.139%	YES		0.142%
52	Pyridine	8	SC1-EF-D	1.3E-03	1.0	0.131%	YES		0.142%
52	Pyridine	10	SC1-EF-E	1.3E-03	1.0	0.127%	YES		0.142%

Table D.1. APR Cartridge Testing (BY-110) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
52	Pyridine	12	SC1-EF-F	1.3E-03	1.0	0.129%	YES		0.142%
52	Pyridine	14	SC1-EF-G	1.2E-03	1.0	0.124%	YES		0.142%
52	Pyridine	16	SC1-EF-H	1.3E-03	1.0	0.126%	YES		0.142%
53	2,4-Dimethylpyridine	2	SD1-IN-A	9.7E-04	0.50	0.195%	YES	c	0.210%
53	2,4-Dimethylpyridine	4	SD1-IN-B	9.6E-04	0.50	0.193%	YES	c	0.210%
53	2,4-Dimethylpyridine	6	SD1-IN-C	9.6E-04	0.50	0.191%	YES	c	0.210%
53	2,4-Dimethylpyridine	8	SD1-IN-D	9.9E-04	0.50	0.198%	YES	c	0.210%
53	2,4-Dimethylpyridine	10	SD1-IN-E	9.6E-04	0.50	0.192%	YES	c	0.210%
53	2,4-Dimethylpyridine	12	SD1-IN-F	9.7E-04	0.50	0.194%	YES	c	0.210%
53	2,4-Dimethylpyridine	14	SD1-IN-G	9.9E-04	0.50	0.198%	YES	c	0.210%
53	2,4-Dimethylpyridine	16	SD1-IN-H	9.9E-04	0.50	0.199%	YES	c	0.210%
53	2,4-Dimethylpyridine	2	SD1-EF-A	8.9E-04	0.50	0.177%	YES	c	0.210%
53	2,4-Dimethylpyridine	4	SD1-EF-B	9.3E-04	0.50	0.187%	YES	c	0.210%
53	2,4-Dimethylpyridine	6	SD1-EF-C	9.2E-04	0.50	0.184%	YES	c	0.210%
53	2,4-Dimethylpyridine	8	SD1-EF-D	9.2E-04	0.50	0.185%	YES	c	0.210%
53	2,4-Dimethylpyridine	10	SD1-EF-E	9.0E-04	0.50	0.180%	YES	c	0.210%
53	2,4-Dimethylpyridine	12	SD1-EF-F	9.1E-04	0.50	0.181%	YES	c	0.210%
53	2,4-Dimethylpyridine	14	SD1-EF-G	9.3E-04	0.50	0.186%	YES	c	0.210%
53	2,4-Dimethylpyridine	16	SD1-EF-H	9.2E-04	0.50	0.183%	YES	c	0.210%
53	2,4-Dimethylpyridine	2	SC1-IN-A	1.0E-03	0.50	0.210%	YES	c	0.210%
53	2,4-Dimethylpyridine	4	SC1-IN-B	1.0E-03	0.50	0.209%	YES	c	0.210%
53	2,4-Dimethylpyridine	6	SC1-IN-C	1.0E-03	0.50	0.207%	YES	c	0.210%
53	2,4-Dimethylpyridine	8	SC1-IN-D	1.0E-03	0.50	0.201%	YES	c	0.210%
53	2,4-Dimethylpyridine	10	SC1-IN-E	9.3E-04	0.50	0.186%	YES	c	0.210%
53	2,4-Dimethylpyridine	12	SC1-IN-F	9.4E-04	0.50	0.188%	YES	c	0.210%
53	2,4-Dimethylpyridine	14	SC1-IN-G	9.6E-04	0.50	0.192%	YES	c	0.210%
53	2,4-Dimethylpyridine	16	SC1-IN-H	9.6E-04	0.50	0.192%	YES	c	0.210%
53	2,4-Dimethylpyridine	2	SC1-EF-A	1.0E-03	0.50	0.208%	YES	c	0.210%
53	2,4-Dimethylpyridine	4	SC1-EF-B	1.0E-03	0.50	0.202%	YES	c	0.210%
53	2,4-Dimethylpyridine	6	SC1-EF-C	1.0E-03	0.50	0.206%	YES	c	0.210%
53	2,4-Dimethylpyridine	8	SC1-EF-D	9.7E-04	0.50	0.194%	YES	c	0.210%
53	2,4-Dimethylpyridine	10	SC1-EF-E	9.4E-04	0.50	0.187%	YES	c	0.210%
53	2,4-Dimethylpyridine	12	SC1-EF-F	9.5E-04	0.50	0.191%	YES	c	0.210%
53	2,4-Dimethylpyridine	14	SC1-EF-G	9.2E-04	0.50	0.183%	YES	c	0.210%
53	2,4-Dimethylpyridine	16	SC1-EF-H	9.3E-04	0.50	0.186%	YES	c	0.210%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
1	Ammonia	2	TL-IN-A	1.4E+02	25	555%		H	2.35%
1	Ammonia	4	TL-IN-B	1.4E+02	25	573%		H	2.35%
1	Ammonia	6	TL-IN-C	1.9E+02	25	767%		H	2.35%
1	Ammonia	8	TL-IN-D	1.7E+02	25	673%		H	2.35%
1	Ammonia	10	TL-IN-E	1.8E+02	25	717%		H	2.35%
1	Ammonia	12	TL-IN-F	1.6E+02	25	626%		H	2.35%
1	Ammonia	14	TL-IN-G	1.1E+02	25	421%		H	2.35%
1	Ammonia	16	TL-IN-H	1.3E+02	25	538%		H	2.35%
1	Ammonia	2	TL-EF-A	5.7E-01	25	2.27%	YES		2.35%
1	Ammonia	4	TL-EF-B	5.5E-01	25	2.22%	YES		2.35%
1	Ammonia	6	TL-EF-C	3.8E+00	25	15.3%			2.35%
1	Ammonia	8	TL-EF-D	6.9E+01	25	277%			2.35%
1	Ammonia	10	TL-EF-E	8.7E+01	25	346%		H	2.35%
1	Ammonia	12	TL-EF-F	1.4E+02	25	550%		H	2.35%
1	Ammonia	14	TL-EF-G	1.5E+02	25	584%		H	2.35%
1	Ammonia	16	TL-EF-H	1.8E+02	25	718%		H	2.35%
1	Ammonia	2	FR57-IN-A	1.3E+02	25	514%			2.35%
1	Ammonia	4	FR57-IN-B	1.2E+02	25	485%			2.35%
1	Ammonia	6	FR57-IN-C	1.5E+02	25	586%			2.35%
1	Ammonia	8	FR57-IN-D	1.3E+02	25	515%			2.35%
1	Ammonia	10	FR57-IN-E	1.2E+02	25	492%			2.35%
1	Ammonia	12	FR57-IN-F	1.3E+02	25	505%			2.35%
1	Ammonia	14	FR57-IN-G	1.3E+02	25	523%			2.35%
1	Ammonia	16	FR57-IN-H	1.2E+02	25	479%			2.35%
1	Ammonia	2	FR57-EF-A	2.9E+01	25	115%		H	2.35%
1	Ammonia	4	FR57-EF-B	1.1E+02	25	449%		H	2.35%
1	Ammonia	6	FR57-EF-C	1.3E+02	25	516%		H	2.35%
1	Ammonia	8	FR57-EF-D	1.2E+02	25	490%			2.35%
1	Ammonia	10	FR57-EF-E	1.4E+02	25	557%			2.35%
1	Ammonia	12	FR57-EF-F	1.4E+02	25	560%			2.35%
1	Ammonia	14	FR57-EF-G	1.5E+02	25	608%			2.35%
1	Ammonia	16	FR57-EF-H	5.9E-01	25	2.35%	YES		2.35%
3	Mercury	2	TL-IN-A	6.5E-04	0.003	21.7%			6.91%
3	Mercury	4	TL-IN-B	6.2E-04	0.003	20.7%			6.91%
3	Mercury	6	TL-IN-C	7.0E-04	0.003	23.1%			6.91%
3	Mercury	8	TL-IN-D		0.003				6.91%
3	Mercury	10	TL-IN-E	7.6E-04	0.003	25.1%			6.91%
3	Mercury	12	TL-IN-F	8.2E-04	0.003	27.3%			6.91%
3	Mercury	14	TL-IN-G	5.0E-04	0.003	16.6%			6.91%
3	Mercury	16	TL-IN-H	6.5E-04	0.003	21.7%			6.91%
3	Mercury	2	TL-EF-A	2.0E-04	0.003	6.63%	YES		6.91%
3	Mercury	4	TL-EF-B	2.0E-04	0.003	6.72%	YES		6.91%
3	Mercury	6	TL-EF-C	2.0E-04	0.003	6.79%	YES		6.91%
3	Mercury	8	TL-EF-D	2.1E-04	0.003	6.84%	YES		6.91%
3	Mercury	10	TL-EF-E	2.0E-04	0.003	6.75%	YES		6.91%
3	Mercury	12	TL-EF-F	1.9E-04	0.003	6.34%	YES		6.91%
3	Mercury	14	TL-EF-G	1.9E-04	0.003	6.38%	YES		6.91%
3	Mercury	16	TL-EF-H	1.9E-04	0.003	6.32%	YES		6.91%
3	Mercury	2	FR57-IN-A	6.2E-04	0.003	20.5%			6.91%
3	Mercury	4	FR57-IN-B	6.0E-04	0.003	20.0%			6.91%
3	Mercury	6	FR57-IN-C	6.5E-04	0.003	21.5%			6.91%
3	Mercury	8	FR57-IN-D	5.9E-04	0.003	19.7%			6.91%
3	Mercury	10	FR57-IN-E	3.7E-04	0.003	12.4%			6.91%
3	Mercury	12	FR57-IN-F	4.6E-04	0.003	15.3%			6.91%
3	Mercury	14	FR57-IN-G	5.0E-04	0.003	16.6%			6.91%
3	Mercury	16	FR57-IN-H	4.9E-04	0.003	16.1%			6.91%
3	Mercury	2	FR57-EF-A	2.0E-04	0.003	6.75%	YES		6.91%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
3	Mercury	4	FR57-EF-B	2.0E-04	0.003	6.72%	YES		6.91%
3	Mercury	6	FR57-EF-C	2.0E-04	0.003	6.70%	YES		6.91%
3	Mercury	8	FR57-EF-D	2.0E-04	0.003	6.71%	YES		6.91%
3	Mercury	10	FR57-EF-E	2.1E-04	0.003	6.82%	YES		6.91%
3	Mercury	12	FR57-EF-F	2.0E-04	0.003	6.79%	YES		6.91%
3	Mercury	14	FR57-EF-G	2.1E-04	0.003	6.91%	YES		6.91%
3	Mercury	16	FR57-EF-H	2.0E-04	0.003	6.52%	YES		6.91%
4	1,3-Butadiene	2	TL-IN-A	3.8E-02	1.0	3.82%	YES		3.82%
4	1,3-Butadiene	4	TL-IN-B	3.8E-02	1.0	3.77%	YES		3.82%
4	1,3-Butadiene	6	TL-IN-C	3.8E-02	1.0	3.78%	YES		3.82%
4	1,3-Butadiene	8	TL-IN-D	3.8E-02	1.0	3.80%	YES		3.82%
4	1,3-Butadiene	10	TL-IN-E	3.8E-02	1.0	3.81%	YES		3.82%
4	1,3-Butadiene	12	TL-IN-F	3.8E-02	1.0	3.80%	YES		3.82%
4	1,3-Butadiene	14	TL-IN-G	3.6E-02	1.0	3.63%	YES		3.82%
4	1,3-Butadiene	16	TL-IN-H	3.8E-02	1.0	3.75%	YES		3.82%
4	1,3-Butadiene	2	TL-EF-A	1.9E-02	1.0	1.93%	YES		3.82%
4	1,3-Butadiene	4	TL-EF-B	1.9E-02	1.0	1.95%	YES		3.82%
4	1,3-Butadiene	6	TL-EF-C	1.8E-02	1.0	1.82%	YES		3.82%
4	1,3-Butadiene	8	TL-EF-D	3.6E-02	1.0	3.61%	YES		3.82%
4	1,3-Butadiene	10	TL-EF-E	3.6E-02	1.0	3.57%	YES		3.82%
4	1,3-Butadiene	12	TL-EF-F	3.7E-02	1.0	3.66%	YES		3.82%
4	1,3-Butadiene	14	TL-EF-G	3.6E-02	1.0	3.60%	YES		3.82%
4	1,3-Butadiene	16	TL-EF-H	3.6E-02	1.0	3.58%	YES		3.82%
4	1,3-Butadiene	2	FR57-IN-A	3.5E-02	1.0	3.49%	YES		3.82%
4	1,3-Butadiene	4	FR57-IN-B	3.5E-02	1.0	3.48%	YES		3.82%
4	1,3-Butadiene	6	FR57-IN-C	3.5E-02	1.0	3.48%	YES		3.82%
4	1,3-Butadiene	8	FR57-IN-D	3.5E-02	1.0	3.47%	YES		3.82%
4	1,3-Butadiene	10	FR57-IN-E	3.6E-02	1.0	3.56%	YES		3.82%
4	1,3-Butadiene	12	FR57-IN-F	3.6E-02	1.0	3.62%	YES		3.82%
4	1,3-Butadiene	14	FR57-IN-G	3.7E-02	1.0	3.66%	YES		3.82%
4	1,3-Butadiene	16	FR57-IN-H	3.7E-02	1.0	3.68%	YES		3.82%
4	1,3-Butadiene	2	FR57-EF-A	2.0E-02	1.0	2.00%	YES		3.82%
4	1,3-Butadiene	4	FR57-EF-B	2.0E-02	1.0	2.04%	YES		3.82%
4	1,3-Butadiene	6	FR57-EF-C	3.7E-02	1.0	3.73%	YES		3.82%
4	1,3-Butadiene	8	FR57-EF-D	3.8E-02	1.0	3.78%	YES		3.82%
4	1,3-Butadiene	10	FR57-EF-E	3.8E-02	1.0	3.78%	YES		3.82%
4	1,3-Butadiene	12	FR57-EF-F	3.8E-02	1.0	3.81%	YES		3.82%
4	1,3-Butadiene	14	FR57-EF-G	3.8E-02	1.0	3.77%	YES		3.82%
4	1,3-Butadiene	16	FR57-EF-H	3.8E-02	1.0	3.77%	YES		3.82%
5	Benzene	2	TL-IN-A	1.6E-03	0.50	0.313%			0.0201%
5	Benzene	4	TL-IN-B	1.6E-03	0.50	0.313%			0.0201%
5	Benzene	6	TL-IN-C	2.2E-03	0.50	0.440%			0.0201%
5	Benzene	8	TL-IN-D	2.2E-03	0.50	0.439%			0.0201%
5	Benzene	10	TL-IN-E		0.50				0.0201%
5	Benzene	12	TL-IN-F	2.4E-03	0.50	0.472%			0.0201%
5	Benzene	14	TL-IN-G	1.9E-03	0.50	0.377%			0.0201%
5	Benzene	16	TL-IN-H	1.5E-03	0.50	0.298%			0.0201%
5	Benzene	2	TL-EF-A	4.2E-04	0.50	0.084%		J	0.0201%
5	Benzene	4	TL-EF-B	5.0E-04	0.50	0.100%		J	0.0201%
5	Benzene	6	TL-EF-C	1.9E-04	0.50	0.038%		J	0.0201%
5	Benzene	8	TL-EF-D	5.1E-04	0.50	0.102%		J	0.0201%
5	Benzene	10	TL-EF-E	1.2E-03	0.50	0.241%			0.0201%
5	Benzene	12	TL-EF-F	8.7E-04	0.50	0.173%		J	0.0201%
5	Benzene	14	TL-EF-G	6.1E-04	0.50	0.122%		J	0.0201%
5	Benzene	16	TL-EF-H	7.8E-04	0.50	0.156%		J	0.0201%
5	Benzene	2	FR57-IN-A	1.0E-04	0.50	0.020%	YES		0.0201%
5	Benzene	4	FR57-IN-B	2.0E-03	0.50	0.391%			0.0201%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
5	Benzene	6	FR57-IN-C	2.4E-03	0.50	0.476%			0.0201%
5	Benzene	8	FR57-IN-D	1.7E-03	0.50	0.337%			0.0201%
5	Benzene	10	FR57-IN-E	1.7E-03	0.50	0.342%			0.0201%
5	Benzene	12	FR57-IN-F	1.6E-03	0.50	0.322%			0.0201%
5	Benzene	14	FR57-IN-G	1.6E-03	0.50	0.315%			0.0201%
5	Benzene	16	FR57-IN-H	1.8E-03	0.50	0.367%			0.0201%
5	Benzene	2	FR57-EF-A	5.4E-04	0.50	0.108%		J	0.0201%
5	Benzene	4	FR57-EF-B	5.7E-04	0.50	0.113%		J	0.0201%
5	Benzene	6	FR57-EF-C	4.9E-04	0.50	0.099%		J	0.0201%
5	Benzene	8	FR57-EF-D	1.1E-03	0.50	0.221%			0.0201%
5	Benzene	10	FR57-EF-E	4.5E-04	0.50	0.089%		J	0.0201%
5	Benzene	12	FR57-EF-F	4.7E-04	0.50	0.093%		J	0.0201%
5	Benzene	14	FR57-EF-G	4.2E-04	0.50	0.084%		J	0.0201%
5	Benzene	16	FR57-EF-H	4.3E-04	0.50	0.086%		J	0.0201%
6	Biphenyl	2	TL-IN-A		0.20				0.0258%
6	Biphenyl	4	TL-IN-B	5.0E-05	0.20	0.025%	YES	U	0.0258%
6	Biphenyl	6	TL-IN-C	5.0E-05	0.20	0.025%	YES	U	0.0258%
6	Biphenyl	8	TL-IN-D		0.20				0.0258%
6	Biphenyl	10	TL-IN-E	4.8E-05	0.20	0.024%	YES	U	0.0258%
6	Biphenyl	12	TL-IN-F	4.8E-05	0.20	0.024%	YES	U	0.0258%
6	Biphenyl	14	TL-IN-G	4.2E-05	0.20	0.021%	YES	U	0.0258%
6	Biphenyl	16	TL-IN-H	4.9E-05	0.20	0.024%	YES	U	0.0258%
6	Biphenyl	2	TL-EF-A	4.7E-05	0.20	0.024%	YES	U	0.0258%
6	Biphenyl	4	TL-EF-B	4.6E-05	0.20	0.023%	YES	U	0.0258%
6	Biphenyl	6	TL-EF-C	4.8E-05	0.20	0.024%	YES	U	0.0258%
6	Biphenyl	8	TL-EF-D	5.1E-05	0.20	0.025%	YES	U	0.0258%
6	Biphenyl	10	TL-EF-E	4.7E-05	0.20	0.024%	YES	U	0.0258%
6	Biphenyl	12	TL-EF-F	4.6E-05	0.20	0.023%	YES	U	0.0258%
6	Biphenyl	14	TL-EF-G	4.4E-05	0.20	0.022%	YES	U	0.0258%
6	Biphenyl	16	TL-EF-H	4.8E-05	0.20	0.024%	YES	U	0.0258%
6	Biphenyl	2	FR57-IN-A	4.1E-05	0.20	0.021%	YES	U	0.0258%
6	Biphenyl	4	FR57-IN-B	4.6E-05	0.20	0.023%	YES	U	0.0258%
6	Biphenyl	6	FR57-IN-C	4.8E-05	0.20	0.024%	YES	U	0.0258%
6	Biphenyl	8	FR57-IN-D	4.6E-05	0.20	0.023%	YES	U	0.0258%
6	Biphenyl	10	FR57-IN-E	4.5E-05	0.20	0.022%	YES	U	0.0258%
6	Biphenyl	12	FR57-IN-F	4.9E-05	0.20	0.024%	YES	U	0.0258%
6	Biphenyl	14	FR57-IN-G	4.8E-05	0.20	0.024%	YES	U	0.0258%
6	Biphenyl	16	FR57-IN-H	4.9E-05	0.20	0.025%	YES	U	0.0258%
6	Biphenyl	2	FR57-EF-A	4.5E-05	0.20	0.022%	YES	U	0.0258%
6	Biphenyl	4	FR57-EF-B	4.6E-05	0.20	0.023%	YES	U	0.0258%
6	Biphenyl	6	FR57-EF-C	4.4E-05	0.20	0.022%	YES	U	0.0258%
6	Biphenyl	8	FR57-EF-D	4.7E-05	0.20	0.024%	YES	U	0.0258%
6	Biphenyl	10	FR57-EF-E	4.5E-05	0.20	0.023%	YES	U	0.0258%
6	Biphenyl	12	FR57-EF-F	4.7E-05	0.20	0.024%	YES	U	0.0258%
6	Biphenyl	14	FR57-EF-G	5.0E-05	0.20	0.025%	YES	U	0.0258%
6	Biphenyl	16	FR57-EF-H	5.2E-05	0.20	0.026%	YES	U	0.0258%
7	1-Butanol	2	TL-IN-A	4.1E-01	20	2.06%		ELQYac	0.00351%
7	1-Butanol	4	TL-IN-B	3.7E-01	20	1.84%		ELQYa	0.00351%
7	1-Butanol	6	TL-IN-C	4.5E-01	20	2.23%		ELQYa	0.00351%
7	1-Butanol	8	TL-IN-D	4.8E-01	20	2.40%		ELQYa	0.00351%
7	1-Butanol	10	TL-IN-E		20				0.00351%
7	1-Butanol	12	TL-IN-F	4.4E-01	20	2.22%		ELQYa	0.00351%
7	1-Butanol	14	TL-IN-G	3.4E-01	20	1.72%		ELQYa	0.00351%
7	1-Butanol	16	TL-IN-H	3.6E-01	20	1.78%		ELQYac	0.00351%
7	1-Butanol	2	TL-EF-A	6.4E-04	20	0.003%	YES	LQUYa	0.00351%
7	1-Butanol	4	TL-EF-B	6.4E-04	20	0.003%	YES	LQUYac	0.00351%
7	1-Butanol	6	TL-EF-C	6.7E-04	20	0.003%	YES	LQUYac	0.00351%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
7	1-Butanol	8	TL-EF-D	7.0E-04	20	0.004%	YES	LQUYac	0.00351%
7	1-Butanol	10	TL-EF-E	7.0E-04	20	0.003%	YES	LQUYac	0.00351%
7	1-Butanol	12	TL-EF-F	6.4E-04	20	0.003%	YES	LQUYac	0.00351%
7	1-Butanol	14	TL-EF-G	6.2E-04	20	0.003%	YES	LQUYac	0.00351%
7	1-Butanol	16	TL-EF-H	6.3E-04	20	0.003%	YES	LQUYac	0.00351%
7	1-Butanol	2	FR57-IN-A	6.3E-04	20	0.003%	YES	LQa	0.00351%
7	1-Butanol	4	FR57-IN-B	4.7E-01	20	2.35%		ELQYa	0.00351%
7	1-Butanol	6	FR57-IN-C	5.5E-01	20	2.76%		ELQYa	0.00351%
7	1-Butanol	8	FR57-IN-D	3.9E-01	20	1.97%		ELQYa	0.00351%
7	1-Butanol	10	FR57-IN-E	4.2E-01	20	2.11%		ELQYa	0.00351%
7	1-Butanol	12	FR57-IN-F	3.9E-01	20	1.93%		ELQYa	0.00351%
7	1-Butanol	14	FR57-IN-G	4.3E-01	20	2.14%		ELQYa	0.00351%
7	1-Butanol	16	FR57-IN-H	3.7E-01	20	1.85%		ELQYa	0.00351%
7	1-Butanol	2	FR57-EF-A	6.1E-04	20	0.003%	YES	LQa	0.00351%
7	1-Butanol	4	FR57-EF-B	6.6E-04	20	0.003%	YES	LQa	0.00351%
7	1-Butanol	6	FR57-EF-C	6.6E-04	20	0.003%	YES	LQUYa	0.00351%
7	1-Butanol	8	FR57-EF-D	6.4E-04	20	0.003%	YES	LQa	0.00351%
7	1-Butanol	10	FR57-EF-E	6.2E-04	20	0.003%	YES	LQa	0.00351%
7	1-Butanol	12	FR57-EF-F	6.5E-04	20	0.003%	YES	LQa	0.00351%
7	1-Butanol	14	FR57-EF-G	6.1E-04	20	0.003%	YES	LQa	0.00351%
7	1-Butanol	16	FR57-EF-H	6.1E-04	20	0.003%	YES	LQa	0.00351%
8	Methanol	2	TL-IN-A	5.2E-01	200	0.262%			0.196%
8	Methanol	4	TL-IN-B	4.6E-01	200	0.232%			0.196%
8	Methanol	6	TL-IN-C	1.2E+00	200	0.578%			0.196%
8	Methanol	8	TL-IN-D	4.7E-01	200	0.236%			0.196%
8	Methanol	10	TL-IN-E	5.6E-01	200	0.281%			0.196%
8	Methanol	12	TL-IN-F	6.8E-01	200	0.339%			0.196%
8	Methanol	14	TL-IN-G	3.5E-01	200	0.174%	YES		0.196%
8	Methanol	16	TL-IN-H	4.6E-01	200	0.229%			0.196%
8	Methanol	2	TL-EF-A	3.8E-01	200	0.188%	YES		0.196%
8	Methanol	4	TL-EF-B	3.4E-01	200	0.172%	YES		0.196%
8	Methanol	6	TL-EF-C	3.7E-01	200	0.187%	YES		0.196%
8	Methanol	8	TL-EF-D	3.9E-01	200	0.194%	YES		0.196%
8	Methanol	10	TL-EF-E	3.8E-01	200	0.190%	YES		0.196%
8	Methanol	12	TL-EF-F	3.9E-01	200	0.193%	YES		0.196%
8	Methanol	14	TL-EF-G	3.5E-01	200	0.176%	YES		0.196%
8	Methanol	16	TL-EF-H	4.2E-01	200	0.208%			0.196%
8	Methanol	2	FR57-IN-A	3.4E-01	200	0.172%			0.196%
8	Methanol	4	FR57-IN-B	6.3E-01	200	0.313%			0.196%
8	Methanol	6	FR57-IN-C	3.9E-01	200	0.195%			0.196%
8	Methanol	8	FR57-IN-D	3.6E-01	200	0.181%	YES		0.196%
8	Methanol	10	FR57-IN-E	3.7E-01	200	0.185%	YES		0.196%
8	Methanol	12	FR57-IN-F	3.9E-01	200	0.193%	YES		0.196%
8	Methanol	14	FR57-IN-G	5.9E-01	200	0.294%			0.196%
8	Methanol	16	FR57-IN-H	3.9E-01	200	0.194%	YES		0.196%
8	Methanol	2	FR57-EF-A	3.5E-01	200	0.176%			0.196%
8	Methanol	4	FR57-EF-B	3.5E-01	200	0.177%	YES		0.196%
8	Methanol	6	FR57-EF-C	3.5E-01	200	0.173%	YES		0.196%
8	Methanol	8	FR57-EF-D	3.6E-01	200	0.181%	YES		0.196%
8	Methanol	10	FR57-EF-E	6.3E-01	200	0.316%			0.196%
8	Methanol	12	FR57-EF-F	3.7E-01	200	0.187%	YES		0.196%
8	Methanol	14	FR57-EF-G	3.8E-01	200	0.192%	YES		0.196%
8	Methanol	16	FR57-EF-H	3.9E-01	200	0.196%	YES		0.196%
9	2-Hexanone	2	TL-IN-A	4.6E-03	5.0	0.093%			0.00148%
9	2-Hexanone	4	TL-IN-B	5.8E-03	5.0	0.116%			0.00148%
9	2-Hexanone	6	TL-IN-C	1.0E-02	5.0	0.208%			0.00148%
9	2-Hexanone	8	TL-IN-D	1.1E-02	5.0	0.211%			0.00148%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
9	2-Hexanone	10	TL-IN-E		5.0				0.00148%
9	2-Hexanone	12	TL-IN-F	1.3E-02	5.0	0.253%			0.00148%
9	2-Hexanone	14	TL-IN-G	9.6E-03	5.0	0.192%			0.00148%
9	2-Hexanone	16	TL-IN-H	6.7E-03	5.0	0.135%			0.00148%
9	2-Hexanone	2	TL-EF-A	6.8E-05	5.0	0.001%	YES	U	0.00148%
9	2-Hexanone	4	TL-EF-B	6.8E-05	5.0	0.001%	YES	U	0.00148%
9	2-Hexanone	6	TL-EF-C	7.1E-05	5.0	0.001%	YES	Q	0.00148%
9	2-Hexanone	8	TL-EF-D	7.4E-05	5.0	0.001%	YES	Q	0.00148%
9	2-Hexanone	10	TL-EF-E	7.4E-05	5.0	0.001%	YES	U	0.00148%
9	2-Hexanone	12	TL-EF-F	6.7E-05	5.0	0.001%	YES	U	0.00148%
9	2-Hexanone	14	TL-EF-G	6.5E-05	5.0	0.001%	YES	U	0.00148%
9	2-Hexanone	16	TL-EF-H	6.7E-05	5.0	0.001%	YES	U	0.00148%
9	2-Hexanone	2	FR57-IN-A	6.6E-05	5.0	0.001%	YES		0.00148%
9	2-Hexanone	4	FR57-IN-B	9.8E-03	5.0	0.195%			0.00148%
9	2-Hexanone	6	FR57-IN-C	1.2E-02	5.0	0.235%			0.00148%
9	2-Hexanone	8	FR57-IN-D	8.0E-03	5.0	0.160%			0.00148%
9	2-Hexanone	10	FR57-IN-E	8.7E-03	5.0	0.174%			0.00148%
9	2-Hexanone	12	FR57-IN-F	1.1E-02	5.0	0.217%			0.00148%
9	2-Hexanone	14	FR57-IN-G	8.8E-03	5.0	0.176%			0.00148%
9	2-Hexanone	16	FR57-IN-H	9.5E-03	5.0	0.191%			0.00148%
9	2-Hexanone	2	FR57-EF-A	6.4E-05	5.0	0.001%	YES		0.00148%
9	2-Hexanone	4	FR57-EF-B	7.0E-05	5.0	0.001%	YES		0.00148%
9	2-Hexanone	6	FR57-EF-C	6.9E-05	5.0	0.001%	YES	U	0.00148%
9	2-Hexanone	8	FR57-EF-D	6.8E-05	5.0	0.001%	YES		0.00148%
9	2-Hexanone	10	FR57-EF-E	6.6E-05	5.0	0.001%	YES	Q	0.00148%
9	2-Hexanone	12	FR57-EF-F	6.9E-05	5.0	0.001%	YES		0.00148%
9	2-Hexanone	14	FR57-EF-G	6.4E-05	5.0	0.001%	YES		0.00148%
9	2-Hexanone	16	FR57-EF-H	6.5E-05	5.0	0.001%	YES		0.00148%
11	4-Methyl-2-hexanone	2	TL-IN-A	2.7E-04	0.50	0.054%		J	0.0166%
11	4-Methyl-2-hexanone	4	TL-IN-B	4.1E-04	0.50	0.081%		J	0.0166%
11	4-Methyl-2-hexanone	6	TL-IN-C	7.5E-04	0.50	0.150%			0.0166%
11	4-Methyl-2-hexanone	8	TL-IN-D	7.5E-04	0.50	0.150%			0.0166%
11	4-Methyl-2-hexanone	10	TL-IN-E		0.50				0.0166%
11	4-Methyl-2-hexanone	12	TL-IN-F	1.1E-03	0.50	0.212%			0.0166%
11	4-Methyl-2-hexanone	14	TL-IN-G	8.4E-04	0.50	0.169%			0.0166%
11	4-Methyl-2-hexanone	16	TL-IN-H	6.4E-04	0.50	0.129%		J	0.0166%
11	4-Methyl-2-hexanone	2	TL-EF-A	7.6E-05	0.50	0.015%	YES	U	0.0166%
11	4-Methyl-2-hexanone	4	TL-EF-B	7.6E-05	0.50	0.015%	YES	U	0.0166%
11	4-Methyl-2-hexanone	6	TL-EF-C	7.9E-05	0.50	0.016%	YES	U	0.0166%
11	4-Methyl-2-hexanone	8	TL-EF-D	8.3E-05	0.50	0.017%	YES	U	0.0166%
11	4-Methyl-2-hexanone	10	TL-EF-E	8.3E-05	0.50	0.017%	YES	U	0.0166%
11	4-Methyl-2-hexanone	12	TL-EF-F	7.5E-05	0.50	0.015%	YES	U	0.0166%
11	4-Methyl-2-hexanone	14	TL-EF-G	7.3E-05	0.50	0.015%	YES	U	0.0166%
11	4-Methyl-2-hexanone	16	TL-EF-H	7.4E-05	0.50	0.015%	YES	U	0.0166%
11	4-Methyl-2-hexanone	2	FR57-IN-A	7.4E-05	0.50	0.015%	YES		0.0166%
11	4-Methyl-2-hexanone	4	FR57-IN-B	7.5E-04	0.50	0.150%			0.0166%
11	4-Methyl-2-hexanone	6	FR57-IN-C	9.8E-04	0.50	0.195%			0.0166%
11	4-Methyl-2-hexanone	8	FR57-IN-D	7.5E-04	0.50	0.150%			0.0166%
11	4-Methyl-2-hexanone	10	FR57-IN-E	8.1E-04	0.50	0.163%			0.0166%
11	4-Methyl-2-hexanone	12	FR57-IN-F	9.0E-04	0.50	0.180%			0.0166%
11	4-Methyl-2-hexanone	14	FR57-IN-G	7.7E-04	0.50	0.154%			0.0166%
11	4-Methyl-2-hexanone	16	FR57-IN-H	7.8E-04	0.50	0.157%			0.0166%
11	4-Methyl-2-hexanone	2	FR57-EF-A	7.2E-05	0.50	0.014%	YES		0.0166%
11	4-Methyl-2-hexanone	4	FR57-EF-B	7.8E-05	0.50	0.016%	YES		0.0166%
11	4-Methyl-2-hexanone	6	FR57-EF-C	7.7E-05	0.50	0.015%	YES	U	0.0166%
11	4-Methyl-2-hexanone	8	FR57-EF-D	7.6E-05	0.50	0.015%	YES		0.0166%
11	4-Methyl-2-hexanone	10	FR57-EF-E	7.4E-05	0.50	0.015%	YES	Q	0.0166%
11	4-Methyl-2-hexanone	12	FR57-EF-F	7.7E-05	0.50	0.015%	YES		0.0166%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
11	4-Methyl-2-hexanone	14	FR57-EF-G	7.1E-05	0.50	0.014%	YES		0.0166%
11	4-Methyl-2-hexanone	16	FR57-EF-H	7.3E-05	0.50	0.015%	YES		0.0166%
13	3-Buten-2-one	2	TL-IN-A	1.3E-04	0.20	0.065%	YES	U	0.0662%
13	3-Buten-2-one	4	TL-IN-B	1.2E-04	0.20	0.062%	YES	U	0.0662%
13	3-Buten-2-one	6	TL-IN-C	1.3E-04	0.20	0.066%	YES	U	0.0662%
13	3-Buten-2-one	8	TL-IN-D	6.2E-03	0.20	3.11%			0.0662%
13	3-Buten-2-one	10	TL-IN-E		0.20				0.0662%
13	3-Buten-2-one	12	TL-IN-F	7.2E-03	0.20	3.62%			0.0662%
13	3-Buten-2-one	14	TL-IN-G	3.8E-03	0.20	1.90%			0.0662%
13	3-Buten-2-one	16	TL-IN-H	1.3E-04	0.20	0.066%	YES	U	0.0662%
13	3-Buten-2-one	2	TL-EF-A	1.3E-04	0.20	0.066%	YES	U	0.0662%
13	3-Buten-2-one	4	TL-EF-B	1.3E-04	0.20	0.066%	YES	U	0.0662%
13	3-Buten-2-one	6	TL-EF-C	2.0E-04	0.20	0.102%		J	0.0662%
13	3-Buten-2-one	8	TL-EF-D	2.9E-04	0.20	0.144%		J	0.0662%
13	3-Buten-2-one	10	TL-EF-E	2.3E-04	0.20	0.115%		J	0.0662%
13	3-Buten-2-one	12	TL-EF-F	1.8E-04	0.20	0.088%		J	0.0662%
13	3-Buten-2-one	14	TL-EF-G	1.4E-04	0.20	0.072%		J	0.0662%
13	3-Buten-2-one	16	TL-EF-H	1.3E-04	0.20	0.065%	YES	U	0.0662%
13	3-Buten-2-one	2	FR57-IN-A	1.6E-04	0.20	0.078%		J	0.0662%
13	3-Buten-2-one	4	FR57-IN-B	5.2E-03	0.20	2.62%			0.0662%
13	3-Buten-2-one	6	FR57-IN-C	5.7E-03	0.20	2.83%			0.0662%
13	3-Buten-2-one	8	FR57-IN-D	4.2E-03	0.20	2.12%			0.0662%
13	3-Buten-2-one	10	FR57-IN-E	4.9E-03	0.20	2.44%			0.0662%
13	3-Buten-2-one	12	FR57-IN-F	5.5E-03	0.20	2.77%			0.0662%
13	3-Buten-2-one	14	FR57-IN-G	2.8E-03	0.20	1.42%			0.0662%
13	3-Buten-2-one	16	FR57-IN-H	6.6E-03	0.20	3.28%			0.0662%
13	3-Buten-2-one	2	FR57-EF-A	2.0E-04	0.20	0.100%		J	0.0662%
13	3-Buten-2-one	4	FR57-EF-B	1.4E-04	0.20	0.068%		J	0.0662%
13	3-Buten-2-one	6	FR57-EF-C	2.0E-04	0.20	0.099%		J	0.0662%
13	3-Buten-2-one	8	FR57-EF-D	1.8E-04	0.20	0.088%		J	0.0662%
13	3-Buten-2-one	10	FR57-EF-E	1.8E-04	0.20	0.090%		J	0.0662%
13	3-Buten-2-one	12	FR57-EF-F	1.7E-04	0.20	0.085%		J	0.0662%
13	3-Buten-2-one	14	FR57-EF-G	1.8E-04	0.20	0.092%		J	0.0662%
13	3-Buten-2-one	16	FR57-EF-H	2.3E-04	0.20	0.114%		J	0.0662%
14	Formaldehyde	2	TL-IN-A	4.8E-03	0.30	1.60%			0.605%
14	Formaldehyde	4	TL-IN-B	6.1E-03	0.30	2.03%			0.605%
14	Formaldehyde	6	TL-IN-C	5.8E-03	0.30	1.92%			0.605%
14	Formaldehyde	8	TL-IN-D	4.8E-03	0.30	1.60%			0.605%
14	Formaldehyde	10	TL-IN-E	5.8E-03	0.30	1.93%			0.605%
14	Formaldehyde	12	TL-IN-F	5.1E-03	0.30	1.71%			0.605%
14	Formaldehyde	14	TL-IN-G	4.1E-03	0.30	1.36%			0.605%
14	Formaldehyde	16	TL-IN-H	2.4E-03	0.30	0.790%			0.605%
14	Formaldehyde	2	TL-EF-A	4.5E-03	0.30	1.51%			0.605%
14	Formaldehyde	4	TL-EF-B	4.9E-03	0.30	1.63%			0.605%
14	Formaldehyde	6	TL-EF-C	6.3E-03	0.30	2.10%			0.605%
14	Formaldehyde	8	TL-EF-D	2.6E-03	0.30	0.879%			0.605%
14	Formaldehyde	10	TL-EF-E	2.8E-03	0.30	0.927%			0.605%
14	Formaldehyde	12	TL-EF-F	4.5E-03	0.30	1.51%			0.605%
14	Formaldehyde	14	TL-EF-G	5.3E-03	0.30	1.75%			0.605%
14	Formaldehyde	16	TL-EF-H	3.2E-03	0.30	1.06%			0.605%
14	Formaldehyde	2	FR57-IN-A	7.0E-03	0.30	2.34%			0.605%
14	Formaldehyde	4	FR57-IN-B	4.9E-03	0.30	1.64%			0.605%
14	Formaldehyde	6	FR57-IN-C	1.0E-02	0.30	3.33%			0.605%
14	Formaldehyde	8	FR57-IN-D	7.5E-03	0.30	2.51%			0.605%
14	Formaldehyde	10	FR57-IN-E	7.7E-03	0.30	2.55%			0.605%
14	Formaldehyde	12	FR57-IN-F	5.3E-03	0.30	1.77%			0.605%
14	Formaldehyde	14	FR57-IN-G	4.3E-03	0.30	1.42%			0.605%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
14	Formaldehyde	16	FR57-IN-H	5.2E-03	0.30	1.75%			0.605%
14	Formaldehyde	2	FR57-EF-A	5.6E-03	0.30	1.86%			0.605%
14	Formaldehyde	4	FR57-EF-B	3.1E-03	0.30	1.04%			0.605%
14	Formaldehyde	6	FR57-EF-C	3.7E-03	0.30	1.23%			0.605%
14	Formaldehyde	8	FR57-EF-D	3.7E-03	0.30	1.23%			0.605%
14	Formaldehyde	10	FR57-EF-E	5.0E-03	0.30	1.66%			0.605%
14	Formaldehyde	12	FR57-EF-F	3.7E-03	0.30	1.22%			0.605%
14	Formaldehyde	14	FR57-EF-G	3.4E-03	0.30	1.12%			0.605%
14	Formaldehyde	16	FR57-EF-H	3.1E-03	0.30	1.04%			0.605%
15	Acetaldehyde	2	TL-IN-A	8.5E-02	25	0.341%			0.00495%
15	Acetaldehyde	4	TL-IN-B	8.5E-02	25	0.341%			0.00495%
15	Acetaldehyde	6	TL-IN-C	1.3E-01	25	0.523%			0.00495%
15	Acetaldehyde	8	TL-IN-D	1.2E-01	25	0.472%			0.00495%
15	Acetaldehyde	10	TL-IN-E	1.1E-01	25	0.446%			0.00495%
15	Acetaldehyde	12	TL-IN-F	1.1E-01	25	0.436%			0.00495%
15	Acetaldehyde	14	TL-IN-G	6.0E-02	25	0.239%			0.00495%
15	Acetaldehyde	16	TL-IN-H	6.0E-02	25	0.239%			0.00495%
15	Acetaldehyde	2	TL-EF-A	5.3E-03	25	0.021%			0.00495%
15	Acetaldehyde	4	TL-EF-B	4.9E-02	25	0.195%			0.00495%
15	Acetaldehyde	6	TL-EF-C	5.9E-02	25	0.235%			0.00495%
15	Acetaldehyde	8	TL-EF-D	4.0E-02	25	0.159%			0.00495%
15	Acetaldehyde	10	TL-EF-E	3.1E-02	25	0.125%			0.00495%
15	Acetaldehyde	12	TL-EF-F	4.0E-02	25	0.162%			0.00495%
15	Acetaldehyde	14	TL-EF-G	5.4E-02	25	0.215%			0.00495%
15	Acetaldehyde	16	TL-EF-H	8.0E-02	25	0.322%			0.00495%
15	Acetaldehyde	2	FR57-IN-A	6.8E-02	25	0.274%			0.00495%
15	Acetaldehyde	4	FR57-IN-B	6.3E-02	25	0.250%			0.00495%
15	Acetaldehyde	6	FR57-IN-C	9.5E-02	25	0.378%			0.00495%
15	Acetaldehyde	8	FR57-IN-D	6.5E-02	25	0.259%			0.00495%
15	Acetaldehyde	10	FR57-IN-E	6.1E-02	25	0.245%			0.00495%
15	Acetaldehyde	12	FR57-IN-F	5.7E-02	25	0.226%			0.00495%
15	Acetaldehyde	14	FR57-IN-G	6.5E-02	25	0.259%			0.00495%
15	Acetaldehyde	16	FR57-IN-H	6.3E-02	25	0.250%			0.00495%
15	Acetaldehyde	2	FR57-EF-A	2.8E-02	25	0.114%			0.00495%
15	Acetaldehyde	4	FR57-EF-B	7.4E-02	25	0.297%			0.00495%
15	Acetaldehyde	6	FR57-EF-C	5.7E-02	25	0.229%			0.00495%
15	Acetaldehyde	8	FR57-EF-D	3.2E-02	25	0.128%			0.00495%
15	Acetaldehyde	10	FR57-EF-E	3.4E-02	25	0.136%			0.00495%
15	Acetaldehyde	12	FR57-EF-F	3.9E-02	25	0.154%			0.00495%
15	Acetaldehyde	14	FR57-EF-G	5.3E-02	25	0.210%			0.00495%
15	Acetaldehyde	16	FR57-EF-H	5.5E-02	25	0.220%			0.00495%
16	Butanal/Butyraldehyde	2	TL-IN-A	2.4E-02	25	0.095%		LQY	0.00165%
16	Butanal/Butyraldehyde	4	TL-IN-B	1.5E-02	25	0.058%		QY	0.00165%
16	Butanal/Butyraldehyde	6	TL-IN-C	3.2E-02	25	0.129%		QY	0.00165%
16	Butanal/Butyraldehyde	8	TL-IN-D	3.5E-02	25	0.139%		QY	0.00165%
16	Butanal/Butyraldehyde	10	TL-IN-E		25				0.00165%
16	Butanal/Butyraldehyde	12	TL-IN-F	3.8E-02	25	0.150%		EQY	0.00165%
16	Butanal/Butyraldehyde	14	TL-IN-G	2.1E-02	25	0.085%		QY	0.00165%
16	Butanal/Butyraldehyde	16	TL-IN-H	8.5E-02	25	0.340%		ELQY	0.00165%
16	Butanal/Butyraldehyde	2	TL-EF-A	3.8E-04	25	0.002%	YES	LQY	0.00165%
16	Butanal/Butyraldehyde	4	TL-EF-B	3.8E-04	25	0.002%	YES	LQY	0.00165%
16	Butanal/Butyraldehyde	6	TL-EF-C	3.9E-04	25	0.002%	YES	LQUY	0.00165%
16	Butanal/Butyraldehyde	8	TL-EF-D	4.1E-04	25	0.002%	YES	LQY	0.00165%
16	Butanal/Butyraldehyde	10	TL-EF-E	4.1E-04	25	0.002%	YES	LQY	0.00165%
16	Butanal/Butyraldehyde	12	TL-EF-F	3.7E-04	25	0.001%	YES	LQUY	0.00165%
16	Butanal/Butyraldehyde	14	TL-EF-G	3.6E-04	25	0.001%	YES	LQUY	0.00165%
16	Butanal/Butyraldehyde	16	TL-EF-H	3.7E-04	25	0.001%	YES	LQUY	0.00165%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
16	Butanal/Butyraldehyde	2	FR57-IN-A	3.7E-04	25	0.001%	YES	c	0.00165%
16	Butanal/Butyraldehyde	4	FR57-IN-B	3.2E-02	25	0.129%		LQY	0.00165%
16	Butanal/Butyraldehyde	6	FR57-IN-C	3.9E-02	25	0.158%		ELQY	0.00165%
16	Butanal/Butyraldehyde	8	FR57-IN-D	1.2E-01	25	0.476%		Ec	0.00165%
16	Butanal/Butyraldehyde	10	FR57-IN-E	1.1E-01	25	0.451%		ELQY	0.00165%
16	Butanal/Butyraldehyde	12	FR57-IN-F	3.0E-02	25	0.121%		LQY	0.00165%
16	Butanal/Butyraldehyde	14	FR57-IN-G	9.8E-02	25	0.390%		ELQY	0.00165%
16	Butanal/Butyraldehyde	16	FR57-IN-H	1.2E-01	25	0.497%		Ec	0.00165%
16	Butanal/Butyraldehyde	2	FR57-EF-A	3.6E-04	25	0.001%	YES	c	0.00165%
16	Butanal/Butyraldehyde	4	FR57-EF-B	3.9E-04	25	0.002%	YES	c	0.00165%
16	Butanal/Butyraldehyde	6	FR57-EF-C	3.9E-04	25	0.002%	YES	LUY	0.00165%
16	Butanal/Butyraldehyde	8	FR57-EF-D	4.1E-04	25	0.002%		Jc	0.00165%
16	Butanal/Butyraldehyde	10	FR57-EF-E	3.7E-04	25	0.001%	YES	c	0.00165%
16	Butanal/Butyraldehyde	12	FR57-EF-F	3.8E-04	25	0.002%	YES	c	0.00165%
16	Butanal/Butyraldehyde	14	FR57-EF-G	3.6E-04	25	0.001%	YES	c	0.00165%
16	Butanal/Butyraldehyde	16	FR57-EF-H	3.6E-04	25	0.001%	YES	c	0.00165%
19	2-Propenal/Acrolein	2	TL-IN-A	8.6E-04	0.100	0.859%	YES		0.972%
19	2-Propenal/Acrolein	4	TL-IN-B	8.6E-04	0.100	0.858%	YES		0.972%
19	2-Propenal/Acrolein	6	TL-IN-C	8.6E-04	0.100	0.856%	YES		0.972%
19	2-Propenal/Acrolein	8	TL-IN-D	8.6E-04	0.100	0.858%	YES		0.972%
19	2-Propenal/Acrolein	10	TL-IN-E	8.6E-04	0.100	0.860%	YES		0.972%
19	2-Propenal/Acrolein	12	TL-IN-F	8.6E-04	0.100	0.857%	YES		0.972%
19	2-Propenal/Acrolein	14	TL-IN-G	8.4E-04	0.100	0.840%	YES		0.972%
19	2-Propenal/Acrolein	16	TL-IN-H	8.7E-04	0.100	0.870%	YES		0.972%
19	2-Propenal/Acrolein	2	TL-EF-A	8.6E-04	0.100	0.865%	YES		0.972%
19	2-Propenal/Acrolein	4	TL-EF-B	8.7E-04	0.100	0.871%	YES		0.972%
19	2-Propenal/Acrolein	6	TL-EF-C	8.9E-04	0.100	0.886%	YES		0.972%
19	2-Propenal/Acrolein	8	TL-EF-D	9.2E-04	0.100	0.917%	YES		0.972%
19	2-Propenal/Acrolein	10	TL-EF-E	9.4E-04	0.100	0.943%	YES		0.972%
19	2-Propenal/Acrolein	12	TL-EF-F	9.3E-04	0.100	0.933%	YES		0.972%
19	2-Propenal/Acrolein	14	TL-EF-G	8.8E-04	0.100	0.879%	YES		0.972%
19	2-Propenal/Acrolein	16	TL-EF-H	8.5E-04	0.100	0.855%	YES		0.972%
19	2-Propenal/Acrolein	2	FR57-IN-A	9.0E-04	0.100	0.896%	YES		0.972%
19	2-Propenal/Acrolein	4	FR57-IN-B	8.8E-04	0.100	0.878%	YES		0.972%
19	2-Propenal/Acrolein	6	FR57-IN-C	8.6E-04	0.100	0.864%	YES		0.972%
19	2-Propenal/Acrolein	8	FR57-IN-D	8.8E-04	0.100	0.876%	YES		0.972%
19	2-Propenal/Acrolein	10	FR57-IN-E	8.9E-04	0.100	0.891%	YES		0.972%
19	2-Propenal/Acrolein	12	FR57-IN-F	8.9E-04	0.100	0.889%	YES		0.972%
19	2-Propenal/Acrolein	14	FR57-IN-G	8.8E-04	0.100	0.877%	YES		0.972%
19	2-Propenal/Acrolein	16	FR57-IN-H	8.8E-04	0.100	0.879%	YES		0.972%
19	2-Propenal/Acrolein	2	FR57-EF-A	9.3E-04	0.100	0.932%	YES		0.972%
19	2-Propenal/Acrolein	4	FR57-EF-B	9.7E-04	0.100	0.972%	YES		0.972%
19	2-Propenal/Acrolein	6	FR57-EF-C	9.0E-04	0.100	0.901%	YES		0.972%
19	2-Propenal/Acrolein	8	FR57-EF-D	9.0E-04	0.100	0.901%	YES		0.972%
19	2-Propenal/Acrolein	10	FR57-EF-E	8.9E-04	0.100	0.890%	YES		0.972%
19	2-Propenal/Acrolein	12	FR57-EF-F	8.9E-04	0.100	0.892%	YES		0.972%
19	2-Propenal/Acrolein	14	FR57-EF-G	9.0E-04	0.100	0.898%	YES		0.972%
19	2-Propenal/Acrolein	16	FR57-EF-H	9.0E-04	0.100	0.902%	YES		0.972%
20	Furan	2	TL-IN-A	3.2E-03	0.001	323%			13.9%
20	Furan	4	TL-IN-B	4.9E-03	0.001	487%			13.9%
20	Furan	6	TL-IN-C	5.0E-03	0.001	496%			13.9%
20	Furan	8	TL-IN-D	4.9E-03	0.001	494%			13.9%
20	Furan	10	TL-IN-E		0.001				13.9%
20	Furan	12	TL-IN-F	2.2E-03	0.001	220%			13.9%
20	Furan	14	TL-IN-G	2.1E-03	0.001	208%			13.9%
20	Furan	16	TL-IN-H	5.8E-03	0.001	576%			13.9%
20	Furan	2	TL-EF-A	1.3E-04	0.001	12.7%	YES	U	13.9%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
20	Furan	4	TL-EF-B	1.3E-04	0.001	12.7%	YES	U	13.9%
20	Furan	6	TL-EF-C	1.3E-04	0.001	13.3%	YES	U	13.9%
20	Furan	8	TL-EF-D	1.4E-04	0.001	13.9%	YES	U	13.9%
20	Furan	10	TL-EF-E	1.4E-04	0.001	13.8%	YES	U	13.9%
20	Furan	12	TL-EF-F	1.3E-04	0.001	12.6%	YES	U	13.9%
20	Furan	14	TL-EF-G	1.2E-04	0.001	12.2%	YES	U	13.9%
20	Furan	16	TL-EF-H	1.2E-04	0.001	12.5%	YES	U	13.9%
20	Furan	2	FR57-IN-A	1.2E-04	0.001	12.4%	YES		13.9%
20	Furan	4	FR57-IN-B	1.9E-03	0.001	189%			13.9%
20	Furan	6	FR57-IN-C	2.6E-03	0.001	264%			13.9%
20	Furan	8	FR57-IN-D	3.8E-03	0.001	378%			13.9%
20	Furan	10	FR57-IN-E	1.1E-03	0.001	111%			13.9%
20	Furan	12	FR57-IN-F	1.3E-03	0.001	134%			13.9%
20	Furan	14	FR57-IN-G	4.0E-03	0.001	396%			13.9%
20	Furan	16	FR57-IN-H	3.2E-03	0.001	316%			13.9%
20	Furan	2	FR57-EF-A	1.2E-04	0.001	12.0%	YES		13.9%
20	Furan	4	FR57-EF-B	1.3E-04	0.001	13.2%	YES		13.9%
20	Furan	6	FR57-EF-C	1.3E-04	0.001	13.0%	YES	U	13.9%
20	Furan	8	FR57-EF-D	1.3E-04	0.001	12.7%	YES		13.9%
20	Furan	10	FR57-EF-E	1.2E-04	0.001	12.4%	YES		13.9%
20	Furan	12	FR57-EF-F	1.3E-04	0.001	12.9%	YES		13.9%
20	Furan	14	FR57-EF-G	1.2E-04	0.001	12.0%	YES		13.9%
20	Furan	16	FR57-EF-H	1.2E-04	0.001	12.2%	YES		13.9%
21	2,3-Dihydrofuran	2	TL-IN-A	3.1E-05	0.001	3.06%	YES	U	3.18%
21	2,3-Dihydrofuran	4	TL-IN-B	2.8E-05	0.001	2.82%	YES	U	3.18%
21	2,3-Dihydrofuran	6	TL-IN-C	3.1E-05	0.001	3.11%	YES	U	3.18%
21	2,3-Dihydrofuran	8	TL-IN-D	3.0E-05	0.001	2.96%	YES	U	3.18%
21	2,3-Dihydrofuran	10	TL-IN-E	3.0E-05	0.001	3.00%	YES	U	3.18%
21	2,3-Dihydrofuran	12	TL-IN-F	3.0E-05	0.001	2.99%	YES	U	3.18%
21	2,3-Dihydrofuran	14	TL-IN-G	2.9E-05	0.001	2.86%	YES	U	3.18%
21	2,3-Dihydrofuran	16	TL-IN-H	2.7E-05	0.001	2.70%	YES	U	3.18%
21	2,3-Dihydrofuran	2	TL-EF-A	2.9E-05	0.001	2.87%	YES	U	3.18%
21	2,3-Dihydrofuran	4	TL-EF-B	2.8E-05	0.001	2.76%	YES	U	3.18%
21	2,3-Dihydrofuran	6	TL-EF-C	2.9E-05	0.001	2.92%	YES	U	3.18%
21	2,3-Dihydrofuran	8	TL-EF-D	3.1E-05	0.001	3.10%	YES	U	3.18%
21	2,3-Dihydrofuran	10	TL-EF-E	3.1E-05	0.001	3.06%	YES	U	3.18%
21	2,3-Dihydrofuran	12	TL-EF-F	2.5E-05	0.001	2.53%	YES	U	3.18%
21	2,3-Dihydrofuran	14	TL-EF-G	2.6E-05	0.001	2.62%	YES	U	3.18%
21	2,3-Dihydrofuran	16	TL-EF-H	2.8E-05	0.001	2.80%	YES	U	3.18%
21	2,3-Dihydrofuran	2	FR57-IN-A	2.7E-05	0.001	2.66%	YES	U	3.18%
21	2,3-Dihydrofuran	4	FR57-IN-B	3.1E-05	0.001	3.07%	YES	U	3.18%
21	2,3-Dihydrofuran	6	FR57-IN-C	3.1E-05	0.001	3.07%	YES	U	3.18%
21	2,3-Dihydrofuran	8	FR57-IN-D	3.2E-05	0.001	3.18%	YES	U	3.18%
21	2,3-Dihydrofuran	10	FR57-IN-E	3.1E-05	0.001	3.09%	YES	U	3.18%
21	2,3-Dihydrofuran	12	FR57-IN-F	3.1E-05	0.001	3.12%	YES	U	3.18%
21	2,3-Dihydrofuran	14	FR57-IN-G	3.2E-05	0.001	3.16%	YES	U	3.18%
21	2,3-Dihydrofuran	16	FR57-IN-H	2.8E-05	0.001	2.84%	YES	U	3.18%
21	2,3-Dihydrofuran	2	FR57-EF-A	2.7E-05	0.001	2.66%	YES	U	3.18%
21	2,3-Dihydrofuran	4	FR57-EF-B	2.8E-05	0.001	2.77%	YES	U	3.18%
21	2,3-Dihydrofuran	6	FR57-EF-C	2.7E-05	0.001	2.72%	YES	U	3.18%
21	2,3-Dihydrofuran	8	FR57-EF-D	3.1E-05	0.001	3.14%	YES	U	3.18%
21	2,3-Dihydrofuran	10	FR57-EF-E	2.7E-05	0.001	2.68%	YES	U	3.18%
21	2,3-Dihydrofuran	12	FR57-EF-F	3.0E-05	0.001	2.96%	YES	U	3.18%
21	2,3-Dihydrofuran	14	FR57-EF-G	3.1E-05	0.001	3.07%	YES	U	3.18%
21	2,3-Dihydrofuran	16	FR57-EF-H	3.1E-05	0.001	3.13%	YES	U	3.18%
22	2,5-Dihydrofuran	2	TL-IN-A	2.2E-04	0.001	21.8%	YES	U	24.1%
22	2,5-Dihydrofuran	4	TL-IN-B	2.1E-04	0.001	20.7%	YES	U	24.1%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
22	2,5-Dihydrofuran	6	TL-IN-C	2.2E-04	0.001	21.9%	YES	U	24.1%
22	2,5-Dihydrofuran	8	TL-IN-D	2.4E-04	0.001	23.5%	YES	U	24.1%
22	2,5-Dihydrofuran	10	TL-IN-E		0.001				24.1%
22	2,5-Dihydrofuran	12	TL-IN-F	2.1E-04	0.001	20.6%	YES	U	24.1%
22	2,5-Dihydrofuran	14	TL-IN-G	2.0E-04	0.001	20.2%	YES	U	24.1%
22	2,5-Dihydrofuran	16	TL-IN-H	2.2E-04	0.001	21.8%	YES	U	24.1%
22	2,5-Dihydrofuran	2	TL-EF-A	2.2E-04	0.001	22.0%	YES	U	24.1%
22	2,5-Dihydrofuran	4	TL-EF-B	2.2E-04	0.001	22.1%	YES	U	24.1%
22	2,5-Dihydrofuran	6	TL-EF-C	2.3E-04	0.001	23.1%	YES	U	24.1%
22	2,5-Dihydrofuran	8	TL-EF-D	2.4E-04	0.001	24.1%	YES	U	24.1%
22	2,5-Dihydrofuran	10	TL-EF-E	2.4E-04	0.001	24.0%	YES	U	24.1%
22	2,5-Dihydrofuran	12	TL-EF-F	2.2E-04	0.001	21.9%	YES	U	24.1%
22	2,5-Dihydrofuran	14	TL-EF-G	2.1E-04	0.001	21.2%	YES	U	24.1%
22	2,5-Dihydrofuran	16	TL-EF-H	2.2E-04	0.001	21.7%	YES	U	24.1%
22	2,5-Dihydrofuran	2	FR57-IN-A	2.2E-04	0.001	21.6%	YES		24.1%
22	2,5-Dihydrofuran	4	FR57-IN-B	2.2E-04	0.001	21.8%	YES	U	24.1%
22	2,5-Dihydrofuran	6	FR57-IN-C	2.2E-04	0.001	22.1%	YES	U	24.1%
22	2,5-Dihydrofuran	8	FR57-IN-D	2.0E-04	0.001	20.4%	YES		24.1%
22	2,5-Dihydrofuran	10	FR57-IN-E	2.1E-04	0.001	20.7%	YES	U	24.1%
22	2,5-Dihydrofuran	12	FR57-IN-F	2.0E-04	0.001	20.4%	YES	U	24.1%
22	2,5-Dihydrofuran	14	FR57-IN-G	2.1E-04	0.001	20.9%	YES	U	24.1%
22	2,5-Dihydrofuran	16	FR57-IN-H	2.1E-04	0.001	21.3%	YES		24.1%
22	2,5-Dihydrofuran	2	FR57-EF-A	2.1E-04	0.001	20.8%	YES		24.1%
22	2,5-Dihydrofuran	4	FR57-EF-B	2.3E-04	0.001	22.8%	YES		24.1%
22	2,5-Dihydrofuran	6	FR57-EF-C	2.3E-04	0.001	22.5%	YES	U	24.1%
22	2,5-Dihydrofuran	8	FR57-EF-D	2.2E-04	0.001	22.0%	YES		24.1%
22	2,5-Dihydrofuran	10	FR57-EF-E	2.1E-04	0.001	21.5%	YES		24.1%
22	2,5-Dihydrofuran	12	FR57-EF-F	2.2E-04	0.001	22.4%	YES		24.1%
22	2,5-Dihydrofuran	14	FR57-EF-G	2.1E-04	0.001	20.8%	YES		24.1%
22	2,5-Dihydrofuran	16	FR57-EF-H	2.1E-04	0.001	21.1%	YES		24.1%
23	2-Methylfuran	2	TL-IN-A	9.7E-05	0.001	9.68%		J	9.05%
23	2-Methylfuran	4	TL-IN-B	7.8E-05	0.001	7.79%		J	9.05%
23	2-Methylfuran	6	TL-IN-C	1.5E-04	0.001	14.9%		J	9.05%
23	2-Methylfuran	8	TL-IN-D	1.5E-04	0.001	15.3%		J	9.05%
23	2-Methylfuran	10	TL-IN-E		0.001				9.05%
23	2-Methylfuran	12	TL-IN-F	1.6E-04	0.001	16.1%		J	9.05%
23	2-Methylfuran	14	TL-IN-G	1.1E-04	0.001	11.0%		J	9.05%
23	2-Methylfuran	16	TL-IN-H	9.0E-05	0.001	8.95%		J	9.05%
23	2-Methylfuran	2	TL-EF-A	8.3E-05	0.001	8.28%	YES	U	9.05%
23	2-Methylfuran	4	TL-EF-B	8.3E-05	0.001	8.29%	YES	U	9.05%
23	2-Methylfuran	6	TL-EF-C	8.7E-05	0.001	8.67%	YES	Q	9.05%
23	2-Methylfuran	8	TL-EF-D	9.0E-05	0.001	9.05%	YES	Q	9.05%
23	2-Methylfuran	10	TL-EF-E	9.0E-05	0.001	9.02%	YES	U	9.05%
23	2-Methylfuran	12	TL-EF-F	8.2E-05	0.001	8.23%	YES	U	9.05%
23	2-Methylfuran	14	TL-EF-G	7.9E-05	0.001	7.95%	YES	U	9.05%
23	2-Methylfuran	16	TL-EF-H	8.1E-05	0.001	8.14%	YES	U	9.05%
23	2-Methylfuran	2	FR57-IN-A	8.1E-05	0.001	8.11%	YES		9.05%
23	2-Methylfuran	4	FR57-IN-B	1.4E-04	0.001	14.2%		J	9.05%
23	2-Methylfuran	6	FR57-IN-C	1.7E-04	0.001	16.6%		J	9.05%
23	2-Methylfuran	8	FR57-IN-D	1.1E-04	0.001	11.2%		J	9.05%
23	2-Methylfuran	10	FR57-IN-E	9.9E-05	0.001	9.90%		J	9.05%
23	2-Methylfuran	12	FR57-IN-F	9.1E-05	0.001	9.05%		J	9.05%
23	2-Methylfuran	14	FR57-IN-G	1.1E-04	0.001	11.4%		J	9.05%
23	2-Methylfuran	16	FR57-IN-H	1.3E-04	0.001	13.1%		J	9.05%
23	2-Methylfuran	2	FR57-EF-A	7.8E-05	0.001	7.82%	YES		9.05%
23	2-Methylfuran	4	FR57-EF-B	8.6E-05	0.001	8.58%	YES		9.05%
23	2-Methylfuran	6	FR57-EF-C	8.5E-05	0.001	8.46%	YES	U	9.05%
23	2-Methylfuran	8	FR57-EF-D	8.3E-05	0.001	8.26%	YES		9.05%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
23	2-Methylfuran	10	FR57-EF-E	8.1E-05	0.001	8.06%	YES		9.05%
23	2-Methylfuran	12	FR57-EF-F	8.4E-05	0.001	8.42%	YES		9.05%
23	2-Methylfuran	14	FR57-EF-G	7.8E-05	0.001	7.81%	YES		9.05%
23	2-Methylfuran	16	FR57-EF-H	7.9E-05	0.001	7.92%	YES		9.05%
24	2,5-Dimethylfuran	2	TL-IN-A	2.9E-05	0.001	2.87%	YES	U	2.99%
24	2,5-Dimethylfuran	4	TL-IN-B	2.7E-05	0.001	2.65%	YES	U	2.99%
24	2,5-Dimethylfuran	6	TL-IN-C	2.9E-05	0.001	2.92%	YES	U	2.99%
24	2,5-Dimethylfuran	8	TL-IN-D	2.8E-05	0.001	2.78%	YES	U	2.99%
24	2,5-Dimethylfuran	10	TL-IN-E	2.8E-05	0.001	2.82%	YES	U	2.99%
24	2,5-Dimethylfuran	12	TL-IN-F	2.8E-05	0.001	2.81%	YES	U	2.99%
24	2,5-Dimethylfuran	14	TL-IN-G	2.7E-05	0.001	2.69%	YES	U	2.99%
24	2,5-Dimethylfuran	16	TL-IN-H	2.5E-05	0.001	2.53%	YES	U	2.99%
24	2,5-Dimethylfuran	2	TL-EF-A	2.7E-05	0.001	2.70%	YES	U	2.99%
24	2,5-Dimethylfuran	4	TL-EF-B	2.6E-05	0.001	2.59%	YES	U	2.99%
24	2,5-Dimethylfuran	6	TL-EF-C	2.7E-05	0.001	2.74%	YES	U	2.99%
24	2,5-Dimethylfuran	8	TL-EF-D	2.9E-05	0.001	2.92%	YES	U	2.99%
24	2,5-Dimethylfuran	10	TL-EF-E	2.9E-05	0.001	2.87%	YES	U	2.99%
24	2,5-Dimethylfuran	12	TL-EF-F	2.4E-05	0.001	2.38%	YES	U	2.99%
24	2,5-Dimethylfuran	14	TL-EF-G	2.5E-05	0.001	2.46%	YES	U	2.99%
24	2,5-Dimethylfuran	16	TL-EF-H	2.6E-05	0.001	2.63%	YES	U	2.99%
24	2,5-Dimethylfuran	2	FR57-IN-A	2.5E-05	0.001	2.50%	YES	U	2.99%
24	2,5-Dimethylfuran	4	FR57-IN-B	2.9E-05	0.001	2.89%	YES	U	2.99%
24	2,5-Dimethylfuran	6	FR57-IN-C	2.9E-05	0.001	2.88%	YES	U	2.99%
24	2,5-Dimethylfuran	8	FR57-IN-D	3.0E-05	0.001	2.99%	YES	U	2.99%
24	2,5-Dimethylfuran	10	FR57-IN-E	2.9E-05	0.001	2.90%	YES	U	2.99%
24	2,5-Dimethylfuran	12	FR57-IN-F	2.9E-05	0.001	2.93%	YES	U	2.99%
24	2,5-Dimethylfuran	14	FR57-IN-G	3.0E-05	0.001	2.97%	YES	U	2.99%
24	2,5-Dimethylfuran	16	FR57-IN-H	2.7E-05	0.001	2.67%	YES	U	2.99%
24	2,5-Dimethylfuran	2	FR57-EF-A	2.5E-05	0.001	2.50%	YES	U	2.99%
24	2,5-Dimethylfuran	4	FR57-EF-B	2.6E-05	0.001	2.61%	YES	U	2.99%
24	2,5-Dimethylfuran	6	FR57-EF-C	2.6E-05	0.001	2.56%	YES	U	2.99%
24	2,5-Dimethylfuran	8	FR57-EF-D	2.9E-05	0.001	2.95%	YES	U	2.99%
24	2,5-Dimethylfuran	10	FR57-EF-E	2.5E-05	0.001	2.52%	YES	U	2.99%
24	2,5-Dimethylfuran	12	FR57-EF-F	2.8E-05	0.001	2.78%	YES	U	2.99%
24	2,5-Dimethylfuran	14	FR57-EF-G	2.9E-05	0.001	2.88%	YES	U	2.99%
24	2,5-Dimethylfuran	16	FR57-EF-H	2.9E-05	0.001	2.94%	YES	U	2.99%
28	2-Pentylfuran	2	TL-IN-A	2.9E-05	0.001	2.89%	YES	U	3.01%
28	2-Pentylfuran	4	TL-IN-B	2.7E-05	0.001	2.67%	YES	U	3.01%
28	2-Pentylfuran	6	TL-IN-C	2.9E-05	0.001	2.94%	YES	U	3.01%
28	2-Pentylfuran	8	TL-IN-D	2.8E-05	0.001	2.80%	YES	U	3.01%
28	2-Pentylfuran	10	TL-IN-E	2.8E-05	0.001	2.84%	YES	U	3.01%
28	2-Pentylfuran	12	TL-IN-F	2.8E-05	0.001	2.83%	YES	U	3.01%
28	2-Pentylfuran	14	TL-IN-G	2.7E-05	0.001	2.71%	YES	U	3.01%
28	2-Pentylfuran	16	TL-IN-H	2.6E-05	0.001	2.55%	YES	U	3.01%
28	2-Pentylfuran	2	TL-EF-A	2.7E-05	0.001	2.72%	YES	U	3.01%
28	2-Pentylfuran	4	TL-EF-B	2.6E-05	0.001	2.61%	YES	U	3.01%
28	2-Pentylfuran	6	TL-EF-C	2.8E-05	0.001	2.76%	YES	U	3.01%
28	2-Pentylfuran	8	TL-EF-D	2.9E-05	0.001	2.94%	YES	U	3.01%
28	2-Pentylfuran	10	TL-EF-E	2.9E-05	0.001	2.89%	YES	U	3.01%
28	2-Pentylfuran	12	TL-EF-F	2.4E-05	0.001	2.40%	YES	U	3.01%
28	2-Pentylfuran	14	TL-EF-G	2.5E-05	0.001	2.48%	YES	U	3.01%
28	2-Pentylfuran	16	TL-EF-H	2.6E-05	0.001	2.64%	YES	U	3.01%
28	2-Pentylfuran	2	FR57-IN-A	2.5E-05	0.001	2.51%	YES	U	3.01%
28	2-Pentylfuran	4	FR57-IN-B	2.9E-05	0.001	2.91%	YES	U	3.01%
28	2-Pentylfuran	6	FR57-IN-C	2.9E-05	0.001	2.90%	YES	U	3.01%
28	2-Pentylfuran	8	FR57-IN-D	3.0E-05	0.001	3.01%	YES	U	3.01%
28	2-Pentylfuran	10	FR57-IN-E	2.9E-05	0.001	2.92%	YES	U	3.01%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
28	2-Pentylfuran	12	FR57-IN-F	2.9E-05	0.001	2.95%	YES	U	3.01%
28	2-Pentylfuran	14	FR57-IN-G	3.0E-05	0.001	2.99%	YES	U	3.01%
28	2-Pentylfuran	16	FR57-IN-H	2.7E-05	0.001	2.68%	YES	U	3.01%
28	2-Pentylfuran	2	FR57-EF-A	2.5E-05	0.001	2.52%	YES	U	3.01%
28	2-Pentylfuran	4	FR57-EF-B	2.6E-05	0.001	2.62%	YES	U	3.01%
28	2-Pentylfuran	6	FR57-EF-C	2.6E-05	0.001	2.57%	YES	U	3.01%
28	2-Pentylfuran	8	FR57-EF-D	3.0E-05	0.001	2.97%	YES	U	3.01%
28	2-Pentylfuran	10	FR57-EF-E	2.5E-05	0.001	2.54%	YES	U	3.01%
28	2-Pentylfuran	12	FR57-EF-F	2.8E-05	0.001	2.80%	YES	U	3.01%
28	2-Pentylfuran	14	FR57-EF-G	2.9E-05	0.001	2.90%	YES	U	3.01%
28	2-Pentylfuran	16	FR57-EF-H	3.0E-05	0.001	2.96%	YES	U	3.01%
29	2-Heptylfuran	2	TL-IN-A	2.7E-05	0.001	2.73%	YES	U	2.84%
29	2-Heptylfuran	4	TL-IN-B	2.5E-05	0.001	2.52%	YES	U	2.84%
29	2-Heptylfuran	6	TL-IN-C	2.8E-05	0.001	2.77%	YES	U	2.84%
29	2-Heptylfuran	8	TL-IN-D	2.6E-05	0.001	2.64%	YES	U	2.84%
29	2-Heptylfuran	10	TL-IN-E	2.7E-05	0.001	2.67%	YES	U	2.84%
29	2-Heptylfuran	12	TL-IN-F	2.7E-05	0.001	2.66%	YES	U	2.84%
29	2-Heptylfuran	14	TL-IN-G	2.6E-05	0.001	2.55%	YES	U	2.84%
29	2-Heptylfuran	16	TL-IN-H	2.4E-05	0.001	2.41%	YES	U	2.84%
29	2-Heptylfuran	2	TL-EF-A	2.6E-05	0.001	2.56%	YES	U	2.84%
29	2-Heptylfuran	4	TL-EF-B	2.5E-05	0.001	2.46%	YES	U	2.84%
29	2-Heptylfuran	6	TL-EF-C	2.6E-05	0.001	2.60%	YES	U	2.84%
29	2-Heptylfuran	8	TL-EF-D	2.8E-05	0.001	2.77%	YES	U	2.84%
29	2-Heptylfuran	10	TL-EF-E	2.7E-05	0.001	2.73%	YES	U	2.84%
29	2-Heptylfuran	12	TL-EF-F	2.3E-05	0.001	2.26%	YES	U	2.84%
29	2-Heptylfuran	14	TL-EF-G	2.3E-05	0.001	2.34%	YES	U	2.84%
29	2-Heptylfuran	16	TL-EF-H	2.5E-05	0.001	2.49%	YES	U	2.84%
29	2-Heptylfuran	2	FR57-IN-A	2.4E-05	0.001	2.37%	YES	U	2.84%
29	2-Heptylfuran	4	FR57-IN-B	2.7E-05	0.001	2.74%	YES	U	2.84%
29	2-Heptylfuran	6	FR57-IN-C	2.7E-05	0.001	2.74%	YES	U	2.84%
29	2-Heptylfuran	8	FR57-IN-D	2.8E-05	0.001	2.84%	YES	U	2.84%
29	2-Heptylfuran	10	FR57-IN-E	2.8E-05	0.001	2.75%	YES	U	2.84%
29	2-Heptylfuran	12	FR57-IN-F	2.8E-05	0.001	2.78%	YES	U	2.84%
29	2-Heptylfuran	14	FR57-IN-G	2.8E-05	0.001	2.82%	YES	U	2.84%
29	2-Heptylfuran	16	FR57-IN-H	2.5E-05	0.001	2.53%	YES	U	2.84%
29	2-Heptylfuran	2	FR57-EF-A	2.4E-05	0.001	2.38%	YES	U	2.84%
29	2-Heptylfuran	4	FR57-EF-B	2.5E-05	0.001	2.47%	YES	U	2.84%
29	2-Heptylfuran	6	FR57-EF-C	2.4E-05	0.001	2.43%	YES	U	2.84%
29	2-Heptylfuran	8	FR57-EF-D	2.8E-05	0.001	2.80%	YES	U	2.84%
29	2-Heptylfuran	10	FR57-EF-E	2.4E-05	0.001	2.39%	YES	U	2.84%
29	2-Heptylfuran	12	FR57-EF-F	2.6E-05	0.001	2.64%	YES	U	2.84%
29	2-Heptylfuran	14	FR57-EF-G	2.7E-05	0.001	2.74%	YES	U	2.84%
29	2-Heptylfuran	16	FR57-EF-H	2.8E-05	0.001	2.79%	YES	U	2.84%
30	2-Propylfuran	2	TL-IN-A	1.7E-05	0.001	1.72%	YES	U	1.79%
30	2-Propylfuran	4	TL-IN-B	1.6E-05	0.001	1.59%	YES	U	1.79%
30	2-Propylfuran	6	TL-IN-C	1.8E-05	0.001	1.75%	YES	U	1.79%
30	2-Propylfuran	8	TL-IN-D	1.7E-05	0.001	1.67%	YES	U	1.79%
30	2-Propylfuran	10	TL-IN-E	1.7E-05	0.001	1.69%	YES	U	1.79%
30	2-Propylfuran	12	TL-IN-F	1.7E-05	0.001	1.68%	YES	U	1.79%
30	2-Propylfuran	14	TL-IN-G	1.6E-05	0.001	1.61%	YES	U	1.79%
30	2-Propylfuran	16	TL-IN-H	1.5E-05	0.001	1.52%	YES	U	1.79%
30	2-Propylfuran	2	TL-EF-A	1.6E-05	0.001	1.62%	YES	U	1.79%
30	2-Propylfuran	4	TL-EF-B	1.6E-05	0.001	1.55%	YES	U	1.79%
30	2-Propylfuran	6	TL-EF-C	1.6E-05	0.001	1.64%	YES	U	1.79%
30	2-Propylfuran	8	TL-EF-D	1.7E-05	0.001	1.75%	YES	U	1.79%
30	2-Propylfuran	10	TL-EF-E	1.7E-05	0.001	1.72%	YES	U	1.79%
30	2-Propylfuran	12	TL-EF-F	1.4E-05	0.001	1.43%	YES	U	1.79%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
30	2-Propylfuran	14	TL-EF-G	1.5E-05	0.001	1.48%	YES	U	1.79%
30	2-Propylfuran	16	TL-EF-H	1.6E-05	0.001	1.57%	YES	U	1.79%
30	2-Propylfuran	2	FR57-IN-A	1.5E-05	0.001	1.49%	YES	U	1.79%
30	2-Propylfuran	4	FR57-IN-B	1.7E-05	0.001	1.73%	YES	U	1.79%
30	2-Propylfuran	6	FR57-IN-C	1.7E-05	0.001	1.73%	YES	U	1.79%
30	2-Propylfuran	8	FR57-IN-D	1.8E-05	0.001	1.79%	YES	U	1.79%
30	2-Propylfuran	10	FR57-IN-E	1.7E-05	0.001	1.74%	YES	U	1.79%
30	2-Propylfuran	12	FR57-IN-F	1.8E-05	0.001	1.76%	YES	U	1.79%
30	2-Propylfuran	14	FR57-IN-G	1.8E-05	0.001	1.78%	YES	U	1.79%
30	2-Propylfuran	16	FR57-IN-H	1.6E-05	0.001	1.60%	YES	U	1.79%
30	2-Propylfuran	2	FR57-EF-A	1.5E-05	0.001	1.50%	YES	U	1.79%
30	2-Propylfuran	4	FR57-EF-B	1.6E-05	0.001	1.56%	YES	U	1.79%
30	2-Propylfuran	6	FR57-EF-C	1.5E-05	0.001	1.53%	YES	U	1.79%
30	2-Propylfuran	8	FR57-EF-D	1.8E-05	0.001	1.76%	YES	U	1.79%
30	2-Propylfuran	10	FR57-EF-E	1.5E-05	0.001	1.51%	YES	U	1.79%
30	2-Propylfuran	12	FR57-EF-F	1.7E-05	0.001	1.66%	YES	U	1.79%
30	2-Propylfuran	14	FR57-EF-G	1.7E-05	0.001	1.73%	YES	U	1.79%
30	2-Propylfuran	16	FR57-EF-H	1.8E-05	0.001	1.76%	YES	U	1.79%
34	Diethylphthalate	2	TL-IN-A		0.54				0.0110%
34	Diethylphthalate	4	TL-IN-B	5.7E-05	0.54	0.011%	YES	U	0.0110%
34	Diethylphthalate	6	TL-IN-C	5.8E-05	0.54	0.011%		J	0.0110%
34	Diethylphthalate	8	TL-IN-D		0.54				0.0110%
34	Diethylphthalate	10	TL-IN-E	5.5E-05	0.54	0.010%	YES	U	0.0110%
34	Diethylphthalate	12	TL-IN-F	5.5E-05	0.54	0.010%	YES	U	0.0110%
34	Diethylphthalate	14	TL-IN-G	5.2E-05	0.54	0.010%		J	0.0110%
34	Diethylphthalate	16	TL-IN-H	5.6E-05	0.54	0.010%	YES	U	0.0110%
34	Diethylphthalate	2	TL-EF-A	5.5E-05	0.54	0.010%	YES	U	0.0110%
34	Diethylphthalate	4	TL-EF-B	5.3E-05	0.54	0.010%	YES	U	0.0110%
34	Diethylphthalate	6	TL-EF-C	6.4E-05	0.54	0.012%		J	0.0110%
34	Diethylphthalate	8	TL-EF-D	5.9E-05	0.54	0.011%	YES	U	0.0110%
34	Diethylphthalate	10	TL-EF-E	5.5E-05	0.54	0.010%	YES	U	0.0110%
34	Diethylphthalate	12	TL-EF-F	5.3E-05	0.54	0.010%	YES	U	0.0110%
34	Diethylphthalate	14	TL-EF-G	5.1E-05	0.54	0.009%		J	0.0110%
34	Diethylphthalate	16	TL-EF-H	6.1E-05	0.54	0.011%		J	0.0110%
34	Diethylphthalate	2	FR57-IN-A	4.8E-05	0.54	0.009%	YES	U	0.0110%
34	Diethylphthalate	4	FR57-IN-B	5.3E-05	0.54	0.010%	YES	U	0.0110%
34	Diethylphthalate	6	FR57-IN-C	5.5E-05	0.54	0.010%	YES	U	0.0110%
34	Diethylphthalate	8	FR57-IN-D	5.3E-05	0.54	0.010%	YES	U	0.0110%
34	Diethylphthalate	10	FR57-IN-E	7.3E-05	0.54	0.013%		J	0.0110%
34	Diethylphthalate	12	FR57-IN-F	5.6E-05	0.54	0.010%	YES	U	0.0110%
34	Diethylphthalate	14	FR57-IN-G	9.2E-05	0.54	0.017%		J	0.0110%
34	Diethylphthalate	16	FR57-IN-H	5.7E-05	0.54	0.010%	YES	U	0.0110%
34	Diethylphthalate	2	FR57-EF-A	5.2E-05	0.54	0.010%	YES	U	0.0110%
34	Diethylphthalate	4	FR57-EF-B	5.4E-05	0.54	0.010%	YES	U	0.0110%
34	Diethylphthalate	6	FR57-EF-C	7.8E-05	0.54	0.014%		J	0.0110%
34	Diethylphthalate	8	FR57-EF-D	5.5E-05	0.54	0.010%	YES	U	0.0110%
34	Diethylphthalate	10	FR57-EF-E	7.3E-05	0.54	0.014%		J	0.0110%
34	Diethylphthalate	12	FR57-EF-F	7.1E-05	0.54	0.013%		J	0.0110%
34	Diethylphthalate	14	FR57-EF-G	7.8E-05	0.54	0.014%		J	0.0110%
34	Diethylphthalate	16	FR57-EF-H	6.0E-05	0.54	0.011%	YES	U	0.0110%
35	Acetonitrile	2	TL-IN-A	3.9E-02	20	0.194%			0.000987%
35	Acetonitrile	4	TL-IN-B	4.8E-02	20	0.241%			0.000987%
35	Acetonitrile	6	TL-IN-C	8.4E-02	20	0.418%		E	0.000987%
35	Acetonitrile	8	TL-IN-D	9.3E-02	20	0.466%		E	0.000987%
35	Acetonitrile	10	TL-IN-E		20				0.000987%
35	Acetonitrile	12	TL-IN-F	8.8E-02	20	0.442%		E	0.000987%
35	Acetonitrile	14	TL-IN-G	7.3E-02	20	0.365%		E	0.000987%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
35	Acetonitrile	16	TL-IN-H	9.7E-02	20	0.485%		E	0.000987%
35	Acetonitrile	2	TL-EF-A	3.2E-04	20	0.002%		J	0.000987%
35	Acetonitrile	4	TL-EF-B	1.3E-03	20	0.007%		J	0.000987%
35	Acetonitrile	6	TL-EF-C	1.2E-03	20	0.006%		J	0.000987%
35	Acetonitrile	8	TL-EF-D	1.5E-01	20	0.757%		E	0.000987%
35	Acetonitrile	10	TL-EF-E	6.7E-04	20	0.003%		J	0.000987%
35	Acetonitrile	12	TL-EF-F	1.1E-03	20	0.005%		J	0.000987%
35	Acetonitrile	14	TL-EF-G	9.4E-04	20	0.005%		J	0.000987%
35	Acetonitrile	16	TL-EF-H	3.4E-04	20	0.002%		J	0.000987%
35	Acetonitrile	2	FR57-IN-A	6.9E-02	20	0.346%		E	0.000987%
35	Acetonitrile	4	FR57-IN-B	1.5E-01	20	0.737%		E	0.000987%
35	Acetonitrile	6	FR57-IN-C	1.4E-01	20	0.694%		E	0.000987%
35	Acetonitrile	8	FR57-IN-D	1.1E-01	20	0.551%		E	0.000987%
35	Acetonitrile	10	FR57-IN-E	1.2E-01	20	0.594%		E	0.000987%
35	Acetonitrile	12	FR57-IN-F	1.2E-01	20	0.592%		E	0.000987%
35	Acetonitrile	14	FR57-IN-G	1.4E-01	20	0.714%		E	0.000987%
35	Acetonitrile	16	FR57-IN-H	1.7E-01	20	0.873%		E	0.000987%
35	Acetonitrile	2	FR57-EF-A	4.6E-03	20	0.023%			0.000987%
35	Acetonitrile	4	FR57-EF-B	3.4E-01	20	1.72%		EY	0.000987%
35	Acetonitrile	6	FR57-EF-C	7.1E-03	20	0.035%			0.000987%
35	Acetonitrile	8	FR57-EF-D	1.5E-01	20	0.751%		E	0.000987%
35	Acetonitrile	10	FR57-EF-E	3.4E-03	20	0.017%			0.000987%
35	Acetonitrile	12	FR57-EF-F	5.5E-01	20	2.76%		EY	0.000987%
35	Acetonitrile	14	FR57-EF-G	5.8E-03	20	0.029%			0.000987%
35	Acetonitrile	16	FR57-EF-H	8.9E-03	20	0.045%			0.000987%
36	Propanenitrile	2	TL-IN-A	3.2E-03	6.0	0.054%			0.00266%
36	Propanenitrile	4	TL-IN-B	2.4E-03	6.0	0.040%			0.00266%
36	Propanenitrile	6	TL-IN-C	8.0E-03	6.0	0.134%			0.00266%
36	Propanenitrile	8	TL-IN-D	7.2E-03	6.0	0.120%			0.00266%
36	Propanenitrile	10	TL-IN-E		6.0				0.00266%
36	Propanenitrile	12	TL-IN-F	5.0E-03	6.0	0.084%			0.00266%
36	Propanenitrile	14	TL-IN-G	4.4E-03	6.0	0.074%			0.00266%
36	Propanenitrile	16	TL-IN-H	4.6E-03	6.0	0.076%			0.00266%
36	Propanenitrile	2	TL-EF-A	1.5E-04	6.0	0.002%	YES	U	0.00266%
36	Propanenitrile	4	TL-EF-B	1.5E-04	6.0	0.002%	YES	U	0.00266%
36	Propanenitrile	6	TL-EF-C	1.5E-04	6.0	0.003%	YES	U	0.00266%
36	Propanenitrile	8	TL-EF-D	1.6E-04	6.0	0.003%	YES	U	0.00266%
36	Propanenitrile	10	TL-EF-E	1.6E-04	6.0	0.003%	YES	U	0.00266%
36	Propanenitrile	12	TL-EF-F	1.5E-04	6.0	0.002%	YES	U	0.00266%
36	Propanenitrile	14	TL-EF-G	1.4E-04	6.0	0.002%	YES	U	0.00266%
36	Propanenitrile	16	TL-EF-H	1.4E-04	6.0	0.002%	YES	U	0.00266%
36	Propanenitrile	2	FR57-IN-A	1.4E-04	6.0	0.002%	YES		0.00266%
36	Propanenitrile	4	FR57-IN-B	4.3E-03	6.0	0.072%			0.00266%
36	Propanenitrile	6	FR57-IN-C	6.0E-03	6.0	0.099%			0.00266%
36	Propanenitrile	8	FR57-IN-D	3.5E-03	6.0	0.059%			0.00266%
36	Propanenitrile	10	FR57-IN-E	3.4E-03	6.0	0.056%			0.00266%
36	Propanenitrile	12	FR57-IN-F	2.9E-03	6.0	0.048%			0.00266%
36	Propanenitrile	14	FR57-IN-G	4.3E-03	6.0	0.071%			0.00266%
36	Propanenitrile	16	FR57-IN-H	5.1E-03	6.0	0.085%			0.00266%
36	Propanenitrile	2	FR57-EF-A	1.4E-04	6.0	0.002%	YES		0.00266%
36	Propanenitrile	4	FR57-EF-B	1.5E-04	6.0	0.003%	YES		0.00266%
36	Propanenitrile	6	FR57-EF-C	1.5E-04	6.0	0.002%	YES	U	0.00266%
36	Propanenitrile	8	FR57-EF-D	1.5E-04	6.0	0.002%	YES		0.00266%
36	Propanenitrile	10	FR57-EF-E	1.4E-04	6.0	0.002%	YES		0.00266%
36	Propanenitrile	12	FR57-EF-F	1.5E-04	6.0	0.002%	YES		0.00266%
36	Propanenitrile	14	FR57-EF-G	1.4E-04	6.0	0.002%	YES		0.00266%
36	Propanenitrile	16	FR57-EF-H	1.4E-04	6.0	0.002%	YES		0.00266%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
37	Butanenitrile	2	TL-IN-A	6.5E-03	8.0	0.082%			0.00108%
37	Butanenitrile	4	TL-IN-B	8.1E-03	8.0	0.101%			0.00108%
37	Butanenitrile	6	TL-IN-C	1.5E-02	8.0	0.189%			0.00108%
37	Butanenitrile	8	TL-IN-D	1.5E-02	8.0	0.191%			0.00108%
37	Butanenitrile	10	TL-IN-E		8.0				0.00108%
37	Butanenitrile	12	TL-IN-F	1.9E-02	8.0	0.240%			0.00108%
37	Butanenitrile	14	TL-IN-G	1.6E-02	8.0	0.205%			0.00108%
37	Butanenitrile	16	TL-IN-H	1.2E-02	8.0	0.155%			0.00108%
37	Butanenitrile	2	TL-EF-A	8.0E-04	8.0	0.010%		J	0.00108%
37	Butanenitrile	4	TL-EF-B	5.8E-04	8.0	0.007%		J	0.00108%
37	Butanenitrile	6	TL-EF-C	5.7E-04	8.0	0.007%		J	0.00108%
37	Butanenitrile	8	TL-EF-D	7.8E-04	8.0	0.010%		J	0.00108%
37	Butanenitrile	10	TL-EF-E	5.2E-04	8.0	0.006%		J	0.00108%
37	Butanenitrile	12	TL-EF-F	4.7E-04	8.0	0.006%		J	0.00108%
37	Butanenitrile	14	TL-EF-G	3.9E-04	8.0	0.005%		J	0.00108%
37	Butanenitrile	16	TL-EF-H	4.4E-04	8.0	0.005%		J	0.00108%
37	Butanenitrile	2	FR57-IN-A	1.4E-04	8.0	0.002%		J	0.00108%
37	Butanenitrile	4	FR57-IN-B	1.6E-02	8.0	0.199%			0.00108%
37	Butanenitrile	6	FR57-IN-C	2.0E-02	8.0	0.246%			0.00108%
37	Butanenitrile	8	FR57-IN-D	1.4E-02	8.0	0.176%			0.00108%
37	Butanenitrile	10	FR57-IN-E	1.7E-02	8.0	0.210%			0.00108%
37	Butanenitrile	12	FR57-IN-F	1.5E-02	8.0	0.186%			0.00108%
37	Butanenitrile	14	FR57-IN-G	1.4E-02	8.0	0.180%			0.00108%
37	Butanenitrile	16	FR57-IN-H	1.6E-02	8.0	0.194%			0.00108%
37	Butanenitrile	2	FR57-EF-A	6.4E-04	8.0	0.008%		J	0.00108%
37	Butanenitrile	4	FR57-EF-B	5.8E-04	8.0	0.007%		J	0.00108%
37	Butanenitrile	6	FR57-EF-C	6.8E-04	8.0	0.008%		J	0.00108%
37	Butanenitrile	8	FR57-EF-D	6.8E-04	8.0	0.008%		J	0.00108%
37	Butanenitrile	10	FR57-EF-E	8.6E-05	8.0	0.001%	YES		0.00108%
37	Butanenitrile	12	FR57-EF-F	5.5E-04	8.0	0.007%		J	0.00108%
37	Butanenitrile	14	FR57-EF-G	4.2E-04	8.0	0.005%		J	0.00108%
37	Butanenitrile	16	FR57-EF-H	3.9E-04	8.0	0.005%		J	0.00108%
38	Pentanenitrile	2	TL-IN-A	1.1E-03	6.0	0.018%			0.00162%
38	Pentanenitrile	4	TL-IN-B	1.4E-03	6.0	0.023%			0.00162%
38	Pentanenitrile	6	TL-IN-C	2.4E-03	6.0	0.039%			0.00162%
38	Pentanenitrile	8	TL-IN-D	2.2E-03	6.0	0.037%			0.00162%
38	Pentanenitrile	10	TL-IN-E		6.0				0.00162%
38	Pentanenitrile	12	TL-IN-F	2.4E-03	6.0	0.039%			0.00162%
38	Pentanenitrile	14	TL-IN-G	2.0E-03	6.0	0.033%			0.00162%
38	Pentanenitrile	16	TL-IN-H	1.5E-03	6.0	0.026%			0.00162%
38	Pentanenitrile	2	TL-EF-A	8.9E-05	6.0	0.001%	YES	U	0.00162%
38	Pentanenitrile	4	TL-EF-B	8.9E-05	6.0	0.001%	YES	U	0.00162%
38	Pentanenitrile	6	TL-EF-C	9.3E-05	6.0	0.002%	YES	U	0.00162%
38	Pentanenitrile	8	TL-EF-D	9.7E-05	6.0	0.002%	YES	U	0.00162%
38	Pentanenitrile	10	TL-EF-E	9.7E-05	6.0	0.002%	YES	U	0.00162%
38	Pentanenitrile	12	TL-EF-F	8.9E-05	6.0	0.001%	YES	U	0.00162%
38	Pentanenitrile	14	TL-EF-G	9.3E-05	6.0	0.002%		J	0.00162%
38	Pentanenitrile	16	TL-EF-H	8.8E-05	6.0	0.001%	YES	U	0.00162%
38	Pentanenitrile	2	FR57-IN-A	8.7E-05	6.0	0.001%	YES		0.00162%
38	Pentanenitrile	4	FR57-IN-B	2.0E-03	6.0	0.033%			0.00162%
38	Pentanenitrile	6	FR57-IN-C	2.3E-03	6.0	0.038%			0.00162%
38	Pentanenitrile	8	FR57-IN-D	1.8E-03	6.0	0.030%			0.00162%
38	Pentanenitrile	10	FR57-IN-E	1.9E-03	6.0	0.031%			0.00162%
38	Pentanenitrile	12	FR57-IN-F	2.1E-03	6.0	0.036%			0.00162%
38	Pentanenitrile	14	FR57-IN-G	2.0E-03	6.0	0.034%			0.00162%
38	Pentanenitrile	16	FR57-IN-H	1.9E-03	6.0	0.032%			0.00162%
38	Pentanenitrile	2	FR57-EF-A	8.4E-05	6.0	0.001%	YES		0.00162%
38	Pentanenitrile	4	FR57-EF-B	9.2E-05	6.0	0.002%	YES		0.00162%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
38	Pentanenitrile	6	FR57-EF-C	9.1E-05	6.0	0.002%	YES	U	0.00162%
38	Pentanenitrile	8	FR57-EF-D	8.9E-05	6.0	0.001%	YES		0.00162%
38	Pentanenitrile	10	FR57-EF-E	8.7E-05	6.0	0.001%	YES	Q	0.00162%
38	Pentanenitrile	12	FR57-EF-F	9.1E-05	6.0	0.002%	YES		0.00162%
38	Pentanenitrile	14	FR57-EF-G	8.4E-05	6.0	0.001%	YES		0.00162%
38	Pentanenitrile	16	FR57-EF-H	8.5E-05	6.0	0.001%	YES		0.00162%
39	Hexanenitrile	2	TL-IN-A	1.6E-04	6.0	0.003%		J	0.00116%
39	Hexanenitrile	4	TL-IN-B	3.4E-04	6.0	0.006%		J	0.00116%
39	Hexanenitrile	6	TL-IN-C	5.9E-04	6.0	0.010%		J	0.00116%
39	Hexanenitrile	8	TL-IN-D	6.4E-04	6.0	0.011%		J	0.00116%
39	Hexanenitrile	10	TL-IN-E		6.0				0.00116%
39	Hexanenitrile	12	TL-IN-F	1.2E-03	6.0	0.021%			0.00116%
39	Hexanenitrile	14	TL-IN-G	1.2E-03	6.0	0.019%			0.00116%
39	Hexanenitrile	16	TL-IN-H	7.6E-04	6.0	0.013%			0.00116%
39	Hexanenitrile	2	TL-EF-A	6.4E-05	6.0	0.001%	YES	U	0.00116%
39	Hexanenitrile	4	TL-EF-B	6.4E-05	6.0	0.001%	YES	U	0.00116%
39	Hexanenitrile	6	TL-EF-C	6.7E-05	6.0	0.001%	YES	U	0.00116%
39	Hexanenitrile	8	TL-EF-D	6.9E-05	6.0	0.001%	YES	U	0.00116%
39	Hexanenitrile	10	TL-EF-E	6.9E-05	6.0	0.001%	YES	U	0.00116%
39	Hexanenitrile	12	TL-EF-F	6.3E-05	6.0	0.001%	YES	U	0.00116%
39	Hexanenitrile	14	TL-EF-G	6.1E-05	6.0	0.001%	YES	U	0.00116%
39	Hexanenitrile	16	TL-EF-H	6.3E-05	6.0	0.001%	YES	U	0.00116%
39	Hexanenitrile	2	FR57-IN-A	6.2E-05	6.0	0.001%	YES		0.00116%
39	Hexanenitrile	4	FR57-IN-B	1.0E-03	6.0	0.017%			0.00116%
39	Hexanenitrile	6	FR57-IN-C	1.4E-03	6.0	0.023%			0.00116%
39	Hexanenitrile	8	FR57-IN-D	1.1E-03	6.0	0.018%			0.00116%
39	Hexanenitrile	10	FR57-IN-E	1.3E-03	6.0	0.022%			0.00116%
39	Hexanenitrile	12	FR57-IN-F	1.6E-03	6.0	0.027%			0.00116%
39	Hexanenitrile	14	FR57-IN-G	1.3E-03	6.0	0.021%			0.00116%
39	Hexanenitrile	16	FR57-IN-H	1.1E-03	6.0	0.018%			0.00116%
39	Hexanenitrile	2	FR57-EF-A	6.0E-05	6.0	0.001%	YES		0.00116%
39	Hexanenitrile	4	FR57-EF-B	6.6E-05	6.0	0.001%	YES		0.00116%
39	Hexanenitrile	6	FR57-EF-C	6.5E-05	6.0	0.001%	YES	U	0.00116%
39	Hexanenitrile	8	FR57-EF-D	6.3E-05	6.0	0.001%	YES		0.00116%
39	Hexanenitrile	10	FR57-EF-E	6.2E-05	6.0	0.001%	YES	Q	0.00116%
39	Hexanenitrile	12	FR57-EF-F	6.5E-05	6.0	0.001%	YES		0.00116%
39	Hexanenitrile	14	FR57-EF-G	6.0E-05	6.0	0.001%	YES		0.00116%
39	Hexanenitrile	16	FR57-EF-H	6.1E-05	6.0	0.001%	YES		0.00116%
43	Ethylamine	2	TL-IN-A	1.9E-02	5.0	0.370%			0.0940%
43	Ethylamine	4	TL-IN-B	2.8E-02	5.0	0.569%			0.0940%
43	Ethylamine	6	TL-IN-C	3.2E-02	5.0	0.641%			0.0940%
43	Ethylamine	8	TL-IN-D	2.9E-02	5.0	0.571%			0.0940%
43	Ethylamine	10	TL-IN-E	2.4E-02	5.0	0.475%			0.0940%
43	Ethylamine	12	TL-IN-F	2.5E-02	5.0	0.504%			0.0940%
43	Ethylamine	14	TL-IN-G	2.4E-02	5.0	0.475%			0.0940%
43	Ethylamine	16	TL-IN-H	4.6E-02	5.0	0.919%			0.0940%
43	Ethylamine	2	TL-EF-A	4.7E-03	5.0	0.094%	YES		0.0940%
43	Ethylamine	4	TL-EF-B	4.7E-03	5.0	0.093%	YES		0.0940%
43	Ethylamine	6	TL-EF-C	2.0E-02	5.0	0.391%			0.0940%
43	Ethylamine	8	TL-EF-D	2.4E-02	5.0	0.472%			0.0940%
43	Ethylamine	10	TL-EF-E	2.5E-02	5.0	0.505%			0.0940%
43	Ethylamine	12	TL-EF-F	2.2E-02	5.0	0.448%			0.0940%
43	Ethylamine	14	TL-EF-G	2.5E-02	5.0	0.496%			0.0940%
43	Ethylamine	16	TL-EF-H	2.6E-02	5.0	0.516%			0.0940%
43	Ethylamine	2	FR57-IN-A	1.7E-02	5.0	0.332%			0.0940%
43	Ethylamine	4	FR57-IN-B	4.4E-03	5.0	0.088%	YES		0.0940%
43	Ethylamine	6	FR57-IN-C	1.2E-02	5.0	0.244%			0.0940%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
43	Ethylamine	8	FR57-IN-D	1.8E-02	5.0	0.369%			0.0940%
43	Ethylamine	10	FR57-IN-E	1.6E-02	5.0	0.319%			0.0940%
43	Ethylamine	12	FR57-IN-F	1.6E-02	5.0	0.321%			0.0940%
43	Ethylamine	14	FR57-IN-G	9.1E-03	5.0	0.182%			0.0940%
43	Ethylamine	16	FR57-IN-H	3.0E-02	5.0	0.597%			0.0940%
43	Ethylamine	2	FR57-EF-A	2.6E-02	5.0	0.518%			0.0940%
43	Ethylamine	4	FR57-EF-B	2.5E-02	5.0	0.495%			0.0940%
43	Ethylamine	6	FR57-EF-C	2.1E-02	5.0	0.418%			0.0940%
43	Ethylamine	8	FR57-EF-D	2.9E-02	5.0	0.576%			0.0940%
43	Ethylamine	10	FR57-EF-E	2.2E-02	5.0	0.437%			0.0940%
43	Ethylamine	12	FR57-EF-F	2.0E-02	5.0	0.407%			0.0940%
43	Ethylamine	14	FR57-EF-G	2.6E-02	5.0	0.530%			0.0940%
43	Ethylamine	16	FR57-EF-H	2.2E-02	5.0	0.435%			0.0940%
44	N-Nitrosodimethylamine	2	TL-IN-A	5.0E-04	0.000	167%			5.49%
44	N-Nitrosodimethylamine	4	TL-IN-B	1.7E-03	0.000	554%			5.49%
44	N-Nitrosodimethylamine	6	TL-IN-C	5.9E-04	0.000	196%			5.49%
44	N-Nitrosodimethylamine	8	TL-IN-D	1.9E-03	0.000	620%			5.49%
44	N-Nitrosodimethylamine	10	TL-IN-E	6.6E-04	0.000	220%			5.49%
44	N-Nitrosodimethylamine	12	TL-IN-F	6.0E-04	0.000	199%			5.49%
44	N-Nitrosodimethylamine	14	TL-IN-G	4.6E-04	0.000	153%			5.49%
44	N-Nitrosodimethylamine	16	TL-IN-H	2.2E-03	0.000	721%			5.49%
44	N-Nitrosodimethylamine	2	TL-EF-A	1.1E-05	0.000	3.55%	YES		5.49%
44	N-Nitrosodimethylamine	4	TL-EF-B	1.1E-05	0.000	3.75%	YES		5.49%
44	N-Nitrosodimethylamine	6	TL-EF-C	1.1E-05	0.000	3.65%	YES		5.49%
44	N-Nitrosodimethylamine	8	TL-EF-D	1.1E-05	0.000	3.62%	YES		5.49%
44	N-Nitrosodimethylamine	10	TL-EF-E	1.1E-05	0.000	3.68%	YES		5.49%
44	N-Nitrosodimethylamine	12	TL-EF-F	1.0E-05	0.000	3.46%	YES		5.49%
44	N-Nitrosodimethylamine	14	TL-EF-G	1.4E-05	0.000	4.50%	YES		5.49%
44	N-Nitrosodimethylamine	16	TL-EF-H	1.3E-05	0.000	4.39%	YES		5.49%
44	N-Nitrosodimethylamine	2	FR57-IN-A	1.1E-03	0.000	355%		BLYa	5.49%
44	N-Nitrosodimethylamine	4	FR57-IN-B	9.9E-04	0.000	331%		BLYa	5.49%
44	N-Nitrosodimethylamine	6	FR57-IN-C	9.6E-04	0.000	319%		BLYa	5.49%
44	N-Nitrosodimethylamine	8	FR57-IN-D	8.7E-04	0.000	290%		LY	5.49%
44	N-Nitrosodimethylamine	10	FR57-IN-E	9.9E-04	0.000	331%		BLYa	5.49%
44	N-Nitrosodimethylamine	12	FR57-IN-F	9.5E-04	0.000	317%		LY	5.49%
44	N-Nitrosodimethylamine	14	FR57-IN-G	7.5E-04	0.000	251%		LY	5.49%
44	N-Nitrosodimethylamine	16	FR57-IN-H	6.6E-04	0.000	221%		LY	5.49%
44	N-Nitrosodimethylamine	2	FR57-EF-A	1.3E-05	0.000	4.37%	YES	L	5.49%
44	N-Nitrosodimethylamine	4	FR57-EF-B	1.3E-05	0.000	4.33%	YES	L	5.49%
44	N-Nitrosodimethylamine	6	FR57-EF-C	1.2E-05	0.000	4.15%	YES	L	5.49%
44	N-Nitrosodimethylamine	8	FR57-EF-D	1.2E-05	0.000	4.03%	YES	L	5.49%
44	N-Nitrosodimethylamine	10	FR57-EF-E	1.3E-05	0.000	4.24%	YES	L	5.49%
44	N-Nitrosodimethylamine	12	FR57-EF-F	1.2E-05	0.000	3.96%	YES	L	5.49%
44	N-Nitrosodimethylamine	14	FR57-EF-G	1.6E-05	0.000	5.39%	YES	LY	5.49%
44	N-Nitrosodimethylamine	16	FR57-EF-H	1.6E-05	0.000	5.49%	YES	LY	5.49%
45	N-Nitrosodiethylamine	2	TL-IN-A	9.2E-06	0.000	9.16%	YES		10.6%
45	N-Nitrosodiethylamine	4	TL-IN-B	9.1E-06	0.000	9.11%	YES		10.6%
45	N-Nitrosodiethylamine	6	TL-IN-C	9.0E-06	0.000	9.04%	YES		10.6%
45	N-Nitrosodiethylamine	8	TL-IN-D	9.1E-06	0.000	9.07%	YES		10.6%
45	N-Nitrosodiethylamine	10	TL-IN-E	9.2E-06	0.000	9.18%	YES		10.6%
45	N-Nitrosodiethylamine	12	TL-IN-F	9.1E-06	0.000	9.11%	YES		10.6%
45	N-Nitrosodiethylamine	14	TL-IN-G	8.8E-06	0.000	8.79%	YES		10.6%
45	N-Nitrosodiethylamine	16	TL-IN-H	8.6E-06	0.000	8.60%	YES		10.6%
45	N-Nitrosodiethylamine	2	TL-EF-A	8.7E-06	0.000	8.69%	YES		10.6%
45	N-Nitrosodiethylamine	4	TL-EF-B	9.2E-06	0.000	9.18%	YES		10.6%
45	N-Nitrosodiethylamine	6	TL-EF-C	8.9E-06	0.000	8.93%	YES		10.6%
45	N-Nitrosodiethylamine	8	TL-EF-D	8.9E-06	0.000	8.86%	YES		10.6%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
45	N-Nitrosodiethylamine	10	TL-EF-E	9.0E-06	0.000	9.00%	YES		10.6%
45	N-Nitrosodiethylamine	12	TL-EF-F	8.5E-06	0.000	8.46%	YES		10.6%
45	N-Nitrosodiethylamine	14	TL-EF-G	8.8E-06	0.000	8.82%	YES		10.6%
45	N-Nitrosodiethylamine	16	TL-EF-H	8.6E-06	0.000	8.60%	YES		10.6%
45	N-Nitrosodiethylamine	2	FR57-IN-A	1.1E-05	0.000	11.5%		Y	10.6%
45	N-Nitrosodiethylamine	4	FR57-IN-B	1.0E-05	0.000	10.3%	YES	Y	10.6%
45	N-Nitrosodiethylamine	6	FR57-IN-C	1.1E-05	0.000	11.2%		Y	10.6%
45	N-Nitrosodiethylamine	8	FR57-IN-D	1.0E-05	0.000	10.2%	YES	Y	10.6%
45	N-Nitrosodiethylamine	10	FR57-IN-E	9.8E-06	0.000	9.77%	YES	Y	10.6%
45	N-Nitrosodiethylamine	12	FR57-IN-F	1.0E-05	0.000	10.0%	YES	Y	10.6%
45	N-Nitrosodiethylamine	14	FR57-IN-G	1.3E-05	0.000	13.1%		Y	10.6%
45	N-Nitrosodiethylamine	16	FR57-IN-H	9.9E-06	0.000	9.90%	YES	Y	10.6%
45	N-Nitrosodiethylamine	2	FR57-EF-A	1.1E-05	0.000	10.6%	YES		10.6%
45	N-Nitrosodiethylamine	4	FR57-EF-B	1.0E-05	0.000	10.5%	YES		10.6%
45	N-Nitrosodiethylamine	6	FR57-EF-C	1.0E-05	0.000	10.0%	YES		10.6%
45	N-Nitrosodiethylamine	8	FR57-EF-D	9.8E-06	0.000	9.75%	YES		10.6%
45	N-Nitrosodiethylamine	10	FR57-EF-E	1.0E-05	0.000	10.3%	YES		10.6%
45	N-Nitrosodiethylamine	12	FR57-EF-F	9.6E-06	0.000	9.58%	YES		10.6%
45	N-Nitrosodiethylamine	14	FR57-EF-G	9.8E-06	0.000	9.77%	YES	Y	10.6%
45	N-Nitrosodiethylamine	16	FR57-EF-H	9.9E-06	0.000	9.95%	YES	Y	10.6%
46	N-Nitrosomethylethylamine	2	TL-IN-A	3.4E-04	0.000	114%			4.43%
46	N-Nitrosomethylethylamine	4	TL-IN-B	3.8E-04	0.000	126%			4.43%
46	N-Nitrosomethylethylamine	6	TL-IN-C	4.5E-04	0.000	151%			4.43%
46	N-Nitrosomethylethylamine	8	TL-IN-D	4.4E-04	0.000	148%			4.43%
46	N-Nitrosomethylethylamine	10	TL-IN-E	5.6E-04	0.000	188%			4.43%
46	N-Nitrosomethylethylamine	12	TL-IN-F	4.9E-04	0.000	162%			4.43%
46	N-Nitrosomethylethylamine	14	TL-IN-G	4.1E-04	0.000	137%			4.43%
46	N-Nitrosomethylethylamine	16	TL-IN-H	4.1E-04	0.000	137%			4.43%
46	N-Nitrosomethylethylamine	2	TL-EF-A	1.0E-05	0.000	3.36%	YES		4.43%
46	N-Nitrosomethylethylamine	4	TL-EF-B	1.1E-05	0.000	3.55%	YES		4.43%
46	N-Nitrosomethylethylamine	6	TL-EF-C	1.0E-05	0.000	3.45%	YES		4.43%
46	N-Nitrosomethylethylamine	8	TL-EF-D	1.0E-05	0.000	3.42%	YES		4.43%
46	N-Nitrosomethylethylamine	10	TL-EF-E	1.0E-05	0.000	3.48%	YES		4.43%
46	N-Nitrosomethylethylamine	12	TL-EF-F	9.8E-06	0.000	3.27%	YES		4.43%
46	N-Nitrosomethylethylamine	14	TL-EF-G	1.1E-05	0.000	3.79%	YES		4.43%
46	N-Nitrosomethylethylamine	16	TL-EF-H	1.1E-05	0.000	3.69%	YES		4.43%
46	N-Nitrosomethylethylamine	2	FR57-IN-A	1.3E-05	0.000	4.43%	YES	Y	4.43%
46	N-Nitrosomethylethylamine	4	FR57-IN-B	1.3E-05	0.000	4.39%	YES	Y	4.43%
46	N-Nitrosomethylethylamine	6	FR57-IN-C	1.3E-05	0.000	4.34%	YES	Y	4.43%
46	N-Nitrosomethylethylamine	8	FR57-IN-D	1.3E-05	0.000	4.35%	YES	Y	4.43%
46	N-Nitrosomethylethylamine	10	FR57-IN-E	1.2E-05	0.000	4.15%	YES	Y	4.43%
46	N-Nitrosomethylethylamine	12	FR57-IN-F	1.3E-05	0.000	4.27%	YES	Y	4.43%
46	N-Nitrosomethylethylamine	14	FR57-IN-G	1.3E-05	0.000	4.28%	YES	Y	4.43%
46	N-Nitrosomethylethylamine	16	FR57-IN-H	1.3E-05	0.000	4.21%	YES	Y	4.43%
46	N-Nitrosomethylethylamine	2	FR57-EF-A	1.2E-05	0.000	4.08%	YES		4.43%
46	N-Nitrosomethylethylamine	4	FR57-EF-B	1.2E-05	0.000	4.05%	YES		4.43%
46	N-Nitrosomethylethylamine	6	FR57-EF-C	1.2E-05	0.000	3.87%	YES		4.43%
46	N-Nitrosomethylethylamine	8	FR57-EF-D	1.1E-05	0.000	3.77%	YES		4.43%
46	N-Nitrosomethylethylamine	10	FR57-EF-E	1.2E-05	0.000	3.96%	YES		4.43%
46	N-Nitrosomethylethylamine	12	FR57-EF-F	1.1E-05	0.000	3.70%	YES		4.43%
46	N-Nitrosomethylethylamine	14	FR57-EF-G	1.2E-05	0.000	4.15%	YES	Y	4.43%
46	N-Nitrosomethylethylamine	16	FR57-EF-H	1.3E-05	0.000	4.23%	YES	Y	4.43%
47	N-Nitrosomorpholine	2	TL-IN-A	8.1E-06	0.001	1.34%	YES		1.68%
47	N-Nitrosomorpholine	4	TL-IN-B	8.0E-06	0.001	1.34%	YES		1.68%
47	N-Nitrosomorpholine	6	TL-IN-C	8.0E-06	0.001	1.33%	YES		1.68%
47	N-Nitrosomorpholine	8	TL-IN-D	8.0E-06	0.001	1.33%	YES		1.68%
47	N-Nitrosomorpholine	10	TL-IN-E	8.1E-06	0.001	1.35%	YES		1.68%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
47	N-Nitrosomorpholine	12	TL-IN-F	8.0E-06	0.001	1.34%	YES		1.68%
47	N-Nitrosomorpholine	14	TL-IN-G	7.7E-06	0.001	1.29%	YES		1.68%
47	N-Nitrosomorpholine	16	TL-IN-H	7.6E-06	0.001	1.26%	YES		1.68%
47	N-Nitrosomorpholine	2	TL-EF-A	7.6E-06	0.001	1.27%	YES		1.68%
47	N-Nitrosomorpholine	4	TL-EF-B	8.1E-06	0.001	1.35%	YES		1.68%
47	N-Nitrosomorpholine	6	TL-EF-C	7.9E-06	0.001	1.31%	YES		1.68%
47	N-Nitrosomorpholine	8	TL-EF-D	7.8E-06	0.001	1.30%	YES		1.68%
47	N-Nitrosomorpholine	10	TL-EF-E	7.9E-06	0.001	1.32%	YES		1.68%
47	N-Nitrosomorpholine	12	TL-EF-F	7.4E-06	0.001	1.24%	YES		1.68%
47	N-Nitrosomorpholine	14	TL-EF-G	7.8E-06	0.001	1.29%	YES		1.68%
47	N-Nitrosomorpholine	16	TL-EF-H	7.6E-06	0.001	1.26%	YES		1.68%
47	N-Nitrosomorpholine	2	FR57-IN-A	1.0E-05	0.001	1.68%	YES	Y	1.68%
47	N-Nitrosomorpholine	4	FR57-IN-B	1.0E-05	0.001	1.67%	YES	Y	1.68%
47	N-Nitrosomorpholine	6	FR57-IN-C	9.9E-06	0.001	1.65%	YES	Y	1.68%
47	N-Nitrosomorpholine	8	FR57-IN-D	9.9E-06	0.001	1.65%	YES	Y	1.68%
47	N-Nitrosomorpholine	10	FR57-IN-E	9.5E-06	0.001	1.58%	YES	Y	1.68%
47	N-Nitrosomorpholine	12	FR57-IN-F	9.7E-06	0.001	1.62%	YES	Y	1.68%
47	N-Nitrosomorpholine	14	FR57-IN-G	9.7E-06	0.001	1.62%	YES	Y	1.68%
47	N-Nitrosomorpholine	16	FR57-IN-H	9.6E-06	0.001	1.60%	YES	Y	1.68%
47	N-Nitrosomorpholine	2	FR57-EF-A	9.3E-06	0.001	1.55%	YES		1.68%
47	N-Nitrosomorpholine	4	FR57-EF-B	9.2E-06	0.001	1.54%	YES		1.68%
47	N-Nitrosomorpholine	6	FR57-EF-C	8.8E-06	0.001	1.47%	YES		1.68%
47	N-Nitrosomorpholine	8	FR57-EF-D	8.6E-06	0.001	1.43%	YES		1.68%
47	N-Nitrosomorpholine	10	FR57-EF-E	9.0E-06	0.001	1.50%	YES		1.68%
47	N-Nitrosomorpholine	12	FR57-EF-F	8.4E-06	0.001	1.41%	YES		1.68%
47	N-Nitrosomorpholine	14	FR57-EF-G	9.5E-06	0.001	1.58%	YES	Y	1.68%
47	N-Nitrosomorpholine	16	FR57-EF-H	9.6E-06	0.001	1.60%	YES	Y	1.68%
48	Tributyl phosphate	2	TL-IN-A		0.20				0.0336%
48	Tributyl phosphate	4	TL-IN-B	6.5E-05	0.20	0.032%	YES	U	0.0336%
48	Tributyl phosphate	6	TL-IN-C	6.5E-05	0.20	0.033%	YES	U	0.0336%
48	Tributyl phosphate	8	TL-IN-D		0.20				0.0336%
48	Tributyl phosphate	10	TL-IN-E	6.2E-05	0.20	0.031%	YES	U	0.0336%
48	Tributyl phosphate	12	TL-IN-F	6.2E-05	0.20	0.031%	YES	U	0.0336%
48	Tributyl phosphate	14	TL-IN-G	5.5E-05	0.20	0.028%	YES	U	0.0336%
48	Tributyl phosphate	16	TL-IN-H	6.3E-05	0.20	0.032%	YES	U	0.0336%
48	Tributyl phosphate	2	TL-EF-A	6.1E-05	0.20	0.031%	YES	U	0.0336%
48	Tributyl phosphate	4	TL-EF-B	6.0E-05	0.20	0.030%	YES	U	0.0336%
48	Tributyl phosphate	6	TL-EF-C	6.3E-05	0.20	0.032%	YES	U	0.0336%
48	Tributyl phosphate	8	TL-EF-D	6.6E-05	0.20	0.033%	YES	U	0.0336%
48	Tributyl phosphate	10	TL-EF-E	6.2E-05	0.20	0.031%	YES	U	0.0336%
48	Tributyl phosphate	12	TL-EF-F	6.0E-05	0.20	0.030%	YES	U	0.0336%
48	Tributyl phosphate	14	TL-EF-G	5.7E-05	0.20	0.029%	YES	U	0.0336%
48	Tributyl phosphate	16	TL-EF-H	6.3E-05	0.20	0.031%	YES	U	0.0336%
48	Tributyl phosphate	2	FR57-IN-A	5.4E-05	0.20	0.027%	YES	U	0.0336%
48	Tributyl phosphate	4	FR57-IN-B	5.9E-05	0.20	0.030%	YES	U	0.0336%
48	Tributyl phosphate	6	FR57-IN-C	6.2E-05	0.20	0.031%	YES	U	0.0336%
48	Tributyl phosphate	8	FR57-IN-D	6.0E-05	0.20	0.030%	YES	U	0.0336%
48	Tributyl phosphate	10	FR57-IN-E	5.9E-05	0.20	0.029%	YES	U	0.0336%
48	Tributyl phosphate	12	FR57-IN-F	6.3E-05	0.20	0.032%	YES	U	0.0336%
48	Tributyl phosphate	14	FR57-IN-G	6.3E-05	0.20	0.031%	YES	U	0.0336%
48	Tributyl phosphate	16	FR57-IN-H	6.4E-05	0.20	0.032%	YES	U	0.0336%
48	Tributyl phosphate	2	FR57-EF-A	5.8E-05	0.20	0.029%	YES	U	0.0336%
48	Tributyl phosphate	4	FR57-EF-B	6.0E-05	0.20	0.030%	YES	U	0.0336%
48	Tributyl phosphate	6	FR57-EF-C	5.7E-05	0.20	0.028%	YES	U	0.0336%
48	Tributyl phosphate	8	FR57-EF-D	6.2E-05	0.20	0.031%	YES	U	0.0336%
48	Tributyl phosphate	10	FR57-EF-E	5.9E-05	0.20	0.030%	YES	U	0.0336%
48	Tributyl phosphate	12	FR57-EF-F	6.2E-05	0.20	0.031%	YES	U	0.0336%
48	Tributyl phosphate	14	FR57-EF-G	6.5E-05	0.20	0.032%	YES	U	0.0336%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
48	Tributyl phosphate	16	FR57-EF-H	6.7E-05	0.20	0.034%	YES	U	0.0336%
49	Dibutyl butylphosphonate	2	TL-IN-A		0.007				0.374%
49	Dibutyl butylphosphonate	4	TL-IN-B	2.4E-05	0.007	0.349%	YES	U	0.374%
49	Dibutyl butylphosphonate	6	TL-IN-C	2.5E-05	0.007	0.352%	YES	U	0.374%
49	Dibutyl butylphosphonate	8	TL-IN-D		0.007				0.374%
49	Dibutyl butylphosphonate	10	TL-IN-E	2.4E-05	0.007	0.336%	YES	U	0.374%
49	Dibutyl butylphosphonate	12	TL-IN-F	2.5E-05	0.007	0.351%	YES	U	0.374%
49	Dibutyl butylphosphonate	14	TL-IN-G	2.1E-05	0.007	0.299%	YES	U	0.374%
49	Dibutyl butylphosphonate	16	TL-IN-H	2.4E-05	0.007	0.342%	YES	U	0.374%
49	Dibutyl butylphosphonate	2	TL-EF-A	2.3E-05	0.007	0.332%	YES	U	0.374%
49	Dibutyl butylphosphonate	4	TL-EF-B	2.3E-05	0.007	0.325%	YES	U	0.374%
49	Dibutyl butylphosphonate	6	TL-EF-C	2.5E-05	0.007	0.355%	YES	U	0.374%
49	Dibutyl butylphosphonate	8	TL-EF-D	2.6E-05	0.007	0.374%	YES	U	0.374%
49	Dibutyl butylphosphonate	10	TL-EF-E	2.4E-05	0.007	0.347%	YES	U	0.374%
49	Dibutyl butylphosphonate	12	TL-EF-F	2.3E-05	0.007	0.325%	YES	U	0.374%
49	Dibutyl butylphosphonate	14	TL-EF-G	2.2E-05	0.007	0.310%	YES	U	0.374%
49	Dibutyl butylphosphonate	16	TL-EF-H	2.4E-05	0.007	0.338%	YES	U	0.374%
49	Dibutyl butylphosphonate	2	FR57-IN-A	2.0E-05	0.007	0.291%	YES	U	0.374%
49	Dibutyl butylphosphonate	4	FR57-IN-B	2.2E-05	0.007	0.321%	YES	U	0.374%
49	Dibutyl butylphosphonate	6	FR57-IN-C	2.3E-05	0.007	0.335%	YES	U	0.374%
49	Dibutyl butylphosphonate	8	FR57-IN-D	2.3E-05	0.007	0.323%	YES	U	0.374%
49	Dibutyl butylphosphonate	10	FR57-IN-E	2.2E-05	0.007	0.316%	YES	U	0.374%
49	Dibutyl butylphosphonate	12	FR57-IN-F	2.5E-05	0.007	0.356%	YES	U	0.374%
49	Dibutyl butylphosphonate	14	FR57-IN-G	2.4E-05	0.007	0.338%	YES	U	0.374%
49	Dibutyl butylphosphonate	16	FR57-IN-H	2.5E-05	0.007	0.361%	YES	U	0.374%
49	Dibutyl butylphosphonate	2	FR57-EF-A	2.2E-05	0.007	0.314%	YES	U	0.374%
49	Dibutyl butylphosphonate	4	FR57-EF-B	2.3E-05	0.007	0.326%	YES	U	0.374%
49	Dibutyl butylphosphonate	6	FR57-EF-C	2.1E-05	0.007	0.306%	YES	U	0.374%
49	Dibutyl butylphosphonate	8	FR57-EF-D	2.4E-05	0.007	0.346%	YES	U	0.374%
49	Dibutyl butylphosphonate	10	FR57-EF-E	2.2E-05	0.007	0.319%	YES	U	0.374%
49	Dibutyl butylphosphonate	12	FR57-EF-F	2.3E-05	0.007	0.333%	YES	U	0.374%
49	Dibutyl butylphosphonate	14	FR57-EF-G	2.4E-05	0.007	0.350%	YES	U	0.374%
49	Dibutyl butylphosphonate	16	FR57-EF-H	2.5E-05	0.007	0.363%	YES	U	0.374%
52	Pyridine	2	TL-IN-A	8.5E-04	1.0	0.085%		J	0.00760%
52	Pyridine	4	TL-IN-B	1.0E-03	1.0	0.103%			0.00760%
52	Pyridine	6	TL-IN-C	1.6E-03	1.0	0.163%			0.00760%
52	Pyridine	8	TL-IN-D	1.6E-03	1.0	0.158%			0.00760%
52	Pyridine	10	TL-IN-E		1.0				0.00760%
52	Pyridine	12	TL-IN-F	1.7E-03	1.0	0.168%			0.00760%
52	Pyridine	14	TL-IN-G	1.3E-03	1.0	0.129%			0.00760%
52	Pyridine	16	TL-IN-H	1.2E-03	1.0	0.116%			0.00760%
52	Pyridine	2	TL-EF-A	7.0E-05	1.0	0.007%	YES	U	0.00760%
52	Pyridine	4	TL-EF-B	7.0E-05	1.0	0.007%	YES	U	0.00760%
52	Pyridine	6	TL-EF-C	7.3E-05	1.0	0.007%	YES	U	0.00760%
52	Pyridine	8	TL-EF-D	7.6E-05	1.0	0.008%	YES	U	0.00760%
52	Pyridine	10	TL-EF-E	7.6E-05	1.0	0.008%	YES	U	0.00760%
52	Pyridine	12	TL-EF-F	6.9E-05	1.0	0.007%	YES	U	0.00760%
52	Pyridine	14	TL-EF-G	6.7E-05	1.0	0.007%	YES	U	0.00760%
52	Pyridine	16	TL-EF-H	6.8E-05	1.0	0.007%	YES	U	0.00760%
52	Pyridine	2	FR57-IN-A	6.8E-05	1.0	0.007%	YES		0.00760%
52	Pyridine	4	FR57-IN-B	1.5E-03	1.0	0.147%			0.00760%
52	Pyridine	6	FR57-IN-C	1.7E-03	1.0	0.172%			0.00760%
52	Pyridine	8	FR57-IN-D	1.3E-03	1.0	0.130%			0.00760%
52	Pyridine	10	FR57-IN-E	1.4E-03	1.0	0.139%			0.00760%
52	Pyridine	12	FR57-IN-F	1.3E-03	1.0	0.130%			0.00760%
52	Pyridine	14	FR57-IN-G	1.4E-03	1.0	0.141%			0.00760%
52	Pyridine	16	FR57-IN-H	1.4E-03	1.0	0.143%			0.00760%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
52	Pyridine	2	FR57-EF-A	6.8E-05	1.0	0.007%		J	0.00760%
52	Pyridine	4	FR57-EF-B	7.2E-05	1.0	0.007%	YES		0.00760%
52	Pyridine	6	FR57-EF-C	7.1E-05	1.0	0.007%	YES	U	0.00760%
52	Pyridine	8	FR57-EF-D	6.9E-05	1.0	0.007%	YES		0.00760%
52	Pyridine	10	FR57-EF-E	6.8E-05	1.0	0.007%	YES		0.00760%
52	Pyridine	12	FR57-EF-F	7.1E-05	1.0	0.007%	YES		0.00760%
52	Pyridine	14	FR57-EF-G	6.6E-05	1.0	0.007%	YES		0.00760%
52	Pyridine	16	FR57-EF-H	6.7E-05	1.0	0.007%	YES		0.00760%
53	2,4-Dimethylpyridine	2	TL-IN-A	4.6E-05	0.50	0.009%	YES	U	0.0101%
53	2,4-Dimethylpyridine	4	TL-IN-B	4.3E-05	0.50	0.009%	YES	U	0.0101%
53	2,4-Dimethylpyridine	6	TL-IN-C	5.4E-05	0.50	0.011%		J	0.0101%
53	2,4-Dimethylpyridine	8	TL-IN-D	4.9E-05	0.50	0.010%	YES	U	0.0101%
53	2,4-Dimethylpyridine	10	TL-IN-E		0.50				0.0101%
53	2,4-Dimethylpyridine	12	TL-IN-F	1.2E-04	0.50	0.025%		J	0.0101%
53	2,4-Dimethylpyridine	14	TL-IN-G	9.5E-05	0.50	0.019%		J	0.0101%
53	2,4-Dimethylpyridine	16	TL-IN-H	7.4E-05	0.50	0.015%		J	0.0101%
53	2,4-Dimethylpyridine	2	TL-EF-A	4.6E-05	0.50	0.009%	YES	U	0.0101%
53	2,4-Dimethylpyridine	4	TL-EF-B	4.6E-05	0.50	0.009%	YES	U	0.0101%
53	2,4-Dimethylpyridine	6	TL-EF-C	4.8E-05	0.50	0.010%	YES	U	0.0101%
53	2,4-Dimethylpyridine	8	TL-EF-D	5.0E-05	0.50	0.010%	YES	U	0.0101%
53	2,4-Dimethylpyridine	10	TL-EF-E	5.0E-05	0.50	0.010%	YES	U	0.0101%
53	2,4-Dimethylpyridine	12	TL-EF-F	4.6E-05	0.50	0.009%	YES	U	0.0101%
53	2,4-Dimethylpyridine	14	TL-EF-G	4.4E-05	0.50	0.009%	YES	U	0.0101%
53	2,4-Dimethylpyridine	16	TL-EF-H	4.5E-05	0.50	0.009%	YES	U	0.0101%
53	2,4-Dimethylpyridine	2	FR57-IN-A	4.5E-05	0.50	0.009%	YES		0.0101%
53	2,4-Dimethylpyridine	4	FR57-IN-B	1.3E-04	0.50	0.026%		J	0.0101%
53	2,4-Dimethylpyridine	6	FR57-IN-C	2.6E-04	0.50	0.052%		J	0.0101%
53	2,4-Dimethylpyridine	8	FR57-IN-D	2.0E-04	0.50	0.041%		J	0.0101%
53	2,4-Dimethylpyridine	10	FR57-IN-E	2.4E-04	0.50	0.049%		J	0.0101%
53	2,4-Dimethylpyridine	12	FR57-IN-F	3.6E-04	0.50	0.073%		J	0.0101%
53	2,4-Dimethylpyridine	14	FR57-IN-G	2.5E-04	0.50	0.050%		J	0.0101%
53	2,4-Dimethylpyridine	16	FR57-IN-H	1.9E-04	0.50	0.038%		J	0.0101%
53	2,4-Dimethylpyridine	2	FR57-EF-A	4.4E-05	0.50	0.009%	YES		0.0101%
53	2,4-Dimethylpyridine	4	FR57-EF-B	4.8E-05	0.50	0.010%	YES		0.0101%
53	2,4-Dimethylpyridine	6	FR57-EF-C	4.7E-05	0.50	0.009%	YES	U	0.0101%
53	2,4-Dimethylpyridine	8	FR57-EF-D	4.6E-05	0.50	0.009%	YES		0.0101%
53	2,4-Dimethylpyridine	10	FR57-EF-E	4.5E-05	0.50	0.009%	YES	Q	0.0101%
53	2,4-Dimethylpyridine	12	FR57-EF-F	4.7E-05	0.50	0.009%	YES		0.0101%
53	2,4-Dimethylpyridine	14	FR57-EF-G	4.4E-05	0.50	0.009%	YES		0.0101%
53	2,4-Dimethylpyridine	16	FR57-EF-H	4.4E-05	0.50	0.009%	YES		0.0101%
12	6-Methyl-2-heptanone	2	TL-IN-A		8.0				
12	6-Methyl-2-heptanone	4	TL-IN-B		8.0				
12	6-Methyl-2-heptanone	6	TL-IN-C		8.0				
12	6-Methyl-2-heptanone	8	TL-IN-D		8.0				
12	6-Methyl-2-heptanone	10	TL-IN-E		8.0				
12	6-Methyl-2-heptanone	12	TL-IN-F		8.0				
12	6-Methyl-2-heptanone	14	TL-IN-G		8.0				
12	6-Methyl-2-heptanone	16	TL-IN-H		8.0				
12	6-Methyl-2-heptanone	2	TL-EF-A		8.0				
12	6-Methyl-2-heptanone	4	TL-EF-B		8.0				
12	6-Methyl-2-heptanone	6	TL-EF-C		8.0				
12	6-Methyl-2-heptanone	8	TL-EF-D		8.0				
12	6-Methyl-2-heptanone	10	TL-EF-E		8.0				
12	6-Methyl-2-heptanone	12	TL-EF-F		8.0				
12	6-Methyl-2-heptanone	14	TL-EF-G		8.0				
12	6-Methyl-2-heptanone	16	TL-EF-H		8.0				
12	6-Methyl-2-heptanone	2	FR57-IN-A	2.2E-03	8.0	0.027%		JNT	
12	6-Methyl-2-heptanone	4	FR57-IN-B		8.0				

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
12	6-Methyl-2-heptanone	6	FR57-IN-C		8.0				
12	6-Methyl-2-heptanone	8	FR57-IN-D		8.0				
12	6-Methyl-2-heptanone	10	FR57-IN-E		8.0				
12	6-Methyl-2-heptanone	12	FR57-IN-F		8.0				
12	6-Methyl-2-heptanone	14	FR57-IN-G		8.0				
12	6-Methyl-2-heptanone	16	FR57-IN-H		8.0				
12	6-Methyl-2-heptanone	2	FR57-EF-A		8.0				
12	6-Methyl-2-heptanone	4	FR57-EF-B		8.0				
12	6-Methyl-2-heptanone	6	FR57-EF-C		8.0				
12	6-Methyl-2-heptanone	8	FR57-EF-D		8.0				
12	6-Methyl-2-heptanone	10	FR57-EF-E		8.0				
12	6-Methyl-2-heptanone	12	FR57-EF-F		8.0				
12	6-Methyl-2-heptanone	14	FR57-EF-G		8.0				
12	6-Methyl-2-heptanone	16	FR57-EF-H		8.0				
16	Butanal/Butyraldehyde	2	TL-IN-A	3.6E-02	25	0.144%			0.00302%
16	Butanal/Butyraldehyde	4	TL-IN-B	3.7E-02	25	0.150%			0.00302%
16	Butanal/Butyraldehyde	6	TL-IN-C	5.9E-02	25	0.234%			0.00302%
16	Butanal/Butyraldehyde	8	TL-IN-D	5.3E-02	25	0.214%			0.00302%
16	Butanal/Butyraldehyde	10	TL-IN-E	4.8E-02	25	0.193%			0.00302%
16	Butanal/Butyraldehyde	12	TL-IN-F	4.9E-02	25	0.197%			0.00302%
16	Butanal/Butyraldehyde	14	TL-IN-G	2.6E-02	25	0.104%			0.00302%
16	Butanal/Butyraldehyde	16	TL-IN-H	2.6E-02	25	0.103%			0.00302%
16	Butanal/Butyraldehyde	2	TL-EF-A	6.7E-04	25	0.003%	YES		0.00302%
16	Butanal/Butyraldehyde	4	TL-EF-B	6.8E-04	25	0.003%	YES		0.00302%
16	Butanal/Butyraldehyde	6	TL-EF-C	6.9E-04	25	0.003%	YES		0.00302%
16	Butanal/Butyraldehyde	8	TL-EF-D	7.1E-04	25	0.003%	YES		0.00302%
16	Butanal/Butyraldehyde	10	TL-EF-E	7.3E-04	25	0.003%	YES		0.00302%
16	Butanal/Butyraldehyde	12	TL-EF-F	7.3E-04	25	0.003%	YES		0.00302%
16	Butanal/Butyraldehyde	14	TL-EF-G	6.8E-04	25	0.003%	YES		0.00302%
16	Butanal/Butyraldehyde	16	TL-EF-H	6.6E-04	25	0.003%	YES		0.00302%
16	Butanal/Butyraldehyde	2	FR57-IN-A	2.6E-02	25	0.106%			0.00302%
16	Butanal/Butyraldehyde	4	FR57-IN-B	2.7E-02	25	0.109%			0.00302%
16	Butanal/Butyraldehyde	6	FR57-IN-C	4.2E-02	25	0.167%			0.00302%
16	Butanal/Butyraldehyde	8	FR57-IN-D	2.7E-02	25	0.109%			0.00302%
16	Butanal/Butyraldehyde	10	FR57-IN-E	2.5E-02	25	0.100%			0.00302%
16	Butanal/Butyraldehyde	12	FR57-IN-F	2.2E-02	25	0.089%			0.00302%
16	Butanal/Butyraldehyde	14	FR57-IN-G	2.7E-02	25	0.109%			0.00302%
16	Butanal/Butyraldehyde	16	FR57-IN-H	2.7E-02	25	0.109%			0.00302%
16	Butanal/Butyraldehyde	2	FR57-EF-A	7.2E-04	25	0.003%	YES		0.00302%
16	Butanal/Butyraldehyde	4	FR57-EF-B	7.6E-04	25	0.003%	YES		0.00302%
16	Butanal/Butyraldehyde	6	FR57-EF-C	7.0E-04	25	0.003%	YES		0.00302%
16	Butanal/Butyraldehyde	8	FR57-EF-D	7.0E-04	25	0.003%	YES		0.00302%
16	Butanal/Butyraldehyde	10	FR57-EF-E	6.9E-04	25	0.003%	YES		0.00302%
16	Butanal/Butyraldehyde	12	FR57-EF-F	6.9E-04	25	0.003%	YES		0.00302%
16	Butanal/Butyraldehyde	14	FR57-EF-G	7.0E-04	25	0.003%	YES		0.00302%
16	Butanal/Butyraldehyde	16	FR57-EF-H	7.0E-04	25	0.003%	YES		0.00302%
20	Furan	2	TL-IN-A	2.4E-05	0.001	2.36%	YES	U	2.46%
20	Furan	4	TL-IN-B	2.2E-05	0.001	2.18%	YES	U	2.46%
20	Furan	6	TL-IN-C	2.4E-05	0.001	2.40%	YES	U	2.46%
20	Furan	8	TL-IN-D	2.3E-05	0.001	2.29%	YES	U	2.46%
20	Furan	10	TL-IN-E	2.3E-05	0.001	2.32%	YES	U	2.46%
20	Furan	12	TL-IN-F	2.3E-05	0.001	2.31%	YES	U	2.46%
20	Furan	14	TL-IN-G	2.2E-05	0.001	2.21%	YES	U	2.46%
20	Furan	16	TL-IN-H	2.1E-05	0.001	2.08%	YES	U	2.46%
20	Furan	2	TL-EF-A	2.2E-05	0.001	2.22%	YES	U	2.46%
20	Furan	4	TL-EF-B	2.1E-05	0.001	2.13%	YES	U	2.46%
20	Furan	6	TL-EF-C	2.3E-05	0.001	2.25%	YES	U	2.46%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
20	Furan	8	TL-EF-D	2.4E-05	0.001	2.40%	YES	U	2.46%
20	Furan	10	TL-EF-E	2.4E-05	0.001	2.36%	YES	U	2.46%
20	Furan	12	TL-EF-F	2.0E-05	0.001	1.96%	YES	U	2.46%
20	Furan	14	TL-EF-G	2.0E-05	0.001	2.03%	YES	U	2.46%
20	Furan	16	TL-EF-H	2.2E-05	0.001	2.16%	YES	U	2.46%
20	Furan	2	FR57-IN-A	2.1E-05	0.001	2.05%	YES	U	2.46%
20	Furan	4	FR57-IN-B	2.4E-05	0.001	2.37%	YES	U	2.46%
20	Furan	6	FR57-IN-C	2.4E-05	0.001	2.37%	YES	U	2.46%
20	Furan	8	FR57-IN-D	2.5E-05	0.001	2.46%	YES	U	2.46%
20	Furan	10	FR57-IN-E	2.4E-05	0.001	2.38%	YES	U	2.46%
20	Furan	12	FR57-IN-F	2.4E-05	0.001	2.41%	YES	U	2.46%
20	Furan	14	FR57-IN-G	2.4E-05	0.001	2.44%	YES	U	2.46%
20	Furan	16	FR57-IN-H	2.2E-05	0.001	2.19%	YES	U	2.46%
20	Furan	2	FR57-EF-A	2.1E-05	0.001	2.06%	YES	U	2.46%
20	Furan	4	FR57-EF-B	2.1E-05	0.001	2.14%	YES	U	2.46%
20	Furan	6	FR57-EF-C	2.1E-05	0.001	2.10%	YES	U	2.46%
20	Furan	8	FR57-EF-D	2.4E-05	0.001	2.42%	YES	U	2.46%
20	Furan	10	FR57-EF-E	2.1E-05	0.001	2.07%	YES	U	2.46%
20	Furan	12	FR57-EF-F	2.3E-05	0.001	2.28%	YES	U	2.46%
20	Furan	14	FR57-EF-G	2.4E-05	0.001	2.37%	YES	U	2.46%
20	Furan	16	FR57-EF-H	2.4E-05	0.001	2.42%	YES	U	2.46%
22	2,5-Dihydrofuran	2	TL-IN-A	1.9E-05	0.001	1.94%	YES	U	2.02%
22	2,5-Dihydrofuran	4	TL-IN-B	1.8E-05	0.001	1.79%	YES	U	2.02%
22	2,5-Dihydrofuran	6	TL-IN-C	2.0E-05	0.001	1.97%	YES	U	2.02%
22	2,5-Dihydrofuran	8	TL-IN-D	1.9E-05	0.001	1.88%	YES	U	2.02%
22	2,5-Dihydrofuran	10	TL-IN-E	1.9E-05	0.001	1.90%	YES	U	2.02%
22	2,5-Dihydrofuran	12	TL-IN-F	1.9E-05	0.001	1.90%	YES	U	2.02%
22	2,5-Dihydrofuran	14	TL-IN-G	1.8E-05	0.001	1.82%	YES	U	2.02%
22	2,5-Dihydrofuran	16	TL-IN-H	1.7E-05	0.001	1.71%		J	2.02%
22	2,5-Dihydrofuran	2	TL-EF-A	1.8E-05	0.001	1.82%	YES	U	2.02%
22	2,5-Dihydrofuran	4	TL-EF-B	1.8E-05	0.001	1.75%	YES	U	2.02%
22	2,5-Dihydrofuran	6	TL-EF-C	1.9E-05	0.001	1.85%	YES	U	2.02%
22	2,5-Dihydrofuran	8	TL-EF-D	2.0E-05	0.001	1.97%	YES	U	2.02%
22	2,5-Dihydrofuran	10	TL-EF-E	1.9E-05	0.001	1.94%	YES	U	2.02%
22	2,5-Dihydrofuran	12	TL-EF-F	1.6E-05	0.001	1.61%	YES	U	2.02%
22	2,5-Dihydrofuran	14	TL-EF-G	1.7E-05	0.001	1.67%	YES	U	2.02%
22	2,5-Dihydrofuran	16	TL-EF-H	1.8E-05	0.001	1.77%	YES	U	2.02%
22	2,5-Dihydrofuran	2	FR57-IN-A	1.7E-05	0.001	1.69%	YES	U	2.02%
22	2,5-Dihydrofuran	4	FR57-IN-B	1.9E-05	0.001	1.95%	YES	U	2.02%
22	2,5-Dihydrofuran	6	FR57-IN-C	1.9E-05	0.001	1.95%	YES	U	2.02%
22	2,5-Dihydrofuran	8	FR57-IN-D	2.0E-05	0.001	2.02%	YES	U	2.02%
22	2,5-Dihydrofuran	10	FR57-IN-E	2.0E-05	0.001	1.96%	YES	U	2.02%
22	2,5-Dihydrofuran	12	FR57-IN-F	2.0E-05	0.001	1.98%	YES	U	2.02%
22	2,5-Dihydrofuran	14	FR57-IN-G	2.0E-05	0.001	2.00%	YES	U	2.02%
22	2,5-Dihydrofuran	16	FR57-IN-H	1.8E-05	0.001	1.80%	YES	U	2.02%
22	2,5-Dihydrofuran	2	FR57-EF-A	1.7E-05	0.001	1.69%	YES	U	2.02%
22	2,5-Dihydrofuran	4	FR57-EF-B	1.8E-05	0.001	1.76%	YES	U	2.02%
22	2,5-Dihydrofuran	6	FR57-EF-C	1.7E-05	0.001	1.73%	YES	U	2.02%
22	2,5-Dihydrofuran	8	FR57-EF-D	2.0E-05	0.001	1.99%	YES	U	2.02%
22	2,5-Dihydrofuran	10	FR57-EF-E	1.7E-05	0.001	1.70%	YES	U	2.02%
22	2,5-Dihydrofuran	12	FR57-EF-F	1.9E-05	0.001	1.88%	YES	U	2.02%
22	2,5-Dihydrofuran	14	FR57-EF-G	1.9E-05	0.001	1.95%	YES	U	2.02%
22	2,5-Dihydrofuran	16	FR57-EF-H	2.0E-05	0.001	1.99%	YES	U	2.02%
23	2-Methylfuran	2	TL-IN-A	2.1E-05	0.001	2.11%	YES	U	2.19%
23	2-Methylfuran	4	TL-IN-B	1.9E-05	0.001	1.95%	YES	U	2.19%
23	2-Methylfuran	6	TL-IN-C	2.1E-05	0.001	2.14%	YES	U	2.19%
23	2-Methylfuran	8	TL-IN-D	2.0E-05	0.001	2.04%	YES	U	2.19%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
23	2-Methylfuran	10	TL-IN-E	2.1E-05	0.001	2.07%	YES	U	2.19%
23	2-Methylfuran	12	TL-IN-F	2.1E-05	0.001	2.06%	YES	U	2.19%
23	2-Methylfuran	14	TL-IN-G	2.0E-05	0.001	1.97%	YES	U	2.19%
23	2-Methylfuran	16	TL-IN-H	1.9E-05	0.001	1.86%	YES	U	2.19%
23	2-Methylfuran	2	TL-EF-A	2.0E-05	0.001	1.98%	YES	U	2.19%
23	2-Methylfuran	4	TL-EF-B	1.9E-05	0.001	1.90%	YES	U	2.19%
23	2-Methylfuran	6	TL-EF-C	2.0E-05	0.001	2.01%	YES	U	2.19%
23	2-Methylfuran	8	TL-EF-D	2.1E-05	0.001	2.14%	YES	U	2.19%
23	2-Methylfuran	10	TL-EF-E	2.1E-05	0.001	2.11%	YES	U	2.19%
23	2-Methylfuran	12	TL-EF-F	1.7E-05	0.001	1.75%	YES	U	2.19%
23	2-Methylfuran	14	TL-EF-G	1.8E-05	0.001	1.81%	YES	U	2.19%
23	2-Methylfuran	16	TL-EF-H	1.9E-05	0.001	1.93%	YES	U	2.19%
23	2-Methylfuran	2	FR57-IN-A	1.8E-05	0.001	1.83%	YES	U	2.19%
23	2-Methylfuran	4	FR57-IN-B	2.1E-05	0.001	2.12%	YES	U	2.19%
23	2-Methylfuran	6	FR57-IN-C	2.1E-05	0.001	2.12%	YES	U	2.19%
23	2-Methylfuran	8	FR57-IN-D	2.2E-05	0.001	2.19%	YES	U	2.19%
23	2-Methylfuran	10	FR57-IN-E	2.1E-05	0.001	2.13%	YES	U	2.19%
23	2-Methylfuran	12	FR57-IN-F	2.1E-05	0.001	2.15%	YES	U	2.19%
23	2-Methylfuran	14	FR57-IN-G	2.2E-05	0.001	2.18%	YES	U	2.19%
23	2-Methylfuran	16	FR57-IN-H	2.0E-05	0.001	1.96%	YES	U	2.19%
23	2-Methylfuran	2	FR57-EF-A	1.8E-05	0.001	1.84%	YES	U	2.19%
23	2-Methylfuran	4	FR57-EF-B	1.9E-05	0.001	1.91%	YES	U	2.19%
23	2-Methylfuran	6	FR57-EF-C	1.9E-05	0.001	1.88%	YES	U	2.19%
23	2-Methylfuran	8	FR57-EF-D	2.2E-05	0.001	2.16%	YES	U	2.19%
23	2-Methylfuran	10	FR57-EF-E	1.9E-05	0.001	1.85%	YES	U	2.19%
23	2-Methylfuran	12	FR57-EF-F	2.0E-05	0.001	2.04%	YES	U	2.19%
23	2-Methylfuran	14	FR57-EF-G	2.1E-05	0.001	2.12%	YES	U	2.19%
23	2-Methylfuran	16	FR57-EF-H	2.2E-05	0.001	2.16%	YES	U	2.19%
34	Diethylphthalate	2	TL-IN-A		0.54				
34	Diethylphthalate	4	TL-IN-B		0.54				
34	Diethylphthalate	6	TL-IN-C		0.54				
34	Diethylphthalate	8	TL-IN-D		0.54				
34	Diethylphthalate	10	TL-IN-E		0.54				
34	Diethylphthalate	12	TL-IN-F		0.54				
34	Diethylphthalate	14	TL-IN-G		0.54				
34	Diethylphthalate	16	TL-IN-H		0.54				
34	Diethylphthalate	2	TL-EF-A		0.54				
34	Diethylphthalate	4	TL-EF-B		0.54				
34	Diethylphthalate	6	TL-EF-C	2.4E-03	0.54	0.434%		JNT	
34	Diethylphthalate	8	TL-EF-D	1.3E-03	0.54	0.235%		JNT	
34	Diethylphthalate	10	TL-EF-E		0.54				
34	Diethylphthalate	12	TL-EF-F		0.54				
34	Diethylphthalate	14	TL-EF-G		0.54				
34	Diethylphthalate	16	TL-EF-H		0.54				
34	Diethylphthalate	2	FR57-IN-A		0.54				
34	Diethylphthalate	4	FR57-IN-B		0.54				
34	Diethylphthalate	6	FR57-IN-C		0.54				
34	Diethylphthalate	8	FR57-IN-D		0.54				
34	Diethylphthalate	10	FR57-IN-E		0.54				
34	Diethylphthalate	12	FR57-IN-F		0.54				
34	Diethylphthalate	14	FR57-IN-G		0.54				
34	Diethylphthalate	16	FR57-IN-H	2.4E-03	0.54	0.440%		JNT	
34	Diethylphthalate	2	FR57-EF-A		0.54				
34	Diethylphthalate	4	FR57-EF-B	7.5E-03	0.54	1.38%		JNT	
34	Diethylphthalate	6	FR57-EF-C		0.54				
34	Diethylphthalate	8	FR57-EF-D	1.8E-03	0.54	0.327%		JNT	
34	Diethylphthalate	10	FR57-EF-E		0.54				
34	Diethylphthalate	12	FR57-EF-F		0.54				

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
34	Diethylphthalate	14	FR57-EF-G		0.54				
34	Diethylphthalate	16	FR57-EF-H		0.54				
35	Acetonitrile	2	TL-IN-A	4.7E-01	20	2.35%	YES		2.62%
35	Acetonitrile	4	TL-IN-B	4.6E-01	20	2.31%	YES		2.62%
35	Acetonitrile	6	TL-IN-C	4.8E-01	20	2.39%	YES		2.62%
35	Acetonitrile	8	TL-IN-D	5.0E-01	20	2.49%	YES		2.62%
35	Acetonitrile	10	TL-IN-E	5.1E-01	20	2.55%	YES		2.62%
35	Acetonitrile	12	TL-IN-F	4.9E-01	20	2.47%	YES		2.62%
35	Acetonitrile	14	TL-IN-G	4.6E-01	20	2.29%	YES		2.62%
35	Acetonitrile	16	TL-IN-H	4.9E-01	20	2.46%	YES		2.62%
35	Acetonitrile	2	TL-EF-A	5.0E-01	20	2.50%	YES		2.62%
35	Acetonitrile	4	TL-EF-B	4.7E-01	20	2.37%	YES		2.62%
35	Acetonitrile	6	TL-EF-C	5.0E-01	20	2.52%	YES		2.62%
35	Acetonitrile	8	TL-EF-D	5.0E-01	20	2.48%	YES		2.62%
35	Acetonitrile	10	TL-EF-E	5.1E-01	20	2.55%	YES		2.62%
35	Acetonitrile	12	TL-EF-F	5.2E-01	20	2.62%	YES		2.62%
35	Acetonitrile	14	TL-EF-G	4.7E-01	20	2.34%	YES		2.62%
35	Acetonitrile	16	TL-EF-H	4.9E-01	20	2.45%	YES		2.62%
35	Acetonitrile	2	FR57-IN-A	4.9E-01	20	2.45%	YES		2.62%
35	Acetonitrile	4	FR57-IN-B	6.2E-01	20	3.08%			2.62%
35	Acetonitrile	6	FR57-IN-C	4.7E-01	20	2.36%	YES		2.62%
35	Acetonitrile	8	FR57-IN-D	4.8E-01	20	2.40%	YES		2.62%
35	Acetonitrile	10	FR57-IN-E	4.8E-01	20	2.38%	YES		2.62%
35	Acetonitrile	12	FR57-IN-F	4.7E-01	20	2.37%	YES		2.62%
35	Acetonitrile	14	FR57-IN-G	4.8E-01	20	2.40%	YES		2.62%
35	Acetonitrile	16	FR57-IN-H	4.9E-01	20	2.44%	YES		2.62%
35	Acetonitrile	2	FR57-EF-A	4.4E-01	20	2.18%	YES		2.62%
35	Acetonitrile	4	FR57-EF-B	4.7E-01	20	2.33%	YES		2.62%
35	Acetonitrile	6	FR57-EF-C	4.9E-01	20	2.45%	YES		2.62%
35	Acetonitrile	8	FR57-EF-D	4.7E-01	20	2.34%	YES		2.62%
35	Acetonitrile	10	FR57-EF-E	4.6E-01	20	2.28%	YES		2.62%
35	Acetonitrile	12	FR57-EF-F	4.6E-01	20	2.28%	YES		2.62%
35	Acetonitrile	14	FR57-EF-G	4.5E-01	20	2.26%	YES		2.62%
35	Acetonitrile	16	FR57-EF-H	4.6E-01	20	2.29%	YES		2.62%
52	Pyridine	2	TL-IN-A	1.6E-03	1.0	0.162%			0.143%
52	Pyridine	4	TL-IN-B	1.4E-03	1.0	0.143%			0.143%
52	Pyridine	6	TL-IN-C	1.3E-03	1.0	0.127%	YES		0.143%
52	Pyridine	8	TL-IN-D	1.3E-03	1.0	0.127%	YES		0.143%
52	Pyridine	10	TL-IN-E	1.6E-03	1.0	0.158%			0.143%
52	Pyridine	12	TL-IN-F	1.3E-03	1.0	0.128%	YES		0.143%
52	Pyridine	14	TL-IN-G	1.3E-03	1.0	0.127%	YES		0.143%
52	Pyridine	16	TL-IN-H	1.2E-03	1.0	0.121%	YES		0.143%
52	Pyridine	2	TL-EF-A	1.4E-03	1.0	0.136%	YES		0.143%
52	Pyridine	4	TL-EF-B	1.3E-03	1.0	0.126%	YES		0.143%
52	Pyridine	6	TL-EF-C	1.2E-03	1.0	0.123%	YES		0.143%
52	Pyridine	8	TL-EF-D	1.2E-03	1.0	0.123%	YES		0.143%
52	Pyridine	10	TL-EF-E	1.3E-03	1.0	0.129%	YES		0.143%
52	Pyridine	12	TL-EF-F	1.3E-03	1.0	0.128%	YES		0.143%
52	Pyridine	14	TL-EF-G	1.3E-03	1.0	0.129%	YES		0.143%
52	Pyridine	16	TL-EF-H	1.3E-03	1.0	0.126%	YES		0.143%
52	Pyridine	2	FR57-IN-A	1.3E-03	1.0	0.131%	YES		0.143%
52	Pyridine	4	FR57-IN-B	1.3E-03	1.0	0.132%	YES		0.143%
52	Pyridine	6	FR57-IN-C	1.3E-03	1.0	0.130%	YES		0.143%
52	Pyridine	8	FR57-IN-D	1.3E-03	1.0	0.130%	YES		0.143%
52	Pyridine	10	FR57-IN-E	1.3E-03	1.0	0.129%	YES		0.143%
52	Pyridine	12	FR57-IN-F	1.3E-03	1.0	0.128%	YES		0.143%
52	Pyridine	14	FR57-IN-G	1.3E-03	1.0	0.134%	YES		0.143%

Table D.2. PAPR Cartridge Testing (BY-108) Calculated Data (continued)

COPC #	Analyte	End Time (h)	Position	Conc. (ppm)	OEL (ppm)	Fraction of OEL	Measurement < DL|RL?	Quality Code	Approx. DL|RL (%OEL)
52	Pyridine	16	FR57-IN-H	1.3E-03	1.0	0.135%	YES		0.143%
52	Pyridine	2	FR57-EF-A	1.4E-03	1.0	0.143%	YES		0.143%
52	Pyridine	4	FR57-EF-B	1.4E-03	1.0	0.135%	YES		0.143%
52	Pyridine	6	FR57-EF-C	1.2E-03	1.0	0.123%	YES		0.143%
52	Pyridine	8	FR57-EF-D	1.2E-03	1.0	0.117%	YES		0.143%
52	Pyridine	10	FR57-EF-E	1.3E-03	1.0	0.126%	YES		0.143%
52	Pyridine	12	FR57-EF-F	1.2E-03	1.0	0.122%	YES		0.143%
52	Pyridine	14	FR57-EF-G	1.2E-03	1.0	0.122%	YES		0.143%
52	Pyridine	16	FR57-EF-H	1.2E-03	1.0	0.116%	YES		0.143%
53	2,4-Dimethylpyridine	2	TL-IN-A	1.2E-03	0.50	0.240%			0.212%
53	2,4-Dimethylpyridine	4	TL-IN-B	1.3E-03	0.50	0.266%			0.212%
53	2,4-Dimethylpyridine	6	TL-IN-C	1.3E-03	0.50	0.252%			0.212%
53	2,4-Dimethylpyridine	8	TL-IN-D	9.4E-04	0.50	0.188%	YES		0.212%
53	2,4-Dimethylpyridine	10	TL-IN-E	1.5E-03	0.50	0.301%			0.212%
53	2,4-Dimethylpyridine	12	TL-IN-F	9.7E-04	0.50	0.193%			0.212%
53	2,4-Dimethylpyridine	14	TL-IN-G	1.0E-03	0.50	0.203%			0.212%
53	2,4-Dimethylpyridine	16	TL-IN-H	9.5E-04	0.50	0.190%			0.212%
53	2,4-Dimethylpyridine	2	TL-EF-A	1.0E-03	0.50	0.201%	YES		0.212%
53	2,4-Dimethylpyridine	4	TL-EF-B	9.3E-04	0.50	0.186%	YES		0.212%
53	2,4-Dimethylpyridine	6	TL-EF-C	9.1E-04	0.50	0.182%	YES		0.212%
53	2,4-Dimethylpyridine	8	TL-EF-D	9.1E-04	0.50	0.181%	YES		0.212%
53	2,4-Dimethylpyridine	10	TL-EF-E	9.5E-04	0.50	0.190%	YES		0.212%
53	2,4-Dimethylpyridine	12	TL-EF-F	9.5E-04	0.50	0.189%	YES		0.212%
53	2,4-Dimethylpyridine	14	TL-EF-G	9.6E-04	0.50	0.191%	YES		0.212%
53	2,4-Dimethylpyridine	16	TL-EF-H	9.3E-04	0.50	0.186%	YES		0.212%
53	2,4-Dimethylpyridine	2	FR57-IN-A	9.7E-04	0.50	0.193%	YES	c	0.212%
53	2,4-Dimethylpyridine	4	FR57-IN-B	9.8E-04	0.50	0.196%	YES	c	0.212%
53	2,4-Dimethylpyridine	6	FR57-IN-C	9.6E-04	0.50	0.193%	YES	c	0.212%
53	2,4-Dimethylpyridine	8	FR57-IN-D	9.6E-04	0.50	0.192%	YES	c	0.212%
53	2,4-Dimethylpyridine	10	FR57-IN-E	9.5E-04	0.50	0.191%	YES	c	0.212%
53	2,4-Dimethylpyridine	12	FR57-IN-F	9.5E-04	0.50	0.190%	YES	c	0.212%
53	2,4-Dimethylpyridine	14	FR57-IN-G	9.9E-04	0.50	0.198%	YES	c	0.212%
53	2,4-Dimethylpyridine	16	FR57-IN-H	9.9E-04	0.50	0.199%	YES	c	0.212%
53	2,4-Dimethylpyridine	2	FR57-EF-A	1.1E-03	0.50	0.212%	YES	c	0.212%
53	2,4-Dimethylpyridine	4	FR57-EF-B	1.0E-03	0.50	0.200%	YES	c	0.212%
53	2,4-Dimethylpyridine	6	FR57-EF-C	9.1E-04	0.50	0.181%	YES	c	0.212%
53	2,4-Dimethylpyridine	8	FR57-EF-D	8.7E-04	0.50	0.173%	YES	c	0.212%
53	2,4-Dimethylpyridine	10	FR57-EF-E	9.3E-04	0.50	0.186%	YES	c	0.212%
53	2,4-Dimethylpyridine	12	FR57-EF-F	9.0E-04	0.50	0.181%	YES	c	0.212%
53	2,4-Dimethylpyridine	14	FR57-EF-G	9.0E-04	0.50	0.181%	YES	c	0.212%
53	2,4-Dimethylpyridine	16	FR57-EF-H	8.6E-04	0.50	0.171%	YES	c	0.212%

Appendix E

Plots of Other COPCs with Significant (2–10% of the OEL) Detected Values

Appendix E

Plots of Other COPCs with Significant (2–10% of the OEL) Detected Value

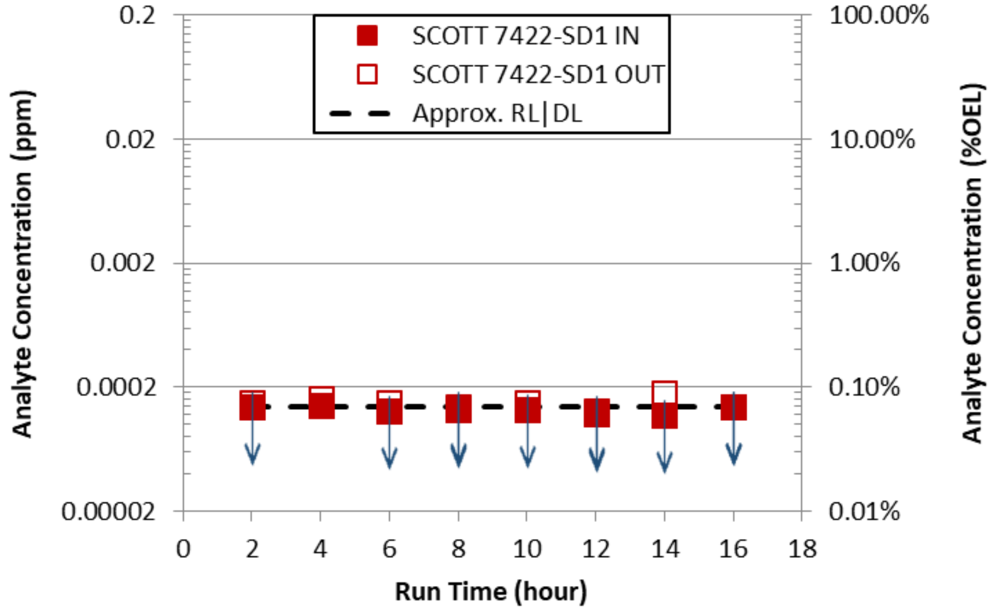
E.1 APR Cartridge Testing on BY-110

Mercury. The reporting limit (RL) for mercury is 8.1% of the Occupational Exposure Limit (OEL), which exceeds the 2.0% OEL threshold for discussion in this appendix. All measured inlet and outlet concentrations of mercury were less than the reporting limit (RL). Therefore, there is no evidence of breakthrough over the measured time period for either cartridge tested. No plot of the mercury data is included here because all of the data points were less than the RL.

1,3-Butadiene. The RL for 1,3-butadiene is 3.9% of the OEL, which exceeds the 2.0% OEL threshold for discussion in this appendix. All measured inlet and outlet concentrations of 1,3-butadiene were less than the RL. Therefore, there was no evidence of breakthrough over the measured time period for either cartridge tested. No plot of the 1,3-butadiene data is included here because all of the data points were less than the RL.

Furan and Substituted Furans. Eight furan Chemicals of Potential Concern (COPC) were measured and quantified during cartridge testing using calibration standards and two different sorbent tube methods. The Carbotrap 300 TDU tube was used to sample three of the lower-boiling-point calibrated furans including furan, 2,5-dihydrofuran, and 2-methylfuran, and each of these are presented in Section 5.0 of this report. The Furans TENAX TA TDU tube was used to sample the remaining non-Tentatively Identified Compound substituted furans, including 2,3-dihydrofuran, 2,5-dimethylfuran, 2-pentylfuran, 2-heptylfuran, and 2-propylfuran. The detection limit (DL) for all furan COPCs except 2-propylfuran exceeded 2% of the OEL, the threshold for discussion in this appendix. For both APR cartridges, all measured inlet and outlet concentrations of 2,3-dihydrofuran, 2,5-dimethylfuran, 2-pentylfuran, and 2-heptyfuran were less than the DLs and RLs. Therefore, there is no indication of breakthrough for any of these substituted furan COPCs. No plots of the data for these substituted furans are included here because all of the data points were less than the DL and RL.

3-Butene-2-one (see Figure E.1) – The DL for 3-butene-2-one corresponds to 0.07% of its OEL. All measured inlet and outlet concentrations for the SCOTT 7422-SD1 cartridge were either less than the DL or close to that level. Inlet concentrations for the SCOTT 7422-SC1 cartridge exceeded the DL, reaching as high as 2.5% of the OEL. However, all outlet measurements were <2% of the OEL for both respirator cartridges. Thus, there is no evidence of breakthrough over the measured time period for either cartridge tested.



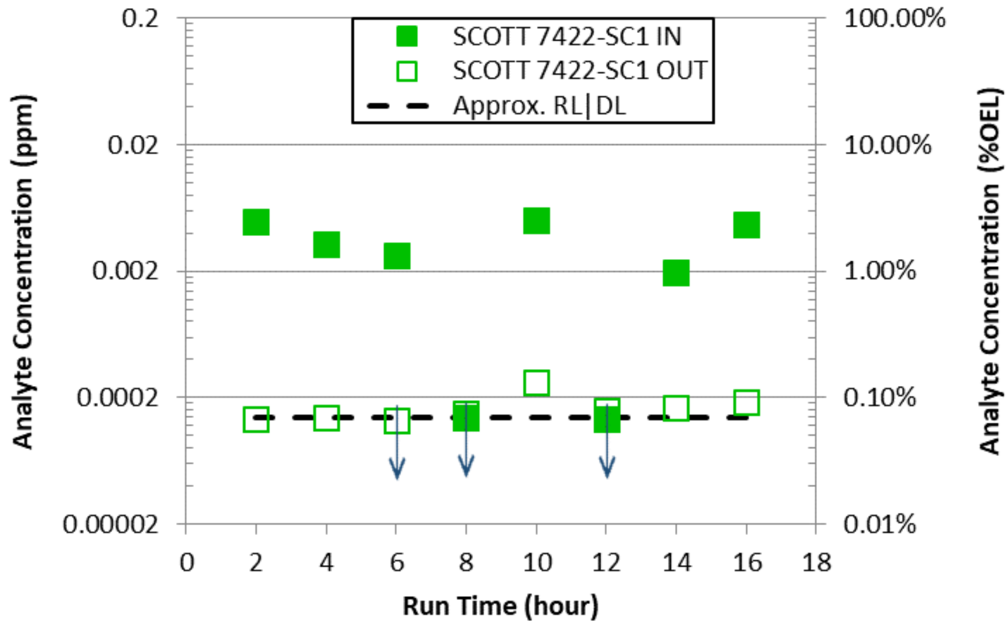


Figure E.1. Plots of Measured 3-Butene-2-one Concentrations before the Inlets and after the Outlets of the Two APR Cartridges Tested (SCOTT 7422-SD1 and SCOTT 7422-SC1). Data points noted with ↓ indicate measurements less than the DL or RL. Outlet data points that are not visible are obscured by the inlet data points.

Formaldehyde (see Figure E.2) – The DL for formaldehyde corresponds to approximately 0.6% of its OEL. For both the SCOTT 7422-SD1 and SCOTT 7422-SC1 cartridges, all inlet and outlet concentrations measured were higher than the DL but <2.0%, except for the 10-hour inlet concentration measurement for the 7422-SC1 cartridge, which was 2.1% of the OEL. Based on the outlet data, there is no evidence of breakthrough over the measured time period for either cartridge tested.

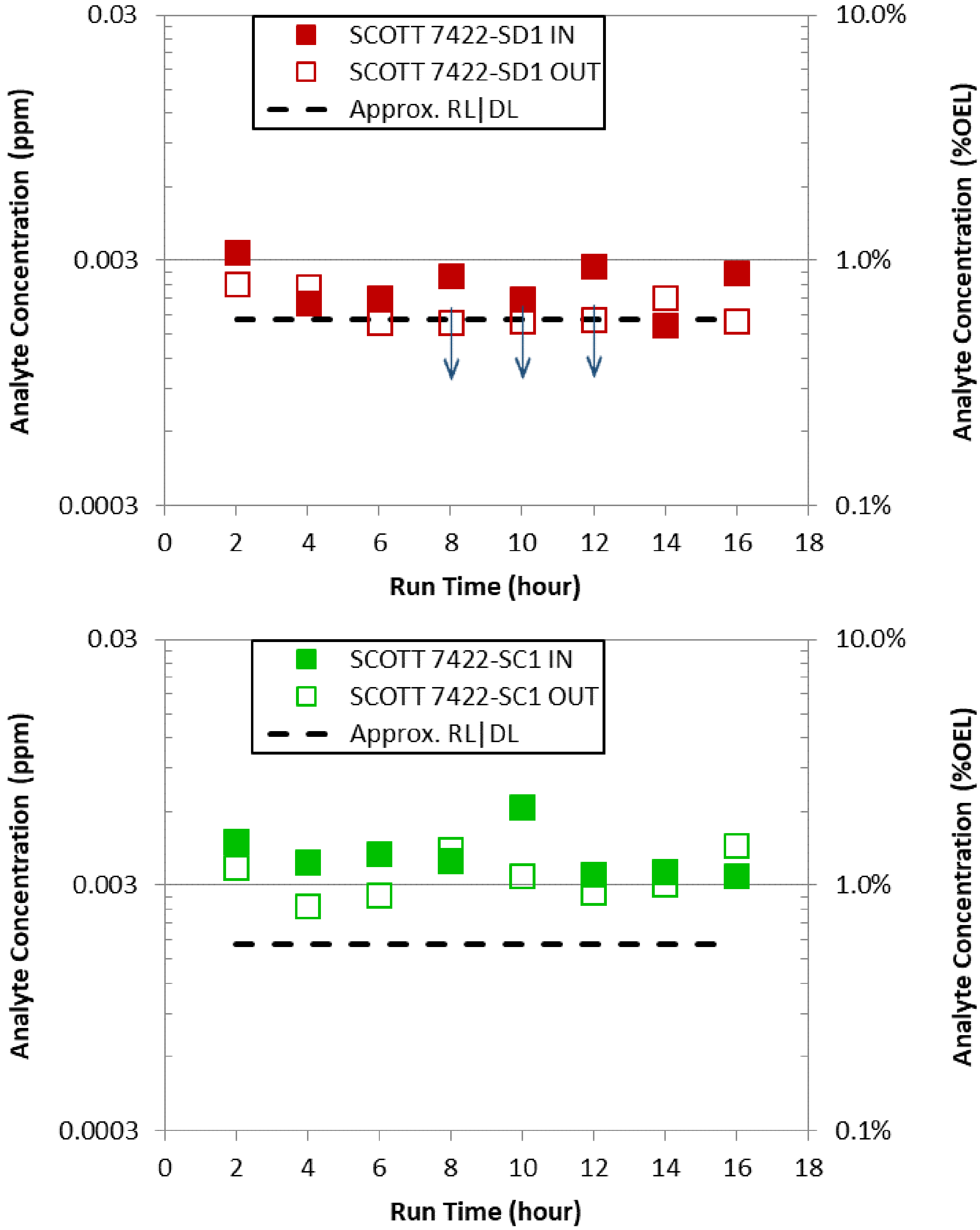


Figure E.2. Plots of Measured Formaldehyde Concentrations before the Inlets and after the Outlets of the Two APR Cartridges Tested (SCOTT 7422-SD1 and SCOTT 7422-SC1). Data points noted with ↓ indicate measurements less than the DL or RL. Outlet data points that are not visible are obscured by the inlet data points.

Acetonitrile (see Figure E.3) – The DL for acetonitrile is 0.001% of the OEL. All measured inlet and outlet concentrations of acetonitrile were above the DL, but <2.0% of the OEL, except for the 12-hour effluent sample from the SCOTT 7422-SC1 cartridge, which measured approximately 3.9% of the OEL. This measurement was above the analytical range of the detector and was reported as an approximate quantitation. Despite a single elevated outlet measurement from one cartridge, there is no evidence from outlet concentrations of breakthrough over the measured time period for either cartridge tested.

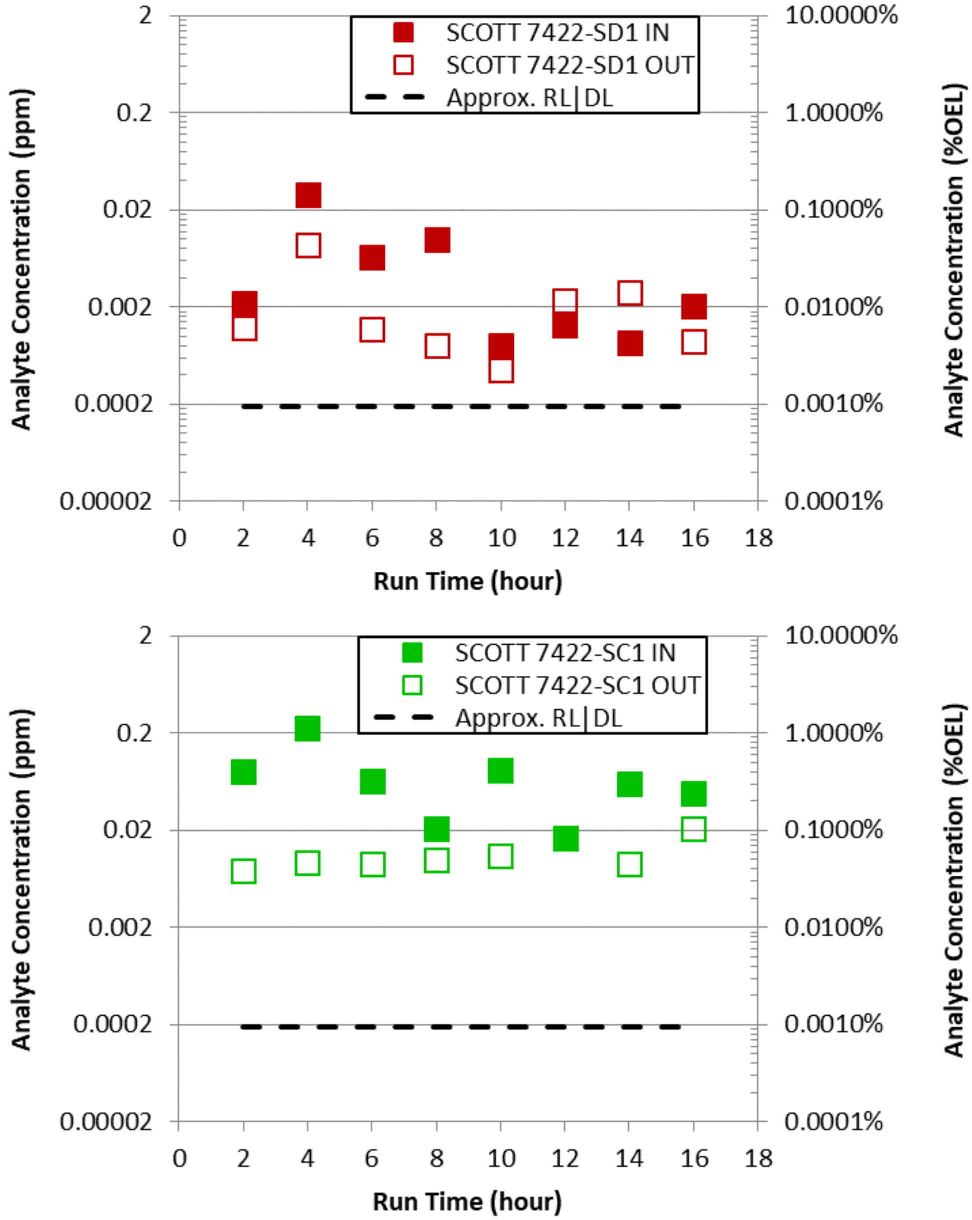


Figure E.3. Plots of Measured Acetonitrile Concentrations before the Inlets and after the Outlets of the Two APR Cartridges Tested (SCOTT 7422-SD1 and SCOTT 7422-SC1). Data points noted with ↓ indicate measurements less than the DL or RL. Outlet data points that are not visible are obscured by the inlet data points.

E.2 PAPR Cartridge Testing on BY-108

1,3-Butadiene. The RL for 1,3-butadiene is 3.8% of the OEL, which exceeds the 2.0% of the OEL threshold for discussion in this appendix. All measured inlet and outlet concentrations of 1,3-butadiene were less than the RL of 3.9% of the OEL. Therefore, there was no evidence of breakthrough over the measured time period for either cartridge tested. No plots of the 1,3-butadiene data is included here because all of the data points were less than the RL.

Furan and Substituted Furans. Eight furan COPCs were measured and quantified during cartridge testing using calibration standards and two different sorbent tube methods. The Carbotrap 300 TDU tube was used to sample three of the lower-boiling-point calibrated furans including furan, 2,5-dihydrofuran, and 2-methylfuran. Plots of furan and 2-methylfuran data are included in Section 5.0 of this report. The Furans TENAX TA TDU tube was used to sample the remaining non-Tentatively Identified Compound substituted furans, including 2,3-dihydrofuran, 2,5-dimethylfuran, 2-pentylfuran, 2-heptylfuran, and 2-propylfuran. The DL for all furan COPCs except 2-propylfuran exceeded 2% of the OEL, which is the threshold for discussion in this appendix. For both PAPR cartridges, all measured inlet and outlet concentrations of 2,3-dihydrofuran, 2,5-dihydrofuran, 2,5-dimethylfuran, 2-pentylfuran, and 2-heptyfuran were less than the respective DLs and RLs. Therefore, there is no indication of breakthrough for any of these substituted furan COPCs. No plots of the data for these substituted furans are included here because all of the data points were less than the DL and RL.

1-Butanol (see Figure E.4) – The DL for 1-Butanol corresponds to 0.004% of its OEL. All measured inlet concentrations to both of the MSA TL and 3M FR-57 cartridges were higher than the analytical DL but <2.8% of the OEL. All of the outlet measurements were less than the DL for both respirator cartridges. Thus, there is no evidence of breakthrough over the measured time period for either cartridge tested.

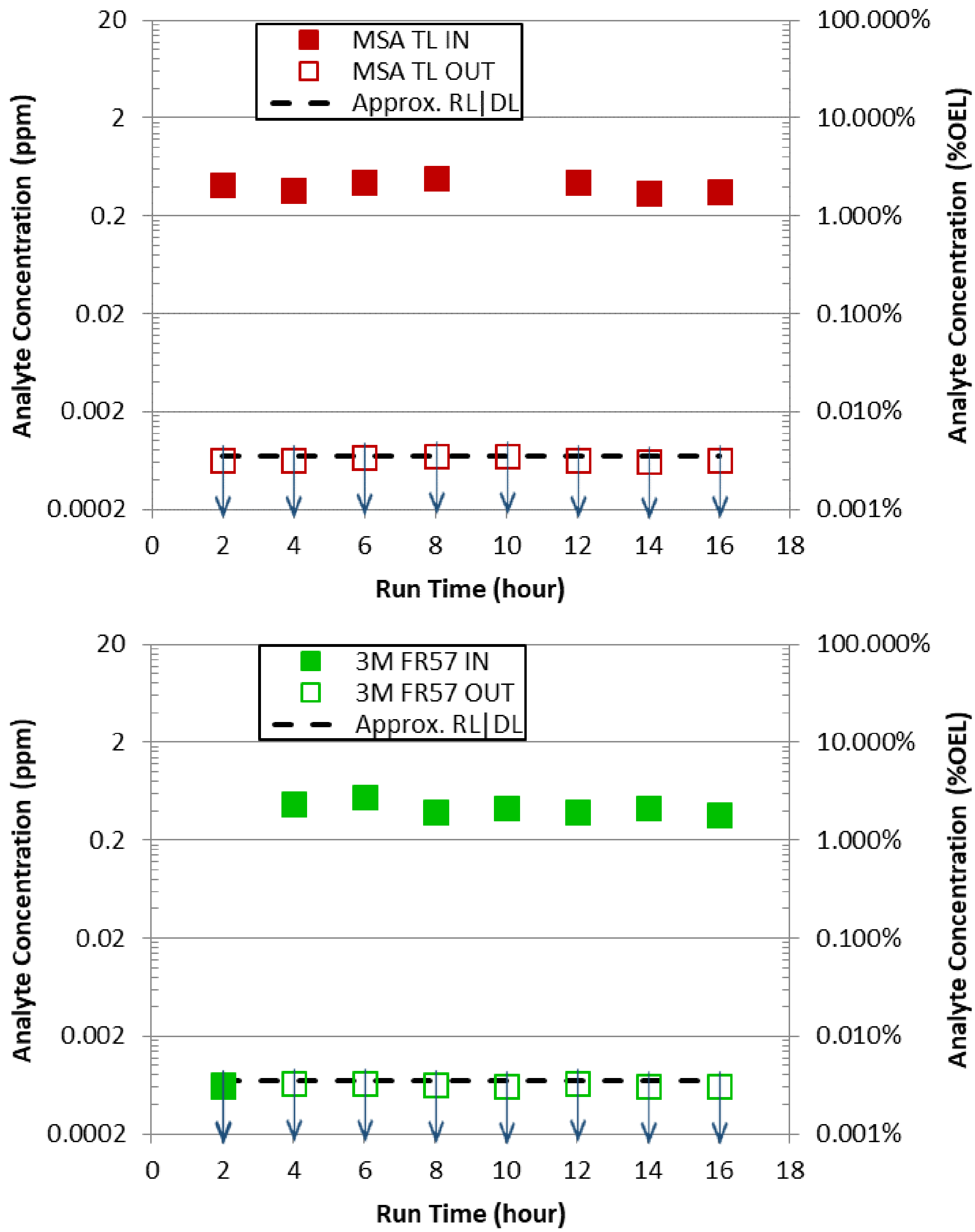
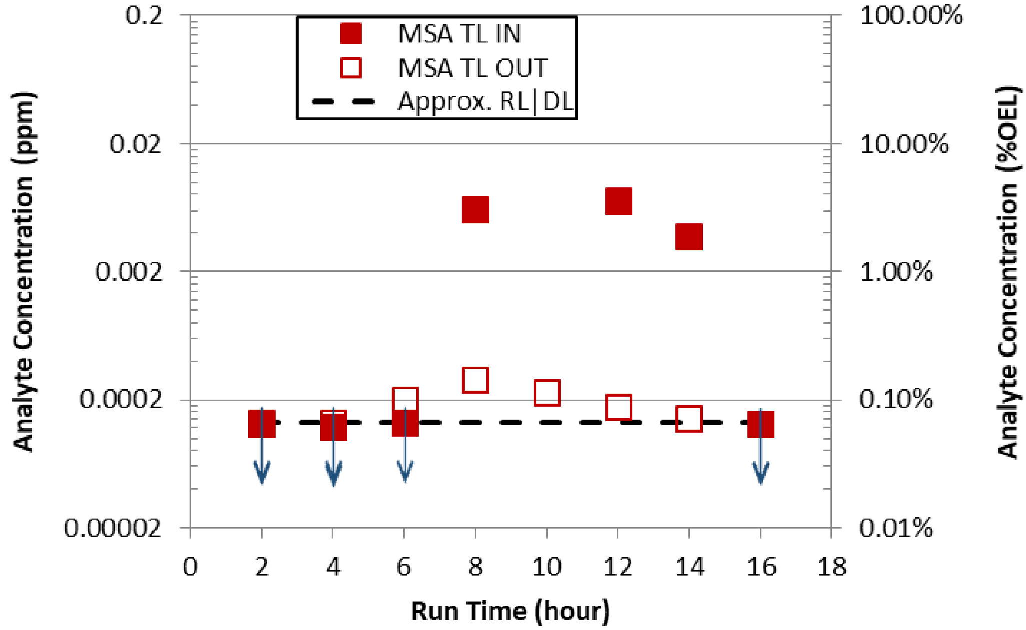


Figure E.4. Plots of Measured 1-Butanol Concentrations before the Inlets and after the Outlets of the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Data points noted with ↓ indicate measurements less than the DL or RL. Outlet data points that are not visible are obscured by the inlet data points.

***3-Butene-2-one** (see Figure E.5)* – The DL for 3-butene-2-one corresponds to 0.07% of its OEL. Some of the measured inlet concentrations for MSA TL cartridge, and all of the measured concentrations for the 3M FR-57 cartridge were higher than the analytical DL, but <3.6% of the OEL. Most of the outlet measurements were greater than analytical DL for both respirator cartridges, but all outlet concentrations were <0.15% of the OEL. Thus, there is no evidence of breakthrough over the measured time period for either cartridge tested.



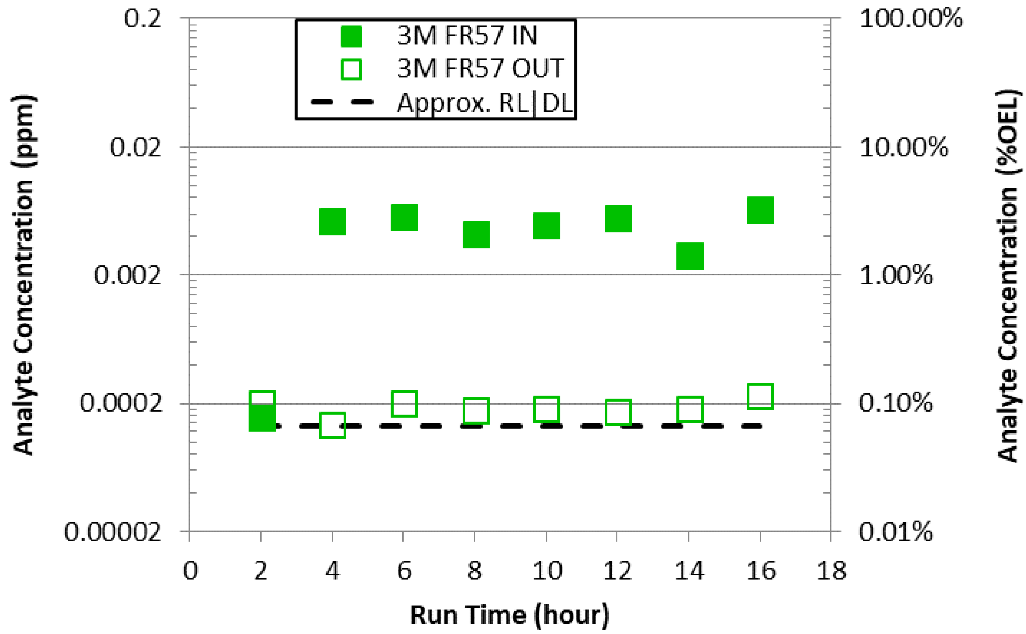


Figure E.5. Plots of Measured 3-Butene-2-one Concentrations before the Inlets and after the Outlets of the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Data points noted with ↓ indicate measurements less than the DL or RL. Outlet data points that are not visible are obscured by the inlet data points.

Formaldehyde (see Figure E.6) – The DL for formaldehyde corresponds to approximately 0.6% of its OEL. For both the MSA TL and 3M FR-57 cartridges, all of the inlet and outlet concentrations measured were higher than the DL, but <10% of the OEL, specifically <3.3%. Based on the outlet data, there is no evidence of breakthrough over the measured time period for either cartridge tested.

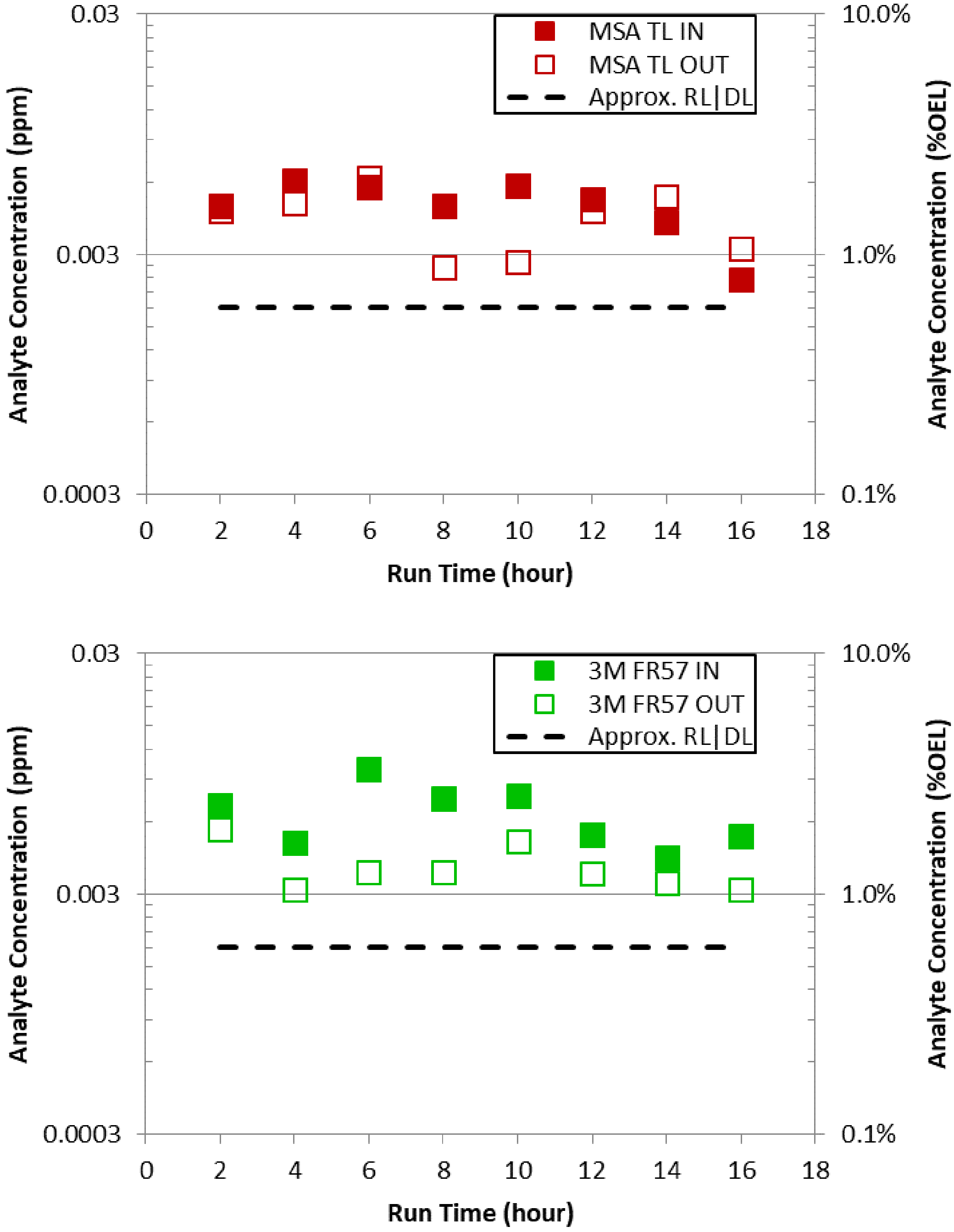


Figure E.6. Plots of Measured Formaldehyde Concentrations before the Inlets and after the Outlets of the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Data points noted with ↓ indicate measurements less than the DL or RL. Outlet data points that are not visible are obscured by the inlet data points.

Acetonitrile (see Figure E.7) – The DL for acetonitrile corresponds to approximately 0.001% of its OEL. For both the MSA TL and 3M FR-57 cartridges, all of the inlet and outlet concentrations measured were higher than the DL but <0.9%, except for the 4-hour and 12-hour outlet measurement for 7422-SC1, which were at 1.7 and 2.8% of the OEL, respectively. Both of these elevated concentration measurements were above the analytical range of the detector and reported as a rough estimate quantitation. Note that the following two outlet measurements (at 14 and 16 hours) were <0.1% of the OEL. Based on this data, there is no evidence of breakthrough over the measured time period for either cartridge tested.

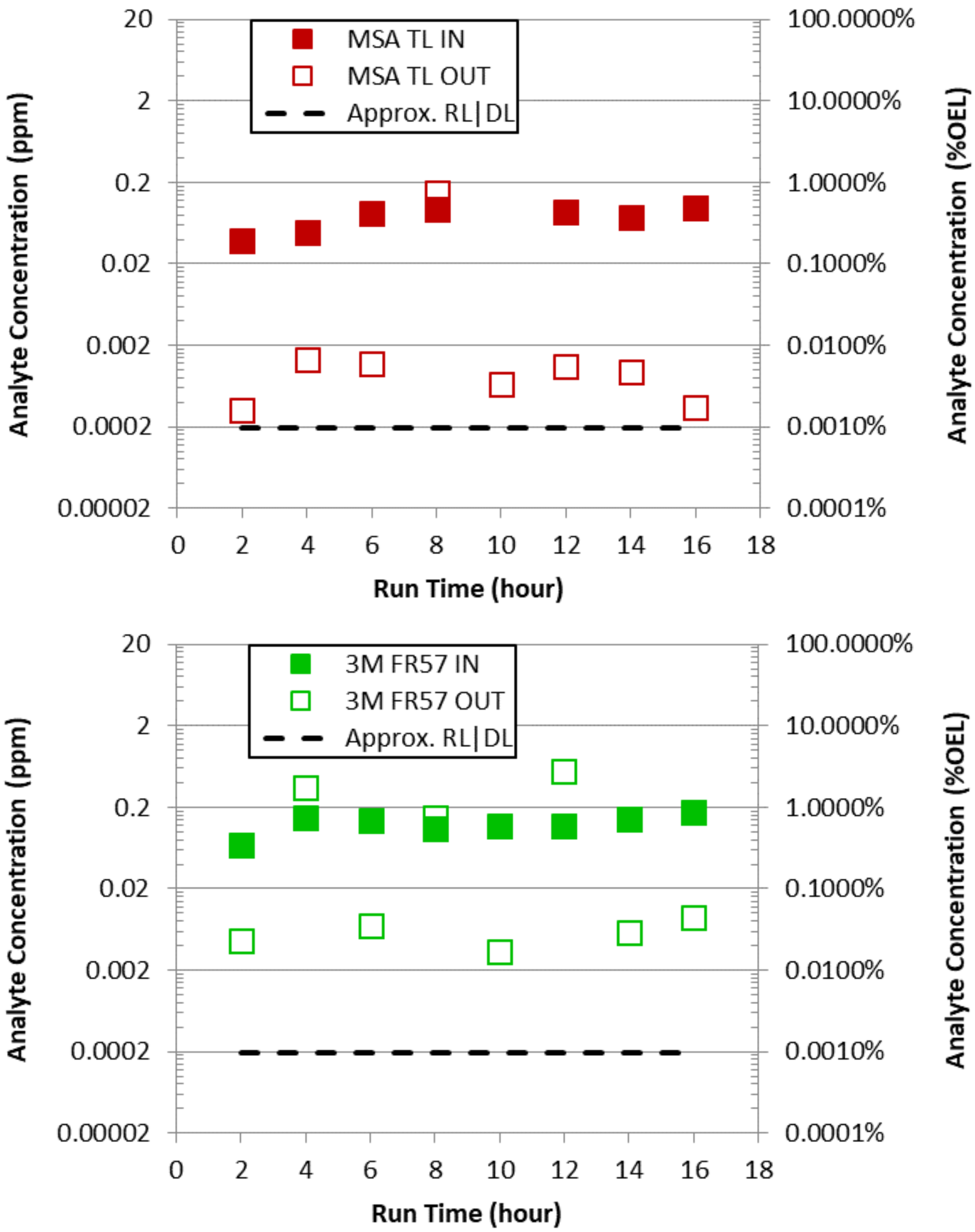


Figure E.7. Plots of Measured Acetonitrile Concentrations before the Inlets and after the Outlets of the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Data points noted with ↓ indicate measurements less than the DL or RL. Outlet data points that are not visible are obscured by the inlet data points.

Appendix F

Historical Data Comparison

Appendix F

Historical Data Comparison

Headspace-characterization data and Industrial Hygiene (IH) data—hereafter referred to as "TWINS HS" and "TWINS IH"—were obtained from the Tank Characterization Database via the Tank Waste Information Network System (TWINS). All vapor analysis results for BY-108 and BY-110 headspaces were obtained via a TWINS query on June 20, 2016, for TWINS HS,[23] and another query on May 9, 2018, for TWINS IH.[24] More recent headspace data also were obtained from the Site-Wide Industrial Hygiene Database (SWIHD) by a query on May 9, 2018, that obtained all headspace data that were present as of that date, producing a set referred to as "SWIHD HS."[25]

F.1 Data Handling and Filtering

For the TWINS IH data set, each line of data in the set represents a measurement made on the contents of a single sorbent tube (or other collector). Frequently, a single sample air stream passed through a series of two or more collectors, which meant that the actual sample concentration was the sum of contributions from all the collectors in the series. The intent of this sample collection method was to have most or all vapor deposited in the first collector, with a relatively small amount of breakthrough into the second collector. The TWINS IH data set currently does not contain explicit information to denote which data came from specific collectors in series or to identify which collectors belong in a set. This absence causes some difficulty in identifying which data should be summed to obtain the true concentration for the sample stream. For the purpose of providing a historical data set for comparison to cartridge data, use of the uncombined raw data was considered to be adequate. Some historical concentration maxima and averages will be underestimated as a result; the underestimates are expected to be within a factor of 2 of the true (summed) concentration value, because in almost all cases there are no more than two collectors in series.

Like the TWINS IH data set, the SWIHD HS data set does not contain explicit information to denote which data came from specific collectors in series or to identify which collectors belong in a set. However, the SWIHD HS samples are recent (2014 to 2016) and have more standardized sample naming conventions than many of the older data in TWINS HS. In addition, the sample volumes reported in TWINS HS all have three or more significant figures. This is crucial because a main identifying feature of samples in series is that they necessarily have identical sample volumes. With the additional information in SWIHD HS, it was possible to plausibly identify which lines of data needed to have concentrations summed to provide the total (true) sample concentrations.

[23] No data have been added to TWINS HS since March 2005, so the June 2016 download does not require updating. TWINS HS downloaded from https://twins.labworks.org/twinsdata/Forms/BuildQuery.aspx?SourceName=vapor.dbo.sp_WEB_TVD_analysis_results&whatsnew=Vapor.

[24] TWINS IH downloaded from https://twins.labworks.org/twinsdata/Forms/BuildQuery.aspx?SourceName=vapor.dbo.v_ih_sampling_results&whatsnew=Vapor

[25] The raw SWIHD headspace sample data came from the same data set for which the Data Access and Visualization Explorer Program provides access. https://www.tankvaporsexplorer.com/

Some historical concentration data were removed from consideration because they were flagged as being "bad" data for the current purpose; that is, they had certain measurement quality issues. TWINS HS data were eliminated from consideration if they were:

- Quality assurance samples (blanks, laboratory control samples, or spikes)
- Marked as suspect (Data Qualifier flag S)
- Associated with a contaminant in a blank, trip blank, or field blank (Data Qualifier flags B, T, or F)
- Marked with a laboratory-defined flag whose meaning was not generically defined and might indicate a serious data-quality issue (Data Qualifier flag Y).

TWINS IH and SWIHD HS data were eliminated from consideration as "bad" if they met any if the following criteria:

- Were associated with a contaminant in a blank (Data Qualifier flag b or B), a laboratory control sample that was out of range (Data Qualifier flag a), or a low-level standard with percent recovery outside the specified range (Data Qualifier flag L)
- Had an excessive relative percent difference between duplicates (Data Qualifier flag c)
- Were marked with a laboratory-defined flag whose meaning was not generically defined and might indicate a serious data-quality issue (Data Qualifier flag Y).

Note that, unlike historical data, cartridge inlet concentration data were not eliminated from consideration if they had the flags listed above. Where there were multiple flags on cartridge inlet concentration data for a chemical, they are discussed in the subsection for that chemical.

TWINS HS results associated with chemicals that were ambiguously identified (e.g., "alkane," "unknown," "C6 ketone") were deleted unless the molecular weight of one of the chemicals could be unambiguously specified (e.g., "octanenitrile and others" was kept). In these mixture cases, where the Chemical ID consisted of a Chemical Abstracts Service number followed by M, the molecular weight of the identified chemical was added to the data record, the Chemical Abstract Service number was used for the Chemical ID, and the concentration was expressed in parts per million (absent from the downloaded database) was calculated from the concentration in milligrams per cubic meter at 25°C and the molecular weight.

Several chemicals in the TWINS IH data set had "needs conversion" notes in the concentration (mg/m^3 and ppm) columns of the database, rather than numbers. It was necessary to use values already in the database to determine these concentrations via ideal-gas calculations (i.e., the molecular weight, the "Reported Value" and its units, and the "Sample Volume" and its units). The temperature and pressure were assumed to be 25°C and 1 atm, respectively.

The method summarized above was consistent with that used by Mahoney and Hoppe (2017), except that below-report measurements—less than the reporting limit (RL) for the analyte—were excluded in PNNL-26820 but were included in this study. More detail of the data processing method is given in PNNL-26820.

For comparison to cartridge tests conducted using gas streams from the BY-108 and BY-110 headspaces, only tank headspace, inlet filter, or breather-filter measurements were considered appropriate. Therefore, the data were filtered to make sure the historical sampling location was similar to the cartridge test sampling location.

The TWINS HS database contained headspace data identified as BY-108 and BY-110 measurements, which were initially considered for this analysis. All of the TWINS HS data for organic compounds and ammonia in these two BY tanks were from measurements made in 1997 or before. Since then, no operational changes in ventilation or the waste inventory have occurred; therefore, the TWINS HS data are considered applicable.

The SWIHD HS database contained headspace data for both BY-108 (three dates in October 2016) and BY-110 (July 28, 2015).

All of the TWINS IH data that had "BY108" or "BY110" noted in the "Location" field of the database were used. Most of the BY-108 data were described as "Riser 12B Headspace" and came from the same October 2016 events that were in SWIHD HS; a few were from 2008–2009 and had survey titles that alluded to "BF" (breather filter), "COPC sampling," or "COPC makeup." The TWINS IH BY-110 data were taken in 2008–2009 and had survey titles that alluded to "BF" or "COPC sampling."

F.2 Data Tabulation

For each of the two tank headspaces, maximum and average[26] headspace concentrations were found for each analyte for the combined TWINS IH and SWIHD HS[(27)] databases. These maxima and averages are given in Table F.1 and Table F.2,[(28)] together with Occupational Exposure Limits (OELs) and counts of the number of samples. The notation "n/a" is used where there were no measurements of the analyte.

Because the TWINS HS data were older, they were considered less representative of the vapors that might have been present during cartridge testing. The practice in other cartridge testing reports has been to omit the TWINS HS from the calculations that support the tables in this appendix, unless the maximum exceeded the OEL and the maximum and average for an analyte were considerably different if they were determined from a combination of all three databases. In such cases, the table gives two rows of results for the chemical; the first row is in plain font for results that do not include TWINS HS data, and the row second in italics for the results that do include the effect of TWINS HS data.

Because the RLs on concentrations in the historical database were generally higher than the RLs or detection limits (DL) in the cartridge tests, it was necessary to analyze data in a way that would let the effect of less-than-RL historical data (a.k.a., below-reports) be recognized. To do this, it was assumed that all of the below-reports in the databases had concentrations equal to the RLs of the measurement. In addition, it was useful to identify situations in which a maximum concentration existed that was singularly high, compared to all other measurements. These kinds of data are shown in Table F.1 and Table F.2 using the conventions described below.

Each entry may be either a single value or one value that is not in parentheses followed by another value that is in parentheses. If there is a single value, it is based only on below-report data if it is preceded by

[26] Arithmetic average

[27] This evaluation used the concentration data in SWIHD HS and converted them to %OEL, rather than directly using the %OEL data in SWIHD HS. Although this approach was consistent with the methods used on the other two data sets, there are cases in which it gave a %OEL value smaller than that found in the SWIHD database. This difference occurs because concentrations in SWIHD HS may be truncated to one or two significant figures, while the %OEL values in SWIHD HS are calculated from concentrations before truncation. The difference between %OEL based on truncated and non-truncated concentrations is small enough to have no effect on conclusions about whether cartridge maxima are consistent with historical maxima.

[28] All %OEL values were calculated from concentration data that had been rounded to a minimum of three significant figures.

“<”; otherwise, it comes only from above-report data. If there are two values the first value is for the overall data set, above-reports and below-reports taken all together. The second, parenthesized value is for above-reports alone. The notation “n/a” indicates when there are no data at all.

The following examples are provided help to clarify this convention:

- If the number of values is given as “46 (35),” there were 46 total data points, 35 above-reports and 11 below-reports (46 – 35).
- If the number of values is a single number such as “6,” the data were either all below-report or all above-report. In this case, if any concentration value has “<” in front of it, all the available data were below-report. If there is no “<” before any concentrations, all data were above-report.
- If the maximum is in a form such as “<0.04 (0.01),” the highest below-report had a RL of 0.04, whereas the highest above-report was only 0.01. It seems counter-intuitive for below-reports to increase the maximum over the above-report value, but it can happen when some measurements were made with less sensitivity (higher RLs) than others.
- If the average is “0.04 (0.01),” the average including below-reports was 0.04, whereas the average for above-reports only was 0.01. The average for the overall data set is preceded by “<” only if all the data were below-reports.

An “!” symbol appended to a concentration indicates that an unusually high data point was the source of a maximum or was a major contributor to a maximum. The “!” symbol was used only in cases where an inspection of the data set showed reason to suspect the high data point—for example, an unusually low sample volume that produced an unusually high RL.

All the notations discussed above apply to the concentration/OEL percentages as well as to the concentrations.

F.3 Identifying Maxima Measured During Disturbances

To better understand the historical maxima, the historical data sets were reviewed to determine which data were taken during planned tank operations that caused waste disturbance or were taken during or just after ventilation system outages.[29]

Note that procedures already in place prevent air-purifying respirators (APR) from being used in downwind areas during certain types of planned operations; for example, waste transfers, other waste-disturbing activities, and ventilation restarts after outages. Tank farm personnel would use equipment that is more protective such as self-contained breathing apparatus or supplied air. Thus, maxima from data taken during these operations need to be recognized as such because they may be less pertinent to the intended purpose of cartridge testing.

[29] Because tanks BY-108 and BY-110 are passively ventilated, they are not subject to ventilation-disturbing operations, which are mentioned only for completeness.

Waste transfers, waste circulation and recirculation, and addition of water from evaporators are considered to be waste-disturbing activities in the discussion in this appendix. Raw water additions also are discussed when present; however, for dates when they are present without waste transfers, they are not taken as waste-disturbing events.[30]

Only TWINS IH data were checked for the presence of disturbance conditions. Headspace data were not so reviewed because it was expected to be rare for headspace sampling to be conducted during planned operations that caused waste disturbances.

The first type of information used to identify waste-disturbing or ventilation-disturbing activities was the title of the Industrial Hygiene survey in the TWINS IH database. Surveys were considered to reflect waste-disturbing operations if their titles included a reference to "retrieval," "transfer," "tank Y to tank Z," "Z% complete" (referring to a retrieval), ALC (air-lift circulator), recirculation, portable exhausters on single-shell tanks, or the 242-A evaporator (implying an ongoing evaporation campaign). However, if the title also included the words "baseline," "re," or "start," the survey was considered to precede transfer operations and to not include the effects of waste disturbance.

The information in the survey title was tested and supplemented by consulting the TWINS databases of tank transfers (pre-2001 and post-2000).[31] These databases are related to Best Basis Inventory[32] determinations and focus on activities that change the waste inventories in tanks. They do not include any information about ventilation disturbances, and only include information on in-tank recirculation if it indirectly changed the inventory (e.g., by inducing a gas release).

F.4 Comparison with Historical Data – Approach

The maximum and average COPC concentrations measured during powered air-purifying respirator (PAPR) and APR cartridge testing in February 2018 were compared to the maximum and average historical concentrations. Where differences were found, the historical data were examined for explanations in the type or circumstances of sampling (e.g., waste-disturbing operations).

The cartridge inlet concentrations discussed in the following sections include (as appropriate) above-report concentrations, below-report concentrations (in which case RLs were used for comparison), and below-detects (in which case DLs were used for comparison). The use of below-detect versus below-report depends on the type of sample analysis performed on the cartridge inlet samples. For more background, see Appendix D of Freeman et al. 2017, which discusses the difference between DLs and RLs for furans.

PAPR cartridges were tested using the BY-108 headspace gas stream, and APR cartridges were tested using the BY-110 headspace gas stream. The maximum cartridge inlet concentrations for the two types of APR cartridges (SD1 and SC1) and the two types of PAPR cartridges (TL1 and TL2) are not discussed separately.

[30] This definition of "waste-disturbing activities" is intended strictly for historical data comparison purposes and is more extensive than the typically used at Hanford, which includes liquid waste transfers, operating air lift circulators, solid waste retrievals, transfer pump recirculation, and large water additions. The definition for present purposes may sometimes also include water additions that are considered small.

[31] See the "Tank Transfers" menu item under https://twins.labworks.org/twinsdata/Forms /About.aspx. Note that many entries in these databases refer to inventory changes caused not by a waste-affecting operation but by re-baselining, changes in inventory calculation assumptions, changes in level instrumentation, etc. Some (not all) spontaneous gas releases also are included.

[32] The Best-Basis Inventory (BBI) establishes the inventory of the underground waste storage tanks at Hanford by using sample data, process knowledge, surveillance data, and waste stream composition information from the Hanford Defined Waste (HDW) computer model (Agnew et al. 1997).

The larger discrepancies, or apparent discrepancies, between historical data and cartridge inlet concentrations are discussed below. Discrepancies are discussed if the cartridge inlet concentration appeared to be low compared to historical maxima that, if present, might have been more of a challenge to the cartridge. The criteria for this condition are 1) the historical concentration of a compound was >10% of the OEL and 2) the cartridge inlet concentration was between 20% and 50% of the historical value. However, discrepancies are considered significant only if the historical concentration was >10% of the OEL and the cartridge inlet concentration is <20% of the historical value. In addition, if ammonia, mercury, nitrous oxide, and nitrosamines had cartridge inlet concentrations or historical concentrations that were >10% of the OEL, they are also included below (even if not discrepant by the above definition) because these compounds are of general interest.

In cases where the cartridge inlet concentration (maximum or average) was below the RL or the DL, the RL or DL is used as a basis for comparison. The same approach is taken for historical concentrations that were below the RL ("below-report", or "<RL").

A comparison between cartridge inlet and historical maximum concentrations is made in the following sections. Because the PAPR cartridge tests were the second time cartridge inlet concentrations have been measured at tank BY-108—the first campaign being in July 2016 [Nune et.al. 2020—the concentrations measured in the earlier campaign are also discussed.

F.5 Comparison with BY-110 Historical Data

BY-110 has been inactive throughout the period of record for which historical vapor concentration data have been collected. Regarding waste disturbances, it must be noted that BY Farm tanks are arranged in six-tank cascades that tie three tanks in BX Farm to three tanks in BY Farm. Tanks BX-110, BX-111, BX-112, BY-110, BY-111, and BY-112 are connected with each other by overflow lines through which vapors may move from one tank headspace to another (Huckaby et al. 2004). Thus, it would have been physically possible for waste disturbances in any of five other tanks to have affected vapor concentrations in BY-110. However, there were no waste-disturbing operations in any of the tanks of the BY-110-related cascades in the period during which vapor data were recorded. Hence, none of the data available for BY-110 were taken during waste-disturbing conditions.

F.5.1 Ammonia – BY-110

The maximum APR cartridge inlet concentration was 943% of the OEL. This cartridge inlet maximum is lower than the historical maximum concentration of 426 ppm (1704% of the OEL). This historical data point comes from the TWINS HS database and was measured on November 11, 1994. The only BY-110 ammonia measurement in the SWIHD HS database is 438 ppm, but this 2015 value is suspect because of a Y data-quality flag. The only other measurement is in TWINS IH, a 1.11 ppm concentration (4% of OEL) measured on April 8, 2008 at a breather filter. The cartridge inlet maximum is >50% of the historical maximum and, therefore, is not considered significantly different.

F.5.2 Nitrous Oxide – BY-110

Nitrous oxide was not measured in cartridge testing. The relatively recent historical maximum in TWINS IH, 2.88 ppm (5.76% of the OEL) was measured at the breather filter in 2009. The maximum above-report concentration in the TWINS HS database was 125 ppm (250% of the OEL); it was measured in November 1994.

F.5.3 Mercury – BY-110

The maximum APR cartridge inlet concentration was below the RL of 8.09% of the OEL. The historical measurements were both below-reports, with the maximum RL being 0.0030 mg/m^3 (concentration <12.0% of the OEL). This measurement came from SWIHD HS and was taken in July 2015. The cartridge inlet maximum may be consistent with the historical maximum, but this is uncertain because there are no above-report historical data.

F.5.4 1,3-Butadiene – BY-110

The maximum APR cartridge inlet concentration was a below-report with a RL of 3.87% of the OEL. This is low compared to the historical maximum concentration, which comes from SWIHD HS and was taken in July 2015. It had a concentration of 2.58 ppm (258% of the OEL). The maximum cartridge inlet concentration was much <20% of the maximum historical measurement and, therefore, was significantly below the historical record.

F.5.5 Furan – BY-110

The maximum APR cartridge inlet concentration of 168% of the OEL is less than the maximum in the SWIHD HS database, which is 2.95 ppb (295% of the OEL). This concentration came from a sample taken on July 28, 2015. The Carbotrap 300 TDU method was used to measure both the cartridge-inlet and historical maxima. The cartridge inlet maximum is >50% of the historical maximum and, therefore, is not considered significantly different.

F.5.6 2,3-Dihydrofuran, 2,5-Dihydrofuran – BY-110

For both 2,3-dihydrofuran (measured by the furans method) and 2,5-dihydrofuran (measured by the Carbotrap 300 TDU method), the APR cartridge inlet concentrations were below the DL of 3.34% of the OEL and 23.4% of the OEL, respectively. These values are much less than the above-report historical maxima, 3.09 ppb (309% of the OEL) and 4.57 ppb (457% of the OEL), respectively. These historical maxima were 2015 SWIHD HS data, with concentrations measured by the furans method. The maximum cartridge inlet concentrations were much less than 20% of the maximum historical measurements and, therefore, were significantly below the historical record.

F.5.7 2-Methylfuran, 2,5-Dimethylfuran, 2-Pentylfuran, 2-Heptylfuran, 2-Propylfuran – BY-110

The APR cartridge inlet maximum was 10.6% of the OEL for 2-methylfuran (measured by the Carbotrap 300 TDU method), while the cartridge inlet maxima for 2,5-dimethylfuran, 2-pentylfuran, 2-heptylfuran, and 2-propylfuran (measured using the furans method) were less than the DL of ~3% of the OEL (or 1.88% of the OEL, for 2-propylfuran). All of the historical maxima were below-reports with RLs in the range of ~15 to 26% of the OEL, except that the 2-methylfuran RL was 206% of the OEL.

There were no above-report historical data, so no conclusion can be drawn about where the cartridge inlet concentrations lie with respect to historical data.

F.5.8 Acetonitrile – BY-110

The maximum APR cartridge inlet concentration of 1.12% of the OEL (measured by the Carbotrap 300 TDU method) is much lower than the historical maximum of 5.37 ppm (26.9% of the OEL) measured in July 2015. This historical maximum comes from SWIHD HS and was made using the acetonitrile method. The maximum APR cartridge inlet concentration, which was measured by the Carbotrap 300 TDU method, is <20% of the historical maximum and is considered significantly less than the historical measurement.

F.5.9 N-nitrosodimethylamine (NDMA), N-nitrosodiethylamine (NDEA), N-nitrosomethylethylamine (NMEA), N-nitrosomorpholine – BY-110

The APR cartridge inlet concentration maxima were 1874% of the OEL for NDMA, 150% of the OEL for NDEA, 252% OEL for NMEA, and a below-report with a RL of 1.66% of the OEL for N-nitrosomorpholine. The historical maxima, all of which were below-reports, had RLs ranging from ~15 to 39% OEL for NDMA, NDEA, and NMEA, and an RL of 6% for N-nitrosomorpholine. These maxima came from the SWIHD HS database for a headspace sample taken in July 2015. The cartridge inlet maxima are much higher than the historical maxima for NDMA, NDEA, and NMEA. For N-nitrosomorpholine, historical and cartridge-inlet data were consistent to the extent that both were below the RL, with similar values of the RL; there is no evidence of significant difference.

Most of the NDMA inlet concentrations for both APR cartridges had multiple data-quality flags, “BL” for all eight measurements from cartridge SC1, and “DL” or “DEL” for the seven highest concentrations from cartridge SD1. The maximum APR cartridge inlet concentration had the “DEL” flags, indicating that the sample had been diluted to bring it within the calibration but the concentration remained above calibration range; in addition, the calibration at the low end of the range was outside specifications.

F.5.10 Dibutyl Butylphosphonate (DBBP) – BY-110

The maximum APR cartridge inlet concentration is below its DL of 0.38% of the OEL. The historical maximum concentration was a SWIHD HS below-report datum with an RL of 0.0003 ppm (<4.29% of the OEL). There were also below-report historical data in TWINS HS, dating from 1994. The highest of the RLs in TWINS HS was 0.0179 ppm (256% of the OEL), while others measured using the same method had RLs a factor of ~5 less, making the maximum RL in TWINS HS questionable. There were no above-report historical data, so no conclusion can be drawn about where the cartridge inlet concentrations lie with respect to historical data.

F.5.11 Summary of Historical Data Comparisons – BY-110 Headspace

In summary, the APR cartridge inlet concentrations for the BY-110 headspace that were substantially lower than historical data can be described as follows:

- Differences that arose from using historical data taken during disturbance as the historical maximum: none.
- Differences that arose from using the RLs of below-report data for the historical maximum: none.
- Differences that arose from using data for vapor produced by a no-longer-existing inventory for the historical maximum: none.

- Differences that could not be resolved because of the scarcity of non-disturbance above-report data: mercury, 2-methylfuran, 2,5-dimethylfuran, 2-heptylfuran, 2-propylfuran, 2-pentylfuran, dibutyl butylphosphonate.
- Cartridge inlet concentrations that were determined to be significantly lower than above-report historical concentrations: 1,3-butadiene, 2,3-dihydrofuran, 2,5-dihydrofuran, acetonitrile.

Table F.1. COPC Comparison to Historical BY-110 Headspace Measurements

COPC Number	COPC Name	CAS Number	Boiling Point (°F)	Boiling Point Source	Occupational Exposure Limit (OEL)	Historical Measurements[1]					Measurements in this study			
						Number of Values	Maximum Value (in OEL units)	Average Value (in OEL units)	Maximum Value (%OEL)	Average Value (%OEL)	Max Inlet (%OEL)	Avg. Inlet (%OEL)	Max outlet (%OEL)	Approx. DL[12] (%OEL)
Inorganic														
1	Ammonia	7664-41-7	-28	Poling et al., 2007[2]	25 ppm	1	1.11	1.11	4.44%	4.44%	943%	571%	1043%	2.29% (RL)
						7	*426*	*344*	*1704%*	*1376%*				
2	Nitrous Oxide	10024-97-2	-127	Poling et al., 2007	50 ppm	1	2.88	2.88	5.76%	5.76%	Not Measured			
						4	*125*	*78.2*	*250%*	*156%*				
3	Mercury	7439-97-6	674	Poling et al., 2007	0.025 mg/m^3	2	<0.003	<0.002	<12.0%	<7.40%	<RL	<RL	<RL	8.09% (RL)
Hydrocarbons														
4	1,3-Butadiene	106-99-0	24	Poling et al., 2007	1 ppm	3 (1)	2.58	0.873 (2.58)	258%	87.3% (258%)	<RL	<RL	<RL	3.87% (RL)
5	Benzene	71-43-2	176	Poling et al., 2007	0.5 ppm	3 (1)	0.008	0.004 (0.008)	2%	0.83% (1.60%)	0.35%	0.097%	0.15%	0.022%
6	Biphenyl	92-52-4	491	Poling et al., 2007	0.2 ppm	3	<0.0005	<0.0005	<0.25%	<0.23%	<DL	<DL	<DL	0.026%
Alcohols														
7	1-Butanol	71-36-3	243	NIOSH[3]	20 ppm	3	0.078	0.028	0.39%	0.14%	1.69%	0.11%	<DL	0.003%
8	Methanol	67-56-1	148	Poling et al., 2007	200 ppm	1	<1.53	<1.53	<0.77%	<0.77%	Not Measured			
Ketones														
9	2-Hexanone	591-78-6	262	NIOSH	5 ppm	3 (1)	0.042	0.015 (0.042)	0.84%	0.30% (0.84%)	0.14%	0.019%	<DL	0.001%
10	3-Methyl-3-butene-2-one	814-78-8	208	CRC Handbook 1989[4]	0.02 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC[11]			
11	4-Methyl-2-hexanone	105-42-0	282	Predicted ACD/Labs[5]	0.5 ppm	1	0.005	0.005	1.00%	1.00%	0.12%	0.024%	<DL	0.016%
12	6-Methyl-2-heptanone	928-68-7	333	Predicted ACD/Labs	8 ppm	0	n/a	n/a	n/a	n/a	0.042%	<DL	<DL	TIC[14]
13	3-Buten-2-one	78-94-4	179	CRC Handbook 1989	0.2 ppm	3	<0.002	<0.002	<1.23%	<0.98%	2.54%	0.74%	0.13%	0.070%
Aldehydes														
14	Formaldehyde	50-00-0	-6	NIOSH	0.3 ppm	2 (1)	0.019	0.010 (0.019)	6.33%	3.43% (6.33%)	2.08%	1.07%	1.45%	0.57% (RL)
15	Acetaldehyde	75-07-0	69	NIOSH	25 ppm	2 (1)	0.24	0.18 (0.24)	0.96%	0.70% (0.96%)	0.38%	0.32%	0.11%	0.005% (RL)
16	Butanal	123-72-8	167	Oxford safety data[6]	25 ppm	5 (2)	0.083	0.033 (0.046)	0.33%	0.13% (0.18%)	0.57%	0.039%	<DL	0.002%
17	2-Methyl-2-butenal	1115-11-3	244	United Nations[7]	0.03 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC[11]			
18	2-Ethyl-hex-2-enal	645-62-5	347	Predicted ACD/Labs	0.1 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
New[15]	2-Propenal	107-02-8	127	NIOSH	0.1 ppm	1	<0.0009	<0.0009	<0.90%	<0.90%	<DL	<DL	<DL	0.96%

Table F.1. BY-110 (continued)

COPC Number	Name	CAS Number	Boiling Point (°F)	Boiling Point Source	Occupational Exposure Limit (OEL)	Historical Measurements[1]					Measurements in this study			
						Number of Values	Maximum Value (in OEL units)	Average Value (in OEL units)	Maximum Value (%OEL)	Average Value (%OEL)	Max Inlet (%OEL)	Avg. Inlet (%OEL)	Max outlet (%OEL)	Approx. DL[12] (%OEL)
Furans														
19	Furan	110-00-9	88	Poling et al., 2007	1 ppb	4 (2)	2.95	2.16 (1.71)	295%	216% (171%)	168%	31.9%	<DL	DL | RL[12] 13.5% | 116%[13]
20	2,3-Dihydrofuran	1191-99-7	130	Alfa Aesar[8]	1 ppb	1	3.09	3.09	309%	309%	<DL	<DL	<DL	3.34% | 19.9%
21	2,5-Dihydrofuran	1708-29-8	152	Aldrich[9]	1 ppb	4 (1)	4.57	2.74 (4.57)	457%	274% (457%)	<DL	<DL	43.8%	23.4% | 112%[13]
22	2-Methylfuran	534-22-5	147	Oxford safety data	1 ppb	4	<2.06	<1.39	<206%	<139%	10.6%	<DL	<DL	8.78% | 95.8%[13]
23	2,5-Dimethylfuran	625-86-5	199	Alfa Aesar	1 ppb	1	<0.26	<0.26	<25.8%	<25.8%	<DL	<DL	<DL	3.14% | 14.5%
24	2-Ethyl-5-methylfuran	1703-52-2	246	Predicted ACD/Labs	1 ppb	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
25	4-(1-Methylpropyl)-2,3-dihydrofuran	34379-54-9	328	Predicted ACD/Labs	1 ppb	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
26	3-(1,1-Dimethylethyl)-2,3-dihydrofuran	34314-82-4	306	Predicted ACD/Labs	1 ppb	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
27	2-Pentylfuran	3777-69-3	333	Alfa Aesar	1 ppb	1	<0.18	<0.18	<18.0%	<18.0%	<DL	<DL	<DL	3.16% | 10.1%
28	2-Heptylfuran	3777-71-7	410	Alfa Aesar	1 ppb	1	<0.15	<0.15	<14.9%	<14.9%	<DL	<DL	<DL	2.98% | 8.40%
29	2-Propylfuran	4229-91-8	231	Alfa Aesar	1 ppb	1	<0.23	<0.23	<22.6%	<22.6%	<DL	<DL	<DL	1.88% | 12.7%
30	2-Octylfuran	4179-38-8	452	Predicted ACD/Labs	1 ppb	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
31	2-(3-Oxo-3-phenylprop-1-enyl)furan	717-21-5	605	Predicted ACD/Labs	1 ppb	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
32	2-(2-Methyl-6-oxoheptyl)furan	51595-87-0	Not available	Not available	1 ppb	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
Phthalates														
33	Diethylphthalate	84-66-2	563	NIOSH	5 mg/m^3	3	<0.003	<0.003	<0.060%	<0.057%	0.016%	0.011%	0.035%	0.011%

Table F.1. BY-110 (continued)

						Historical Measurements[1]					Measurements in this study			
COPC Number and Name		CAS Number	Boiling Point (°F)	Boiling Point Source	Occupational Exposure Limit (OEL)	Number of Values	Maximum Value (in OEL units)	Average Value (in OEL units)	Maximum Value (%OEL)	Average Value (%OEL)	Max Inlet (%OEL)	Avg. Inlet (%OEL)	Max outlet (%OEL)	Approx. DL[12] (%OEL)
Nitriles														
34	Acetonitrile	75-05-8	179	NIOSH	20 ppm	4 (3)	5.37	1.47 (1.86)	26.9%	7.35% (9.30%)	1.12%	0.20%	3.91%	0.001%
35	Propanenitrile	107-12-0	207	NIOSH	6 ppm	3 (1)	0.014	0.0061 (0.014)	0.23%	0.10% (0.23%)	0.050%	0.014%	<DL	0.003%
36	Butanenitrile	109-74-0	244	NIOSH	8 ppm	3 (1)	0.012	0.0057 (0.012)	0.15%	0.071% (0.15%)	0.15%	0.022%	0.006%	0.001%
37	Pentanenitrile	110-59-8	284	Alfa Aesar	6 ppm	3	<0.002	<0.002	<0.035%	<0.028%	0.025%	0.005%	<DL	0.002%
38	Hexanenitrile	628-73-9	328	Predicted ACD/Labs	6 ppm	3 (1)	0.004	0.0025 (0.004)	0.067%	0.042% (0.067%)	0.017%	0.002%	<DL	0.001%
39	Heptanenitrile	629-08-3	368	Alfa Aesar	6 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
40	2-Methylene butanenitrile	1647-11-6	Not available	Not available	0.3 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
41	2,4-Pentadienenitrile	1615-70-9	278	Predicted ACD/Labs	0.3 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
Amines														
42	Ethylamine	75-04-7	62	Poling et al., 2007	5 ppm	2	<0.018	<0.018	<0.36%	<0.36%	0.88%	0.53%	0.55%	0.092% (RL)
Nitrosamines														
43	N-Nitrosodimethylamine	62-75-9	306	NIOSH	0.3 ppb	2	<0.054	<0.032	<18.0%	<10.5%	1874%	895%	8.58%	5.15% (RL)
44	N-Nitrosodiethylamine	55-18-5	351	Oxford safety data	0.1 ppb	2	<0.039	<0.023	<39.0%	<22.8%	150%	106%	<RL	10.3% (RL)
45	N-Nitrosomethylethylamine	10595-95-6	310	Predicted ACD/Labs	0.3 ppb	2	<0.046	<0.027	<15.3%	<8.97%	252%	171%	6.73%	3.98% (RL)
46	N-Nitrosomorpholine	59-89-2	435	Oxford safety data	0.6 ppb	2	<0.035	<0.020	<5.83%	<3.38%	<RL	<RL	<RL	1.66% (RL)
Organophosphates														
47	Tributyl phosphate	126-73-8	552	NIOSH	0.2 ppm	3	<0.0003	<0.0003	<0.15%	<0.137%	<DL	<DL	<DL	0.034%
48	Dibutyl butylphosphonate	78-46-6	602	Predicted ACD/Labs	0.007 ppm	3 *7*	<0.0003 *<0.018*	<0.0003 *<0.004!*	<4.29% *<256%*	<4.16% *<60.3%!*	<DL	<DL	<DL	0.38%
Halogenated														
49	Chlorinated Biphenyls	Varies	Varies	Varies	1 mg/m^3	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
50	2-Fluoropropene	1184-60-7	-11	SynQuest[10]	0.1 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
Pyridines														
51	Pyridine	110-86-1	240	NIOSH	1 ppm	5 (1)	<0.007 (0.003)	0.004 (0.003)	<0.66% (0.30%)	0.41% (0.30%)	0.12%	0.018%	<RL	0.007% (RL)
52	2,4-Dimethylpyridine	108-47-4	318	Alfa Aesar	0.5 ppm	5	<0.005	<0.003	<1.01%	<0.56%	0.033%	0.011%	<RL	0.010% (RL)

Table F.1. BY-110 (continued)

	COPC Number and Name	CAS Number	Boiling Point (°F)	Boiling Point Source	Occupational Exposure Limit (OEL)	Historical Measurements[1]					Measurements in this study			
						Number of Values	Maximum Value (in OEL units)	Average Value (in OEL units)	Maximum Value (%OEL)	Average Value (%OEL)	Max Inlet (%OEL)	Avg. Inlet (%OEL)	Max outlet (%OEL)	Approx. DL[12] (%OEL)
Organonitrites														
53	Methyl nitrite	624-91-9	10	Oxford safety data	0.1 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
54	Butyl nitrite	544-16-1	172	Alfa Aesar	0.1 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
Organonitrates														
55	Butyl nitrate	928-45-0	276	Predicted ACD/Labs	2.5 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
56	1,4-Butanediol, dinitrate	3457-91-8	499	Predicted ACD/Labs	0.05 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
57	2-Nitro-2-methylpropane	594-70-7	260	Alfa Aesar	0.3 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
58	1,2,3-Propanetriol, 1,3-dinitrate	623-87-0	338	Predicted ACD/Labs	0.05 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
Isocyanates														
59	Methyl Isocyanate	624-83-9	103	NIOSH	0.02 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
Organometallic														
New[15]	Dimethylmercury	593-74-8	200	NIOSH	0.010 mg/m^3 (as Hg)	0	n/a	n/a	n/a	n/a	Not Measured			

[1] Historical data from TWINS industrial hygiene vapor database and SWIH database, as applicable; see text for links and dates of queries.

Plain font in the table indicates that only the recent databases (SWIHD headspace and TWINS Industrial Hygiene, as applicable) were included. Italics, if present, mean that the pre-2006 TWINS headspace data were also included.

"n/a" indicates no historical data was found in the databases

Values in parenthesis "( )", if present, indicate the maximum or average reported (detected) value >RL or >DL.

"!", if present, indicates a maximum RL that came from a sample with a volume less than 0.5 L or from a sample whose RL, for undiscernible reasons, was a factor of 5 or more high compared to other samples measured using the same analytical method.

"<RL", "<DL", or "<" indicates that all pertinent measurements of the analyte were less than the reporting or detection limit

[2] Poling, B. E.; Prausnitz, J. M.; O'Connell, J. P. The Properties of Gases and Liquids. McGraw Hill, 2007.

[3] NIOSH: National Institute of Occupational Safety and Health

[4] CRC Handbook of Chemistry and Physics, CRC Press, 1989.

[5] ACD/Labs software http://www.acdlabs.com/products/percepta/predictors.php

[6] Oxford safety data from The Physical and Theoretical Chemistry Laboratory at Oxford University

[7] Food and Agriculture Organization of the United Nations

[8] Alfa Aesar: https://www.alfa.com/

[9] Aldrich: https://www.sigmaaldrich.com/

[10] SynQuest: http://synquestlabs.com/product/id/8330.html

[11] TIC: Tentatively Identified Compounds that were not observed in this study using the specified analytical methods.

[12] Approximate Detection Limit (DL) is calculated using the reported detection limit (or reporting limit - RL where noted) from the analytical laboratory and the average volume (from flowrate x time) of vapor exposed to the sorbent tube. For Furans, both DL and RL values are reported as "DL / RL".

[13] Furans measured using VOA (Volatile Organic Analysis) method.

[14] TIC (see footnote 11) do not have analytical calibration standards or quantified detection limits. Mass and concentration are estimates only.

[15] 2-Propenal and Dimethyl Mercury were added to the COPC List in September, 2017.

F.6 Comparison with BY-108 Historical Data

BY-108 has been inactive throughout the period of record for which historical vapor concentration data have been collected. Regarding waste disturbances, it must be noted that BY Farm tanks are arranged in six-tank cascades that tie three tanks in BX Farm to three tanks in BY Farm. Tanks BX-107, BX-108, BX-109, BY-107, BY-108, and BY-109 are connected with each other by overflow lines through which vapors may move from one tank headspace to another (Huckaby et al. 2004). Thus, it would have been physically possible for waste disturbances in any of five other tanks to have affected vapor concentrations in BY-108. However, there were no waste-disturbing operations in any of the tanks of the BY-108-related cascades in the period during which vapor data were recorded. Hence none of the available data for BY-108 were taken during waste-disturbing conditions.

F.6.1 Ammonia – BY-108

The maximum PAPR cartridge inlet concentration was 767% of the OEL. This cartridge inlet maximum is low compared to the historical maximum concentration of 644 ppm (2576% of the OEL). This historical data point comes from the TWINS IH database, which contains only one ammonia datum, and was a breather-filter measurement made on July 14, 2009. For comparison, five October 2016 samples in SWIHD HS contained 367 to 441 ppm of ammonia. The cartridge inlet maximum falls between 20% and 50% of the historical maximum, but not below the 20% level that is considered significantly below historical.

Note: The cartridge inlet concentration maximum measured during the July 2016 cartridge tests (Nune et al 2017) was 1915% of the OEL, more than twice the PAPR cartridge inlet maximum.

F.6.2 Nitrous Oxide – BY-108

Nitrous oxide was not measured in cartridge testing. The relatively recent historical maximum in TWINS IH, 1.80 ppm (3.60% of the OEL) was measured at the breather filter in 2009. The maximum above-report concentration in the TWINS HS database was 831 ppm (1662% of the OEL); it was measured in September 1996.

F.6.3 Mercury – BY-108

The maximum PAPR cartridge inlet concentration was 27.3% of the OEL. The value is low compared to the historical maximum, 0.0170 mg/m^3 (concentration 68.0% of the OEL). This measurement came from SWIHD HS and was taken in October 2016. The cartridge inlet maximum falls between 20% and 50% of the historical maximum, but not below the 20% level that is considered significantly below historical.

Note: The cartridge inlet concentration maximum measured during the July 2016 cartridge tests was 52.0% of the OEL, about twice the PAPR cartridge inlet maximum.

F.6.4 1,3-Butadiene – BY-108

The maximum PAPR cartridge inlet concentration was a below-report with an RL of 3.82% of the OEL. This is low compared to the historical maximum concentration, which comes from TWINS IH and was taken on April 8, 2008. It had a concentration of 3.38 ppm (338% of the OEL). For comparison, six October 2016 samples in SWIHD HS contained 1.79 to 2.64 ppm of butadiene. The 10 above-reports in TWINS HS were taken between 1994 and 1997 and ranged from 0.0430 ppm to 0.174 ppm (4.30 to 17.4% of the OEL)). The maximum cartridge inlet concentration was much <20% of the maximum historical measurement, and therefore was significantly below the historical record.

Note: the PAPR cartridge inlet concentration measured in these tests was about a factor of 40 below the 138% of the OEL maximum inlet concentration measured during the July 2016 cartridge tests.

F.6.5 Benzene – BY-108

The maximum PAPR cartridge inlet concentration of 0.48% of the OEL is low compared to the historical maximum concentration, a below-report datum that had an RL of 0.0529 ppm (10.6% of the OEL). This RL was for a September 17, 2009 sample in TWINS IH whose volume was small (0.15 L), producing an unusually high RL. The maximum relatively recent above-report concentration, excluding TWINS HS data, was 0.0100 ppm (2.00% of the OEL), found in the SWIHD HS database and measured in October 2016. The numerous above-report historical data in TWINS HS, which were collected between 1994 and 1997, ranged from 0.0160 ppm to 0.189 ppm (up to 37.9% of the OEL).[33] The maximum cartridge inlet concentration is slightly >20% of the recent historical maximum in SWIHD HS, and <20% of the older historical maximum in TWINS HS. The cartridge inlet maximum is considered to be significantly less than the historical maxima.

Note: The cartridge inlet concentration maximum measured during the July 2016 cartridge tests was 0.86% of the OEL, approximately twice the PAPR cartridge inlet maximum.

F.6.6 1-Butanol – BY-108

The maximum PAPR cartridge inlet concentration of 2.76% of the OEL is <20% of the TWINS IH maximum of 4.32 ppm (21.6% OEL) found from 2009 breather-filter data. It is also much lower than the 63.5 ppm (318% of the OEL) measured in the headspace on October 27, 1994. The above-report TWINS HS headspace data collected on other dates between 1994 and 1997 were between 4.40 and 22.1 ppm (22.0 to 110% of the OEL). The cartridge inlet concentration is <20% of historical high concentrations and therefore is considered to be significantly less than the historical maxima.

All of the above-reported PAPR cartridge inlet data have multiple data-quality flags, “ELQYa” or “ELQYac”, indicating measurements made above the calibration range with spike recovery outside its specified range. The “EY” portion of the set of flags means that concentrations are probably in the range where the instrument response is no longer linear and may be underestimates. The “Q” indicates data are qualitative only. However, it is unlikely that the flags mean that actual concentrations were high enough to change the conclusion that cartridge inlet maxima were significantly less than historical maxima.

Note: The cartridge inlet concentration maximum measured during the July 2016 cartridge tests was 5.02% of the OEL, which is approximately twice the PAPR cartridge inlet maximum. These also had multiple flags, “EY” or “ELY”, and were above the calibration range.

F.6.7 Acetaldehyde – BY-108

The maximum PAPR cartridge inlet concentration of 0.52% of the OEL is lower than the maximum of 2.8 ppm (11.3% of the OEL) that was measured on April 8, 2008. This was the only measurement in TWINS IH. No data were found in TWINS HS, and the October 2016 SWIHD HS maximum was 0.302 ppm (1.21% of the OEL). The cartridge inlet concentration is <20% of the historical maximum and is considered significantly less than historical, with the caveat that several recent headspace concentrations were close to the cartridge inlet maximum.

Note: The cartridge inlet concentration maximum measured during the July 2016 cartridge tests was 1.12% of the OEL, about twice the PAPR cartridge inlet maximum.

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[33] The TWINS HS maximum of 37.9% of the OEL does not appear in Table F.2 because it does not fully meet the criteria for display: it is greater than 3× the maximum in more recent historical data, but it does not exceed the OEL.

F.6.8 Furan – BY-108

The maximum PAPR cartridge inlet concentration of 576% of the OEL is much lower than the maximum in the TWINS IH database, which is a below-report with an RL of 58.3 ppb (<5830% of the OEL). This high RL came from a 0.15-L sample taken on September 17, 2009. The cartridge inlet concentration also was much lower than the only above-report concentration in the TWINS HS database, 547 ppb (54,700% of the OEL), which was measured in the headspace in 1994. The only above-report concentration in the TWINS IH database was 10.4 ppb (1036% of the OEL), which was measured in a 1-L sample taken at a breather filter on September 17, 2009. In the SWIHD HS database, the maximum concentration was 18.4 ppb (1840% of the OEL) in October 2016. The cartridge inlet concentration is <20% of the oldest historical maximum but is within the range of 20 to 50% of the more recent above-report maximum. The cartridge inlet concentration is considered significantly less than historical, with the caveat that several recent headspace concentrations were close to the cartridge inlet maximum.

Note: The PAPR cartridge inlet concentration measured in these tests, using the Carbotrap 300 TDU method, was reasonably close to the 819% of the OEL maximum inlet concentration measured during the July 2016 cartridge tests, also using the Carbotrap 300 TDU method.

F.6.9 2,3-Dihydrofuran, 2,5-Dihydrofuran, 2-Methylfuran, 2,5-Dimethylfuran, 2-Pentylfuran, 2-Propylfuran – BY-108

For both 2,5-dihydrofuran and 2-methylfuran, the PAPR cartridge inlet concentrations are much less than the below-report historical maxima that had RLs of ~5000% of the OEL. These high historical RLs came from the same 0.15-L TWINS IH sample discussed for furan. The cartridge inlet maximum was less than the DL of 24.1% OEL for 2,5-dihydrofuran, while the cartridge inlet maximum was 16.6% of the OEL for 2-methylfuran. Both of these cartridge inlet maxima were measured by the Carbotrap 300 TDU method.

For 2,3-dihydrofuran, 2,5-dimethylfuran, 2-pentylfuran, and 2-propylfuran, the PAPR cartridge inlet concentrations were measured by the furans method and are less than the DL of ~3% of the OEL (or 1.79% of the OEL, for 2-propylfuran). All of the historical maxima were below-reports with RLs in the range of ~20 to 50% OEL.

There were no above-report historical data, so no conclusion can be drawn about where the cartridge inlet concentrations lie with respect to historical data.

Note: The cartridge inlet concentration maxima measured during the July 2016 cartridge tests were frequently higher than those measured in the PAPR tests. The July 2016 maxima were 74.5% of the OEL for 2,3-dihydrofuran (furans method), 278% of the OEL for 2,5-dihydrofuran (Carbotrap 300 TDU method), 39.2% of the OEL for 2-methylfuran (Carbotrap 300 TDU method), less than a DL of approximately 3% of the OEL for 2,5-dimethylfuran (furans method), 3.57% of the OEL for 2-pentylfuran (furans method), and 11.1% of the OEL for 2-propylfuran (furans method). Furans data measured by the Carbotrap 300 TDU method were not fully reviewed as of the date of issuance of this report and should be considered For Information Only.

F.6.10 2-Heptylfuran – BY-108

The maximum PAPR cartridge inlet concentration is a below-detect for which the DL was 2.84% of the OEL. This may or may not be consistent with the historical maximum from recent data, a below-report with an RL of 0.196 ppb (<19.6% of the OEL, SWIHD HS). In addition, the cartridge inlet maximum is much lower than the TWINS HS maximum of 61.2 ppb (6120% of the OEL) measured in the headspace in 1994. The maximum cartridge inlet concentration is <20% of the maximum (TWINS HS) historical data and is considered to be significantly lower than the historical maximum. However, it is worth noting that both of the BY-108 2-heptylfuran measurements that are present in TWINS HS were considered to be misidentifications (Sklarew and Mitroshkov 2006).

Note: The cartridge inlet concentration maximum measured during the July 2016 cartridge tests (furans method) was 4.51% of the OEL, possibly twice the PAPR cartridge inlet maximum as for several other species.

F.6.11 Acetonitrile – BY-108

The maximum PAPR cartridge inlet concentration of 0.87% of the OEL, measured by the Carbotrap 300 TDU method, is much lower than the historical maximum of 18.8 ppm (94.0% of the OEL) that was measured in October 2016. This historical maximum comes from SWIHD HS and was made using the acetonitrile method. Other measurements made in the same period, by the same method, ranged from 2.23 ppm to 9.76 ppm. The cartridge inlet concentration is <20% of the historical maximum and is considered significantly less than historical.

Note: The cartridge inlet concentration maximum measured by the Carbotrap 300 TDU method during the July 2016 cartridge tests was 0.77% of the OEL, about equal to the PAPR cartridge inlet maximum measured by the same method.

F.6.12 N-nitrosodimethylamine (NDMA) – BY-108

The maximum PAPR cartridge inlet concentration was 721% of the OEL, about one-third of the historical maximum of 6.19 ppb (2063% of the OEL). The historical maximum came from the SWIHD HS database, a headspace measurement made in October 2016. There are no TWINS HS data for nitrosamines in this tank. The cartridge inlet maximum falls between 20 and 50% of the historical maximum, but not below the 20% level that is considered significantly below historical.

All the NDMA inlet concentrations for the TL2 PAPR cartridge had multiple data-quality flags, “BLYa” or “LY.” The “BLYa” notation indicates measurable concentration in the blank, calibration-standard measurement outside its specified range at the low end of the calibration range, and spike recovery outside its specified range. However, the maximum PAPR cartridge inlet concentration did not come from this data set and had no flags.

Note: The cartridge inlet concentration maximum measured during the July 2016 cartridge tests was 134% OEL, <20% of the PAPR cartridge inlet maximum.

F.6.13 N-nitrosodiethylamine (NDEA), N-nitrosomethylethylamine (NMEA), and N-nitrosomorpholine – BY-108

For these three nitrosamines, the PAPR cartridge inlet maxima were 13.1% of the OEL for NDEA, 188% of the OEL for NMEA, and below the DL of 1.68% of the OEL for N-nitrosomorpholine. The historical maxima were October 2016 SWIHD HS below-reports that had RLs of 1030% of the OEL for NDEA, 413% for NMEA, and 153% for N-nitrosomorpholine. The only above-report data come from a single breather-filter sample in TWINS IH, taken on July 15, 2009. The concentrations were 0.00809 ppb NDEA (8.09% of the OEL), 0.0239 ppb NMEA (7.97% of the OEL), and 0.0482 ppb N-nitrosomorpholine (8.03% of the OEL). There are no TWINS HS data for nitrosamines in this tank.

The cartridge inlet maxima are broadly equivalent to the above-report historical maximum for NDEA, much higher than historical above-reports for NMEA, and approximately 20% of the above-report historical maximum for N-nitrosomorpholine. Of these three nitrosamines, only N-nitrosomorpholine can be demonstrated to be significantly less than historical maxima.

Note: The cartridge inlet concentration maxima measured during the July 2016 cartridge tests were frequently higher than those in the PAPR tests. The July 2016 maxima were 34.5% OEL for NDEA, 132% OEL for NMEA, and 18.3% OEL for N-nitrosomorpholine. For these chemicals, the only 2018 PAPR maximum that was substantially lower than in 2016 was for N-nitrosomorpholine.

F.6.14 Dibutyl Butylphosphonate (DBBP) – BY-108

The maximum PAPR cartridge inlet concentration is below its DL of 0.37% of the OEL. The historical maximum concentration was a below-report datum with an RL of 0.00636 ppm (<90.9% of the OEL). This RL was for a September 17, 2009, sample in TWINS IH that had a small volume, 0.15 L. All the historical data in TWINS HS, dating from 1994, were also below-reports. There were no above-report historical data, so no conclusion can be drawn about where the cartridge inlet concentrations lie with respect to historical data.

Note: The cartridge inlet concentration maximum measured during the July 2016 cartridge tests also was below the DL, which was 1.46% OEL.

F.6.15 2-Fluoropropene – BY-108

2-Fluoropropene was a Tentatively Identified Compound in the PAPR cartridge inlet—it was not positively identified as being present—while the historical maximum concentration was 0.53 ppm (530% of the OEL). The historical data were present only in the TWINS HS database, a single data point taken in 1994. The cartridge inlet concentration is probably <20% of historical data, but because it is a Tentatively Identified Compound, no conclusion can be drawn.

Note: This chemical also was not positively identified in the 2016 cartridge inlet data.

F.6.16 Summary of Historical Data Comparisons – BY-108 Headspace

In summary, the PAPR cartridge inlet concentrations for the BY-108 headspace that were substantially lower than historical data can be described as follows:

- Differences that arose from using historical data taken during disturbance as the historical maximum: none.
- Differences that arose from using the RLs of below-report data for the historical maximum: none.
- Differences that arose from using data for vapor produced by a no-longer-existing inventory for the historical maximum: none.
- Differences that could not be resolved because of the scarcity of non-disturbance above-report data: 2,3-dihydrofuran, 2,5-dihydrofuran, 2-methylfuran, 2,5-dimethylfuran, 2-propylfuran, 2-pentylfuran, dibutyl butylphosphonate, 2-fluoropropene.

Cartridge inlet concentrations that were determined to be significantly lower than above-report historical concentrations: 1,3-butadiene, benzene, 1-butanol, acetaldehyde, furan, 2-heptylfuran, acetonitrile, N-nitrosomorpholine.

Table F.2. COPC Comparison to Historical BY-108 Headspace Measurements

COPC Number and Name		CAS Number	Boiling Point (°F)	Boiling Point Source	Occupational Exposure Limit (OEL)	Historical Measurements[1]					Measurements in this study			
						Number of Values	Maximum Value (in OEL units)	Average Value (in OEL units)	Maximum Value (%OEL)	Average Value (%OEL)	Max Inlet (%OEL)	Avg. Inlet (%OEL)	Max outlet (%OEL)	Approx. DL[12] (%OEL)
Inorganic														
1	Ammonia	7664-41-7	-28	Poling et al., 2007[2]	25 ppm	7 (6)	644	381 (445)	2576%	1524% (1780%)	767%	561%	718%	2.35% (RL)
2	Nitrous Oxide	10024-97-2	-127	Poling et al., 2007	50 ppm	1 *40*	1.80 *831*	1.80 *545*	3.60% *1662%*	3.60% *1090%*	Not Measured			
3	Mercury	7439-97-6	674	Poling et al., 2007	0.025 mg/m^3	7	0.017	0.016	68.0%	64.0%	27.3%	19.9%	<RL	6.91% (RL)
Hydrocarbons														
4	1,3-Butadiene	106-99-0	24	Poling et al., 2007	1 ppm	17 (8)	3.38	0.962 (2.03)	338%	96.2% (203%)	<RL	<RL	<RL	3.82% (RL)
5	Benzene	71-43-2	176	Poling et al., 2007	0.5 ppm	25 (12)	<0.0529! (0.010)	0.0112 (0.0065)	<10.6%! (2.00%)	2.24% (1.30%)	0.48%	0.35%	0.24%	0.020%
6	Biphenyl	92-52-4	491	Poling et al., 2007	0.2 ppm	15	<0.0102	<0.00244	<5.10%	<1.22%	<DL	<DL	<DL	0.026%
Alcohols														
7	1-Butanol	71-36-3	243	NIOSH[3]	20 ppm	13 (11) *87 (85)*	4.32 *63.5*	2.05 (2.42) *13.2 (13.5)*	21.6% *318%*	10.3% (12.1%) *66.0% (67.5%)*	2.76%	1.96%	<DL	0.004%
8	Methanol	67-56-1	148	Poling et al., 2007	200 ppm	3 (2)	<1.54 (0.0218)	0.525 (0.0173)	<0.77% (0.011%)	0.26% (0.009%)	0.58%	0.25%	0.32%	0.20% (RL)
Ketones														
9	2-Hexanone	591-78-6	262	NIOSH	5 ppm	25 (19)	0.046	0.0274 (0.0311)	0.92%	0.55% (0.62%)	0.25%	0.17%	<DL	0.001%
10	3-Methyl-3-butene-2-one	814-78-8	208	CRC Handbook 1989[4]	0.02 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC[11]			
11	4-Methyl-2-hexanone	105-42-0	282	Predicted ACD/Labs[5]	0.5 ppm	12 (5)	<0.004 (0.002)	0.00283 (0.002)	<0.80% (0.40%)	0.57% (0.40%)	0.21%	0.14%	<DL	0.017%
12	6-Methyl-2-heptanone	928-68-7	333	Predicted ACD/Labs	8 ppm	0	n/a	n/a	n/a	n/a	0.045%	0.035%	<DL	TIC[14]
13	3-Buten-2-one	78-94-4	179	CRC Handbook 1989	0.2 ppm	25	<0.0589	<0.0108	<29.5%	<5.40%	3.62%	1.76%	0.14%	0.066%
Aldehydes														
14	Formaldehyde	50-00-0	-6	NIOSH	0.3 ppm	6	0.017	0.0126	5.67%	4.20%	3.33%	1.89%	2.10%	0.61% (RL)
15	Acetaldehyde	75-07-0	69	NIOSH	25 ppm	7	2.82	0.62	11.3%	2.48%	0.52%	0.32%	0.32%	0.005% (RL)
16	Butanal	123-72-8	167	Oxford safety data[6]	25 ppm	32 (26)	0.137	0.0699 (0.0805)	0.55%	0.28% (0.32%)	0.50%	0.21%	<DL	0.002%
17	2-Methyl-2-butenal	1115-11-3	244	United Nations[7]	0.03 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
18	2-Ethyl-hex-2-enal	645-62-5	347	Predicted ACD/Labs	0.1 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
New[15]	2-Propenal	107-02-8	127	NIOSH	0.1 ppm	15	<0.0112	<0.00708	<11.2%	<7.08%	<DL	<DL	<DL	0.97%

Table F.2. BY-108 (continued)

#	COPC Number and Name	CAS Number	Boiling Point (°F)	Boiling Point Source	Occupational Exposure Limit (OEL)	Historical Measurements[1]: Number of Values	Historical Measurements[1]: Maximum Value (in OEL units)	Historical Measurements[1]: Average Value (in OEL units)	Historical Measurements[1]: Maximum Value (%OEL)	Historical Measurements[1]: Average Value (%OEL)	Measurements in this study: Max Inlet (%OEL)	Measurements in this study: Avg. Inlet (%OEL)	Measurements in this study: Max outlet (%OEL)	Measurements in this study: Approx. DL[12] (%OEL)
Furans														
19	Furan	110-00-9	88	Poling et al., 2007	1 ppb	21 (13) *22 (14)*	<58.3 (18.4) *547*	11 (9.54) *35.3 (47.9)*	<5830% (1840%) *54700%*	1100% (954%) *3530% (4790%)*	576%	307%	<DL	DL | RL[12] 13.9% | 119%[13]
20	2,3-Dihydrofuran	1191-99-7	130	Alfa Aesar[8]	1 ppb	5	<0.465	<0.321	<46.5%	<32.1%	<DL	<DL	<DL	3.18% | 19.0%
21	2,5-Dihydrofuran	1708-29-8	152	Aldrich[9]	1 ppb	21	<56.6	<7.95!	<5660%	<795%!	<DL	<DL	<DL	24.1% | 116%[13]
22	2-Methylfuran	534-22-5	147	Oxford safety data	1 ppb	21	<48.4	<6.79!	<4840%	<679%!	16.6%	11.8%	<DL	9.05% | 98.7%[13]
23	2,5-Dimethylfuran	625-86-5	199	Alfa Aesar	1 ppb	5	<0.339	<0.234	<33.9%	<23.4%	<DL	<DL	<DL	2.99% | 13.8%
24	2-Ethyl-5-methylfuran	1703-52-2	246	Predicted ACD/Labs	1 ppb	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
25	4-(1-Methylpropyl)-2,3-dihydrofuran	34379-54-9	328	Predicted ACD/Labs	1 ppb	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
26	3-(1,1-Dimethylethyl)-2,3-dihydrofuran	34314-82-4	306	Predicted ACD/Labs	1 ppb	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
27	2-Pentylfuran	3777-69-3	333	Alfa Aesar	1 ppb	5	<0.236	<0.163	<23.6%	<16.3%	<DL	<DL	<DL	3.01% | 9.61%
28	2-Heptylfuran	3777-71-7	410	Alfa Aesar	1 ppb	5 *7 (2)*	<0.196 *61.2*	<0.135 *12.8 (44.6)*	<19.6% *6120%*	<13.5% *1280% (4460%)*	<DL	<DL	<DL	2.84% | 7.99%
29	2-Propylfuran	4229-91-8	231	Alfa Aesar	1 ppb	5	<0.296	<0.204	<29.6%	<20.4%	<DL	<DL	<DL	1.79% | 12.1%
30	2-Octylfuran	4179-38-8	452	Predicted ACD/Labs	1 ppb	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
31	2-(3-Oxo-3-phenylprop-1-enyl)furan	717-21-5	605	Predicted ACD/Labs	1 ppb	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
32	2-(2-Methyl-6-oxoheptyl)furan	51595-87-0	Not available	Not available	1 ppb	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
Phthalates														
33	Diethylphthalate	84-66-2	563	NIOSH	5 mg/m^3	15	<0.0651	<0.0161	<1.30%	<0.32%	0.017%	<DL	0.014%	0.011%

Table F.2. BY-108 (continued)

						Historical Measurements[1]					Measurements in this study			
	COPC Number and Name	CAS Number	Boiling Point (°F)	Boiling Point Source	Occupational Exposure Limit (OEL)	Number of Values	Maximum Value (in OEL units)	Average Value (in OEL units)	Maximum Value (%OEL)	Average Value (%OEL)	Max Inlet (%OEL)	Avg. Inlet (%OEL)	Max outlet (%OEL)	Approx. DL[12] (%OEL)
Nitriles														
34	Acetonitrile	75-05-8	179	NIOSH	20 ppm	19 (11)	18.8	2.26 (3.86)	94.0%	11.3% (19.3%)	0.87%	0.51%	2.76%	0.001%
35	Propanenitrile	107-12-0	207	NIOSH	6 ppm	16 (12)	<0.0459 (0.029)	0.0203 (0.0197)	<0.77% (0.48%)	0.34% (0.33%)	0.13%	0.072%	<DL	0.003%
36	Butanenitrile	109-74-0	244	NIOSH	8 ppm	16 (12)	<0.0552 (0.035)	0.0239 (0.0229)	<0.69% (0.44%)	0.30% (0.29%)	0.25%	0.17%	0.010%	0.001%
37	Pentanenitrile	110-59-8	284	Alfa Aesar	6 ppm	16 (12)	<0.0478 (0.012)	0.0114 (0.00742)	<0.80% (0.20%)	0.19% (0.12%)	0.039%	0.030%	<DL	0.002%
38	Hexanenitrile	628-73-9	328	Predicted ACD/Labs	6 ppm	16 (12)	<0.0408! (0.007)	0.00866 (0.00492)	<0.68%! (0.12%)	0.14% (0.082%)	0.027%	0.015%	<DL	0.001%
39	Heptanenitrile	629-08-3	368	Alfa Aesar	6 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
40	2-Methylene butanenitrile	1647-11-6	Not available	Not available	0.3 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
41	2,4-Pentadienenitrile	1615-70-9	278	Predicted ACD/Labs	0.3 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
Amines														
42	Ethylamine	75-04-7	62	Poling et al., 2007	5 ppm	7	<0.0173	<0.00618!	<0.35%	<0.12%!	0.92%	0.44%	0.58%	0.094% (RL)
Nitrosamines														
43	N-Nitrosodimethylamine	62-75-9	306	NIOSH	0.3 ppb	7 (5)	6.19	2.86 (3.96)	2063%	953% (1320%)	721%	328%	<RL	5.49% (RL)
44	N-Nitrosodiethylamine	55-18-5	351	Oxford safety data	0.1 ppb	7 (1)	<1.03 (0.00809)	0.403 (0.00809)	<1030% (8.09%)	403% (8.09%)	13.1%	<RL	<RL	10.6% (RL)
45	N-Nitrosomethylethylamine	10595-95-6	310	Predicted ACD/Labs	0.3 ppb	7 (1)	<1.24 (0.0239)	0.596 (0.0239)	<413% (7.97%)	199% (7.97%)	188%	74.8%	<RL	4.43% (RL)
46	N-Nitrosomorpholine	59-89-2	435	Oxford safety data	0.6 ppb	7 (1)	<0.919 (0.0482)	0.447 (0.0482)	<153% (8.03%)	74.5% (8.03%)	<RL	<RL	<RL	1.68% (RL)
Organophosphates														
47	Tributyl phosphate	126-73-8	552	NIOSH	0.2 ppm	15	<0.00598	<0.00135	<2.99%	<0.68%	<DL	<DL	<DL	0.034%
48	Dibutyl butylphosphonate	78-46-6	602	Predicted ACD/Labs	0.007 ppm	15	<0.00636	<0.00155	<90.9%	<22.1%	<DL	<DL	<DL	0.37%
Halogenated														
49	Chlorinated Biphenyls	Varies	Varies	Varies	1 mg/m^3	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
50	2-Fluoropropene	1184-60-7	-11	SynQuest[10]	0.1 ppm	0 *1*	n/a *0.53*	n/a *0.53*	n/a *530%*	n/a *530%*	Not Detected - TIC			
Pyridines														
51	Pyridine	110-86-1	240	NIOSH	1 ppm	21 (1)	<0.0502! (0.003)	0.00997 (0.003)	<5.02%! (0.30%)	1.00% (0.30%)	0.17%	0.13%	<RL	0.008% (RL)
52	2,4-Dimethylpyridine	108-47-4	318	Alfa Aesar	0.5 ppm	22 (4)	<0.0385! (0.004)	0.00587 (0.003)	<7.70%! (0.80%)	1.17% (0.60%)	0.073%	0.029%	<RL	0.010% (RL)

Table F.2. BY-108 (continued)

COPC Number and Name		CAS Number	Boiling Point (°F)	Boiling Point Source	Occupational Exposure Limit (OEL)	Historical Measurements[1]					Measurements in this study			
						Number of Values	Maximum Value (in OEL units)	Average Value (in OEL units)	Maximum Value (%OEL)	Average Value (%OEL)	Max Inlet (%OEL)	Avg. Inlet (%OEL)	Max outlet (%OEL)	Approx. DL[12] (%OEL)
Organonitrites														
53	Methyl nitrite	624-91-9	10	Oxford safety data	0.1 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
54	Butyl nitrite	544-16-1	172	Alfa Aesar	0.1 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
Organonitrates														
55	Butyl nitrate	928-45-0	276	Predicted ACD/Labs	2.5 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
56	1,4-Butanediol, dinitrate	3457-91-8	499	Predicted ACD/Labs	0.05 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
57	2-Nitro-2-methylpropane	594-70-7	260	Alfa Aesar	0.3 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
58	1,2,3-Propanetriol, 1,3-dinitrate	623-87-0	338	Predicted ACD/Labs	0.05 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
Isocyanates														
59	Methyl Isocyanate	624-83-9	103	NIOSH	0.02 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
Organometallic														
New[15]	Dimethylmercury	593-74-8	200	NIOSH	0.010 mg/m^3 (as Hg)	0	n/a	n/a	n/a	n/a	Not Measured			

[1] *Historical data from TWINS industrial hygiene vapor database and SWIH database, as applicable; see text for links and dates of queries.*

Plain font in the table indicates that only the recent databases (SWIHD headspace and TWINS Industrial Hygiene, as applicable) were included. Italics, if present, mean that the pre-2006 TWINS headspace data were also included.

"n/a" indicates no historical data was found in the databases.

Values in parenthesis "( )", if present, indicate the maximum or average reported (detected) value >RL or >DL.

"!", if present, indicates a maximum RL that came from a sample with a volume less than 0.5 L or from a sample whose RL, for undiscernible reasons, was a factor of 5 or more high compared to other samples measured using the same analytical method.

"<RL", "<DL", or "<" indicates that all pertinent measurements of the analyte were less than the reporting or detection limit.

[2] *Poling, B. E.; Prausnitz, J. M.; O'Connell, J. P. The Properties of Gases and Liquids. McGraw Hill, 2007.*

[3] *NIOSH: National Institute of Occupational Safety and Health*

[4] *CRC Handbook of Chemistry and Physics, CRC Press, 1989.*

[5] *ACD/Labs software http://www.acdlabs.com/products/percepta/predictors.php*

[6] *Oxford safety data from The Physical and Theoretical Chemistry Laboratory at Oxford University*

[7] *Food and Agriculture Organization of the United Nations*

[8] *Alfa Aesar: https://www.alfa.com/*

[9] *Aldrich: https://www.sigmaaldrich.com/*

[10] *SynQuest: http://synquestlabs.com/product/id/8330.html*

[11] *TIC: Tentatively Identified Compounds that were not observed in this study using the specified analytical methods.*

[12] *Approximate Detection Limit (DL) is calculated using the reported detection limit (or reporting limit - RL where noted) from the analytical laboratory and the average volume (from flowrate x time) of vapor exposed to the sorbent tube.*
For Furans, both DL and RL values are reported as "DL / RL".

[13] *Furans measured using VOA (Volatile Organic Analysis) method.*

[14] *TIC (see footnote 11) do not have analytical calibration standards or quantified detection limits. Mass and concentration are estimates only.*

[15] *2-Propenal and Dimethyl Mercury were added to the COPC List in September, 2017.*

F.7 References

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Appendix G

Manufacturer's Service-Life Estimation

Appendix G

Manufacturer's Service-Life Estimation

The experimental breakthrough times for ammonia from both BY-110 and BY-108 were compared to the estimated service life of the cartridges, using online calculators provided by the vendor (e.g., SCOTT's SureLife® Cartridge Calculator provided by SCOTT Safety, now part of 3M). Although the experimental breakthrough time was obtained under a mixture composed of potentially over a thousand chemicals the estimated service life of the cartridge is based only on the single ammonia component concentration.

As with prior respirator analyses the experimental breakthrough time was determined to be the point when measured outlet ammonia concentrations from the respirator cartridge test system first exceeded 10% of the OEL. The breakthrough signature of ammonia was assessed to infer a higher resolution than the 2-hour collection times. An interpolation was used to determine the time when 10% of the Occupational Exposure Limit (OEL) concentration at the outlet would have occurred. Based on theoretical adsorption information, a semi-logarithmic relationship was found between the cumulative ammonia mass fed to the cartridge and the cartridge outlet concentration. Therefore, the approximate cumulative mass of ammonia fed at 10% of the OEL can be interpolated based on this relationship. Then, the breakthrough time at 10% of the OEL can be interpolated based on the cumulative ammonia mass and the recorded breakthrough time. Once the interpolated breakthrough time was determined, the average inlet concentrations and measured gas stream properties were determined up until that point for use in subsequent estimation of service life using the manufacture's calculator or algorithm.

For the APR cartridge test, the set flow rate was 30 L/min per cartridge, and for the PAPR cartridge test, the set flow rate was 95 L/min per cartridge.

The comparison results for the PAPR cartridges are summarized in Table G.1. The estimated service life for TL1 cartridge was obtained with the parameters in Table G.1 using the online calculator provided by MSA. The data is from Appendices C and D. The TL1 cartridge is a type TL (AM/CL/CD/FM/HC/MA/SD/HE) PAPR cartridge from MSA (order #10080456). The TL2 cartridge is a type FR-57 (OV, SD, HC, CL, CD, HF, AM, MA, FM, HE) PAPR cartridge from 3M. No safety factor was used in either the MSA calculator or the 3M service life estimation methods. Also, the estimated results using the MSA calculator or the 3M service life estimation methods did not reflect any relative humidity impact.

Based on the service life projections in Table G.1 both the TL1 and TL2 estimates (average and maximum) were consistent with the observed breakthrough times. Specifically, the observed breakthrough time for the TL1 cartridge was 5.6 hours and the estimate service life was 2.2 to 2.5 hours using the maximum and average inlet concentrations, respectively. For the TL2 cartridge the observed breakthrough time was 1.7 hours, with a corresponding service life estimate of 0.9 to 1.0 hours using the maximum and average inlet concentrations, respectively.

Table G.1. Comparison of Interpolated Experimental Breakthrough Times to Manufacturer Service Life Estimates for PAPR Cartridges with Average and Maximum Inlet Concentrations.

COPCs	Cartridge	Tank	T (°F)	RH (%)	OEL (ppm)	Break-through criterion (%OEL)	Avg. Inlet Conc.(ppm)	Exptl. flow rate (L/min)	Exptl. Pressure (Torr)	Exptl. Breakthrough time (h)	*Calculator flow rate (L/min)	Estimated service Life (h)
NH_3	TL1	BY-108	45.8	75.6	25	10	158	95	708.8	5.6	102.5	2.5
	TL2	BY-108	54.3	76.6	25	10	128	95	681.3	1.7	^57	1.0
COPCs	**Cartridge**	**Tank**	**T (°F)**	**RH (%)**	**OEL (ppm)**	**Break-through criterion (%OEL)**	**Max. Inlet Conc.(ppm)**	**Exptl. flow rate (L/min)**	**Exptl. Pressure (Torr)**	**Exptl. Breakthrough time (h)**	***Calculator flow rate (L/min)**	**Estimated service Life (h)**
NH_3	TL1	BY-108	45.8	75.6	25	10	192	95	708.8	5.6	102.5	2.2
	TL2	BY-108	54.3	76.6	25	10	147	95	681.3	1.7	^57	0.9

* For the TL1 cartridge, the flow rate is per cartridge used in the MSA calculator (two cartridges with a total flow rate of 205 L/min). For the TL2 cartridge, the flow rate is per cartridge used in the calculation to estimate service life based on the NIOSH test result (see Figure G.1 at the end of this appendix).
^ For the TL2 cartridge, the flow rate is per cartridge used in the NIOSH test which is suggested by 3M Company to estimate the service. The operating flow rate for the Breathe Easy respirator equipped with three TL2 cartridges is 210 L/min.

The comparison results for the APR cartridges are summarized in Table G.2. The data is also from Appendices C and D. The SD1 cartridge is a type 7422-SD1 APR cartridge (AM, CD, CL, FM, HC,HF, HS, MA, OV, P100, SD), and the SC1 cartridge is a type 7422-SC1 APR cartridge (AM, CD, CL, FM, HC, HF, HS, MA, OV, SD). Both of these cartridges are from SCOTT Safety (now part of 3M).Note that the table also includes corresponding service life estimates based on maximum concentrations from the entire 16-hour test period. The reason for including these estimates is to account for the large fluctuations in observed inlet ammonia concentrations for the BY-110 testing. For example, the initial inlet concentration for the SC1 cartridge testing was 112% of the OEL, whereas all other inlet concentrations for that testing were >600%.

Table G.2. Comparison of Interpolated Experimental Breakthrough Times to Manufacturer Service Life Estimates for APR Cartridges with Average and Maximum Inlet Concentrations.

COPCs	Cartridge	Tank	T (°F)	RH (%)	OEL (ppm)	Break-through criterion (%OEL)	Avg. Inlet Conc.(ppm)	Exptl. flow rate (L/min)	Exptl. Pressure (Torr)	Exptl. Breakthrough time (h)	*Calculator flow rate (L/min)	Estimated service Life (h)
NH_3	SD1	BY-110	48.1	69.4	25	10	154	~30	739.7	3.2	30	4.3
	SC1	BY-110	53.6	64.0	25	10	28	~30	720.3	1.8	30	11.3
COPCs	**Cartridge**	**Tank**	**T (°F)**	**RH (%)**	**OEL (ppm)**	**Break-through criterion (%OEL)**	**Max .Inlet Conc.(ppm)**	**Exptl. flow rate (L/min)**	**Exptl. Pressure (Torr)**	**Exptl. Breakthrough time (h)**	***Calculator flow rate (L/min)**	**Estimated service Life (h)**
NH_3	SD1	BY-110	48.1	69.4	25	10	204	~30	739.7	3.2	30	3.5
	SC1	BY-110	53.6	64.0	25	10	236	~30	720.3	1.8	30	2.4

* Service life estimates for the SD1 and SC1 cartridges were made using the SureLife® Cartridge Calculator by specialists at SCOTT Safety (3M). Two cartridges are used in the SCOTT APR respirators so the flow rates were converted to a per-cartridge basis.

For the SD1 and SC1 cartridges, the range in estimated service life was much broader, primarily due to the larger variation in inlet concentrations. For the SD1 cartridge, the service life estimation using the initial average inlet concentration was 4.3 hours, compared to the observed breakthrough time of 3.2 hours. However, if the maximum inlet concentration was applied, the estimated service life was 3.5 hours, which is much closer to the observed value. Note that minimum and maximum flow rates also were applied in the SD1 and SC1 estimates because flow degradation was reported by the WRPS operators during the testing. A flow rate of 30 L/min was considered to be an upper range for the calculator estimates.

Variations in the SC1 service life estimates were the most significant in the set reported. Using the initial average concentration (which corresponded to the first measured concentration only), the estimated service life was 11.3 hours, compared to the observed breakthrough time of 1.8 hours. However, when applying the maximum concentration for the 16-hour test period, the service life was estimated to be 2.4 hours, which is slightly higher than, but consistent with, the observed range. As stated above, the argument for using the higher inlet concentrations for the SC1 cartridge is that the first inlet concentration was significantly lower than all of the other measurements (112% of the OEL versus >600%).

Figure G.1. Email Correspondence between PNNL and 3M Regarding the Breakthrough Calculation Procedure.

From: Erik Johnson
To: Liu, Jian (LSL2)
Subject: RE: PAPR cartridge service life estimation
Date: Friday, October 27, 2017 11:03:41 AM
Attachments: image003.png
image002.png

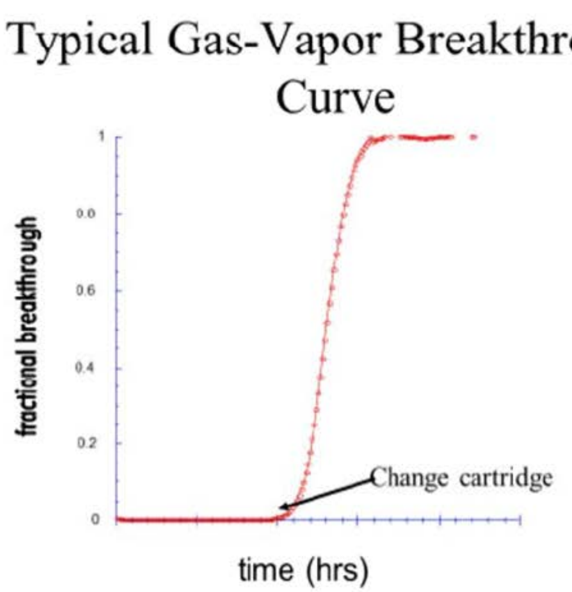
Jian,

The FR-57 is in the 3M Service Life Software for organic vapors. Unfortunately there are fewer math models for non-organic vapors. For other gases/vapors, please see the following technical data bulletins.

https://www.dqeready.com/Documents/Products/3M-FR-57-Technical-Data.aspx
https://multimedia.3m.com/mws/media/471663O/determination-of-service-life-for-niosh-cbrn-cartridges.pdf

For example, the NIOSH test criteria for ammonia is 1000 ppm challenge, and at least 25 minutes before 50 ppm breakthrough. Temperature and humidity ranges you mentioned are less of a concern for ammonia as opposed to organic vapor service life. The Breathe Easy PAPR flow rate is about 220 L/min for the system (73 L/min per cartridge); as opposed to the NIOSH testing at 170 L/min (57 L/min per cartridge).

It is best to have service life data at multiple exposure levels in order to estimate service life. As a very rough estimate, one could use an inverse linear relationship (e.g. decrease exposure in half and double service life). However, it is more often an exponential relationship (longer service life). The effect of breakthrough concentration is difficult to include because once breakthrough starts, it increases rapidly. Therefore, based on the graph below, a correction factor of 2 seems more than adequate for differing breakthrough quantities.



Putting this all together, a rough estimate of service life at 193 ppm would be:
25 minutes * (1000 ppm / 193 ppm) * (170 L/min / 220 L/min) * (1/2) = 50 minutes

Likewise at 311 ppm would be = 31 minutes.

Mind you these are based on the minimum NIOSH service life requirements and some conservative assumptions. Actual service life may be longer. However, cartridges must be changes sooner if contaminant odor/irritation is detected.

-Erik

3M
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3M Personal Safety Division
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erikwjohnson@mmm.com | www.3M.com/ppesafety

From: Liu, Jian (LSL2) [mailto:Jian.Liu@pnnl.gov]
Sent: Friday, October 27, 2017 11:31 AM
To: Erik Johnson <erikwjohnson@mmm.com>
Subject: [EXTERNAL] PAPR cartridge service life estimation

Hi Erik,

It was nice talking to you. I would like to ask you to estimate the service life of the FR57 (OV/SD/HC/CL/CD/HF/AM/MA/FM/HE) for some chemicals using your online calculator.

Scenario 1. Temperature: 26.5 C, RH: 81%, flowrate 95 L/min (for one cartridge)

Ammonia inlet concentration 193 ppm/breakthrough limit 2.5 ppm

Scenario 2. Temperature: 33.3 C, RH: 58%, flowrate 95 L/min (for one cartridge)

Ammonia inlet concentration 311 (or 300 if 311 is not possible) ppm/breakthrough limit 2.5 ppm

Thank you.

Best regards,

Jian

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