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Analysis of Air-Purifying Respirator (APR) and Powered Air-Purifying Respirator (PAPR) Cartridge Performance Testing on a Hanford AP Tank Farm Exhauster Slipstream

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U.S. DEPARTMENT OF ENERGY

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Pacific Northwest National Laboratory
Richland, Washington 99352

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 Hanford AP tank farm exhauster slipstream. 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 testing on a slipstream from the Hanford AP tank exhauster was conducted on March 23–24, 2018. This testing focused on both APR and PAPR cartridges. Previous testing of APR cartridges was conducted on the AP exhauster in June of 2016. However, an AP exhauster upgrade was completed in September 2016. In the most recent testing, slipstream vapors from the new AP exhauster were fed to two respirator cartridge test stands, one for the PAPR respirator cartridges and the other for the APR respirator cartridges. Both the APR and PAPR test stands were developed by WRPS in collaboration with HiLine Engineering (Richland, Washington). Multipurpose APR cartridges—SCOTT 7422-SD1 and SCOTT 7422-SC1 (SCOTT Safety, Monroe, North Carolina)—were assessed on separate days 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)—were also tested consecutively over the same two days as the APR cartridge tests, 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 inlet vapor concentrations from the AP exhauster slipstream to the APR cartridges, two COPCs—furan and N-nitrosodimethylamine (NDMA)—exceeded their corresponding Occupational Exposure Limit (OEL).[3] Three COPCs—ammonia, mercury, and N-nitrosomethylethylamine (NMEA)—had one or more inlet concentration measurements >10% of their OELs, but <100%. All other COPC inlet and outlet measurements did not exceed 10% of their OELs. Overviews of the five highest concentration COPCs are given below.

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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 above 10% of the OEL of a COPC. 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] Respirator Change Schedules. 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.

- Maximum ammonia concentrations at the inlets to the SCOTT 7422-SD1 and SCOTT 7422-SC1 cartridges were 95% and 87% of the OEL, respectively. These concentrations were lower than the historic maximum measurements from the AP exhauster (412% of the OEL). Ammonia breakthrough, above 10% of the OEL, appeared to occur in the SCOTT 7422-SD1 cartridge between 14 and 16 hours of run time. All outlet concentrations for the SCOTT 7422-SC1 cartridge were <10% of the OEL but rose above the reporting limit (RL) for the last two measurements, indicating potential breakthrough after 16 hours. The observed ammonia breakthrough behavior for the SC1 cartridge is consistent with prior respirator cartridge tests on Hanford tank vapor sources with similar concentrations. For the SD1 cartridge, the estimated service life of 19 hours was longer than the 14 to 16 hours observed breakthrough time. At lower ammonia inlet concentrations (e.g., 100% of the OEL), the service-life estimates are particularly sensitive to small changes in ammonia concentration. Therefore, differences in estimated versus observed breakthrough are likely a result of uncertainty between average measured inlet concentration and actual concentration.
- Maximum mercury concentrations at the inlets to the SCOTT 7422-SD1 and SCOTT 7422-SC1 cartridges were 16% and 14% of the OEL, respectively. These concentrations were lower than the historical maximum of 32%. All the cartridge outlet concentrations for mercury were below the RL, except for the 16-hour measurement for the SCOTT 7244-SC1 cartridge, which exceeded 10% of the OEL. These data suggest that mercury breakthrough may have occurred between 14 and 16 hours for the SCOTT 7244-SC1. However, there was no evidence of breakthrough for the SCOTT 7244-SD1 cartridge.
- Maximum furan concentrations at the inlets to the SCOTT 7422-SD1 and SCOTT 7422-SC1 cartridges were 104% and 102% of the OEL, respectively. These concentrations were lower than the historic maximum of 715% of the OEL. Outlet concentrations from both cartridges were below the RL and detection limit (DL) so there was no evidence that breakthrough occurred.
- Maximum NDMA concentrations at the inlets to the SCOTT 7422-SD1 and SCOTT 7422-SC1 cartridges were 1733% and 2681% of the OEL, respectively. These concentrations were lower than the historic maximum of 5267% of the OEL. All the cartridge outlet concentrations from both cartridges tested were below the DL.[1] Therefore, there was no evidence that breakthrough occurred.
- Most NMEA inlet concentrations exceeded 10% of the OEL (up to 21%) but were lower than the historic maximum of 49% of the OEL. All outlet concentrations were below DL. Therefore, there was no evidence that breakthrough occurred.

The *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.

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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. 2020. *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.

PAPR Cartridge Testing

Based on measured inlet vapor concentrations to the PAPR cartridges, two COPCs—ammonia and NDMA—exceeded their corresponding OELs. Three COPCs—mercury, furan, and NMEA—had one or more inlet concentration measurements >10% of their respective OELs, but <100% of the OELs. None of the other COPC inlet and outlet measurements exceeded 10% of their OELs. Of the five COPCs with higher inlet concentrations, only ammonia showed clear evidence of breakthrough above 10% of its OEL. Overviews of the PAPR cartridge test results for the above COPCs are as follows:

- Maximum ammonia concentrations at the respirator cartridge inlet to the MSA OptiFilter TL and 3M FR-57 cartridges were 102% and 97% of the OEL, respectively. These concentrations were lower than the historic maximum measurements from the AP exhauster (412% of the OEL). All cartridge outlet concentrations from the MSA TL cartridge were less than the RL so there was no evidence breakthrough occurred. However, between 4 and 6 hours, ammonia breakthrough appeared to occur in the 3M FR-57 cartridge, above 10% of the OEL. The observed ammonia breakthrough behavior for both cartridges is consistent with service-life estimates and prior respirator cartridge tests on Hanford tank vapor sources with similar concentrations.
- Maximum mercury concentrations at the inlets to the MSA TL and 3M FR-57 cartridges were both 12% of the OEL, which is lower than the historical maximum of 32% of the OEL. All of the cartridge outlet concentrations for mercury were below the RL, indicating that no breakthrough occurred.
- Maximum furan concentrations at the inlets to the MSA TL and 3M FR-57 cartridges were 57% and 19% of the OEL, respectively. However, most inlet concentrations measured were below the DL. These concentrations were significantly lower than the historic AP exhauster maximum of 715% of the OEL. All the cartridge outlet concentrations for furan were below the DL of approximately 24% of the OEL, indicating that no breakthrough occurred.
- Maximum NDMA concentrations at the inlets to the MSA TL and 3M FR-57 cartridges were 3130% and 2127% of the OEL, respectively. These concentrations were lower, but generally consistent with the historic maximum of 5267% of the OEL. All cartridge outlet concentrations from both cartridges tested for NDMA were below the DL. Therefore, there was no evidence of breakthrough occurred.
- Maximum NMEA concentrations at the inlets to the MSA TL and 3M FR-57 cartridges were 22% and 17% of the OEL, respectively. These concentrations were lower than the historic maximum of 49% of the OEL. All the cartridge outlet concentrations from both cartridges tested for NDMA were below the DL. Therefore, there was no evidence that breakthrough occurred.

Based on the measurements in this study, ammonia exhibited breakthrough above 10% of its OEL in tests with the SCOTT 7422-SD1 APR and the 3M FR-57 PAPR cartridges. In addition, onset of breakthrough was exhibited with the SCOTT 7422-SC1 cartridge, where effluent concentrations rose above the DL but had not yet exceeded 10% of the OEL by the end of the test. This is consistent with prior tank vapor testing in which 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 accumulated for the MSA TL and 3M FR-57 PAPR cartridges to date also indicate that ammonia can be considered the leading indicator of breakthrough in those cartridges.

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 estimations for the current study were consistent for the SCOTT 7422-SC1 cartridge; that is, greater than 16 hours observed and estimated. However, for the SCOTT-7422-SD1 cartridge, the observed breakthrough time of 14 to 16 hours was lower than the predicted service life of 19 hours. The reason for the slightly higher estimated service life for the SCOTT-7422-SD1 cartridge is believed to be slight differences in the average inlet concentration used for the estimation versus the actual value, because the service-life estimates are particularly sensitive to inlet concentrations at low concentrations such as those encountered in this study. For example, if the maximum concentration were used for the SCOTT-7422-SD1 cartridge (23.7 ppm) versus the average (19.4 ppm) the predicted breakthrough time would decrease by approximately 3 hours. Furthermore, it is important to note that the observed breakthrough time for the SCOTT-7422-SD1 cartridge is well beyond the practical maximum cartridge use time for tank farm applications.

Variations in humidity, temperature, or cartridge inlet concentration for any COPCs, especially ammonia, compared to those measured in the current study could impact breakthrough time. Ammonia service life estimations along with experimental breakthrough times should be used to inform an Industrial Hygiene determination of 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*[1] 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] 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	July 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 1), which provided additional information on historic COPC source concentrations and the significance of any differences between cartridge-testing results and historic maxima. b. Reference to the *Overview of 2016 through 2018 Testing of Air-Purifying Respirator Cartridge Performance on Multiple Hanford Tank Headspaces and Exhausters*[7] (PNNL-26821 Revision 1 was added. c. Adding descriptive information to Appendices A, B, and C to provide additional clarity on the contents and methods applied d. Clarifying terminology regarding breakthrough time versus service life and change-out schedule.

[7] Freeman CJ, J Liu, C Clayton, SK Nune, LA Mahoney, CL Bottenus, TM Brouns, P Humble, and MJ Minette. 2020. *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.

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
IH	Industrial Hygiene
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

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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 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 conducted on vapors from the AP tank farm exhauster during quiescent tank farm conditions.[8] Previous testing of APR cartridges was conducted on the AP exhauster in June of 2016. However, an AP exhauster upgrade was completed in September 2016 that increased overall AP tank farm exhaust capability from one to two exhaust stacks, stack height from 13 ft to 40 ft, and a variable ventilation rate up to 429% higher (see Figure 1).[9] Two different APR cartridges from SCOTT Safety (Monroe, North Carolina) were assessed for the new AP exhauster source, along with two different PAPR cartridges—one from MSA Safety Inc. (Pittsburgh, Pennsylvania) and another from 3M (Maplewood, Minnesota).

Figure 1. AP Tank Farm During Construction of the Upgraded AP Exhauster System

[8] No waste-disturbing activities were being conducted in the AP tank farm immediately before or during cartridge testing.

[9] WRPS. 2017. *AP Farm Ventilation Upgrades Project: Application for Project Management Institute Project of the Year Award*. Washington River Protection Solutions, Richland, Washington. https://pmicrb.org/images/WRPS_AP_Farm_Ventilation_Upgrades_Project.pdf

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 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 approach.[12] The "rules of thumb" may not work for every chemical or situation, but provide an estimation of cartridge life. The following are rules of thumb outlined in the publication:

- If the boiling point of a compound 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[10] can help in interpreting the results obtained from experimental testing of respirator cartridges.

[10] 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 the AP tank farm exhauster.[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 the cartridges effectively protect the worker, 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.[11] 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,[12] and slightly below MSA-

[11] 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 approximately 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).

[12] 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 stack 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 for Survey 18-01495 using the APR test rig,[28][13] and MSA OptiFilter TL (TL1)[14] for Survey 18-01496 and 3M FR-57 (TL2)[15] 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 measured at the beginning and end of each 16-hour verification survey. Downstream sorbent tubes were changed out every 2 hours until the experiment was finished. 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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[13] 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/

[14] 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/HF 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.

[15] 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.

4.0 Data Analysis

Respirator cartridge tests on vapors from the Hanford AP tank farm exhauster were conducted during March 23–24, 2018. Two different APR cartridges—SCOTT 7422-SD1 and SCOTT 7422-SC1—and two different multipurpose PAPR cartridges—MSA OptiFilter TL and 3M FR-57—were each tested for 16 hours of continuous run time. Testing and analyses focused on the 61 COPCs identified in Table 1 (APR Cartridges) and Table 2 (PAPR Cartridges), along with other hazardous airborne contaminants. Analytical sorbent tubes were used to collect the various chemicals and 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 1) 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 vapor cartridge inlet temperature from the AP exhauster slipstream ranged from 49 to 63°F, and the relative humidity ranged from 61 to 95%.

4.1 APR Cartridge Testing

Table 1 shows the measured concentrations from Hanford AP tank farm exhauster slipstream testing of the APR cartridges (SCOTT 7422-SD1 and SCOTT 7422-SC1) for all of the COPCs evaluated. Two inlet COPC concentrations exceeded their corresponding OELs. These COPCs were furan, and N-nitrosodimethylamine (NDMA). The inlet (or outlet) concentrations of three other COPCs were lower than their corresponding OELs but exceeded 10%. These COPCs were ammonia, mercury and N-nitrosomethylethylamine (NMEA). All five 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 (DLs)/reporting limits (RLs) <10% of their OELs but >2%.[16] These COPCs were 1,3-butadiene, formaldehyde, and N-nitrosomorpholine. All of the other COPCs had inlet (or outlet) concentrations <2% of their OELs or their DLs.

[16] The term “detection limit” or DL is used here to refer either to analytical reporting limit (RL) or 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	23.7 ppm	25 ppm	2.43%		Up to 95% of OEL for inlet values. All outlets ≤12.7%.
2	Nitrous Oxide	10024-97-2	Not Measured	50 ppm			
3	Mercury	7439-97-6	4.05 ug/m3	25 ug/m3	6.85%		Up to 16.2% of OEL for inlet values. All outlets <13.0%.
Hydrocarbons							
4	1,3-Butadiene	106-99-0	0.0655 ppm	1 ppm	1.97%		Up to 6.6% of OEL for inlet values. All outlets <6.4%.
5	Benzene	71-43-2	0.0005 ppm	0.5 ppm	0.036%		Up to 0.06% of OEL for inlet values. All outlets ≤0.1%.
6	Biphenyl	92-52-4	0.0001 ppm	0.2 ppm	0.046%	X	
Alcohols							
7	1-Butanol	71-36-3	0.012 ppm	20 ppm	0.022%		Up to 0.06% of OEL for inlet values. All outlets <DL.
8	Methanol	67-56-1	Not Measured	200 ppm			
Ketones							
9	2-Hexanone	591-78-6	0.0003 ppm	5 ppm	0.002%		Up to 0.005% 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	0.0001 ppm	0.5 ppm	0.021%	X	
12	6-Methyl-2-heptanone	928-68-7	Not Detected	8 ppm	TIC	X	
13	3-Buten-2-one	78-94-4	0.0008 ppm	0.2 ppm	0.167%		Up to 0.4% of OEL for inlet values. All outlets <DL.
Aldehydes							
14	Formaldehyde	50-00-0	0.0080 ppm	0.3 ppm	0.579%		Up to 1.0% of OEL for inlet values. All outlets ≤2.7%.
15	Acetaldehyde	75-07-0	0.0154 ppm	25 ppm	0.005%		Up to 0.06% of OEL for inlet values. All outlets ≤0.03%.
16	Butanal	123-72-8	0.0008 ppm	25 ppm	0.002%		Up to 0.003% 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	0.0009 ppm	0.1 ppm	0.931%	X	

[1] An approximate DL is calculated using the reported DLs (or RLs) from the analytical laboratory and the average volume (from flowrate x 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	1.04 ppb	1 ppb	DL | RL[1] 23.0% | 115%[3]		Up to 104% of OEL for inlet values. All outlets <DL.
20 2,3-Dihydrofuran	1191-99-7	0.03 ppb	1 ppb	3.28% | 19.6%	X	
21 2,5-Dihydrofuran	1708-29-8	0.26 ppb	1 ppb	25.8% | 111%[3]	X	
22 2-Methylfuran	534-22-5	0.10 ppb	1 ppb	10.3% | 95.2%[3]	X	
23 2,5-Dimethylfuran	625-86-5	0.03 ppb	1 ppb	3.09% | 14.3%	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	3.11% | 9.93%	X	
28 2-Heptylfuran	3777-71-7	0.03 ppb	1 ppb	2.93% | 8.25%	X	
29 2-Propylfuran	4229-91-8	0.02 ppb	1 ppb	1.85% | 12.5%	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	0.0011 mg/m3	5 mg/m3	0.019%		All inlets <DL. All outlets ≤0.02%.
Nitriles						
34 Acetonitrile	75-05-8	0.0446 ppm	20 ppm	0.002%		Up to 0.05% of OEL for all inlet values. All outlets ≤0.2%.
35 Propanenitrile	107-12-0	0.0003 ppm	6 ppm	0.006%	X	
36 Butanenitrile	109-74-0	0.0002 ppm	8 ppm	0.002%	X	
37 Pentanenitrile	110-59-8	0.0002 ppm	6 ppm	0.003%	X	
38 Hexanenitrile	628-73-9	0.0001 ppm	6 ppm	0.002%	X	
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	0.0047 ppm	5 ppm	0.094%	X	

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	8.04 ppb	0.3 ppb	5.76%		Up to 2681% of OEL for inlet values. All outlets <DL
44 N-Nitrosodiethylamine	55-18-5	0.01 ppb	0.1 ppb	12.5%	X	
45 N-Nitrosomethylethylamine	10595-95-6	0.06 ppb	0.3 ppb	4.84%		Up to 20.7% of OEL for inlet values. All outlets <DL.
46 N-Nitrosomorpholine	59-89-2	0.02 ppb	0.6 ppb	1.84%		Up to 3.3% of OEL for all inlet values. All outlets <DL.
Organophosphates						
47 Tributyl phosphate	126-73-8	0.12 ppb	200 ppb	0.059%	X	
48 Dibutyl butylphosphonate	78-46-6	0.04 ppb	7 ppb	0.643%	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	0.44 ppb	1000 ppb	0.044%	X	
52 2,4-Dimethylpyridine	108-47-4	0.26 ppb	500 ppb	0.051%	X	
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 OptiFilter TL and 3M FR-57 for all of the COPCs evaluated. Two inlet COPC concentrations exceeded their corresponding OELs. These COPCs were ammonia and NDMA. The inlet (or outlet) concentrations of three other COPCs were lower than their corresponding OELs but exceeded 10%. These COPCs were mercury, furan and NMEA. All five 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 five COPCs with respirator cartridge inlet (or outlet) concentrations or DL/RL <10% of their OELs but >2%. These COPCs were 1,3-butadiene, formaldehyde, 2-heptylfuran, acetonitrile, and N-nitrosomorpholine. 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	25.4 ppm	25 ppm	2.48%		Up to 102% of OEL for inlet values. All outlets ≤57.3%.
2 Nitrous Oxide	10024-97-2	Not Measured	50 ppm			
3 Mercury	7439-97-6	3.10 ug/m3	25 ug/m3	7.02%		Up to 12.4% of OEL for inlet values. All outlets <RL.
Hydrocarbons						
4 1,3-Butadiene	106-99-0	0.0352 ppm	1 ppm	1.98%		Up to 3.5% of OEL for inlet values. All outlets ≤2.4%.
5 Benzene	71-43-2	0.0007 ppm	0.5 ppm	0.039%		Up to 0.1% of OEL for inlet values. All outlets ≤0.1%.
6 Biphenyl	92-52-4	0.0001 ppm	0.2 ppm	0.027%	X	
Alcohols						
7 1-Butanol	71-36-3	0.0046 ppm	20 ppm	0.023%		Up to 0.01% of OEL for inlet values. All outlets ≤0.004%.
8 Methanol	67-56-1	1.19 ppm	200 ppm	0.206%		Up to 0.6% of OEL for inlet values. All outlets <RL.
Ketones						
9 2-Hexanone	591-78-6	0.0001 ppm	5 ppm	0.002%		Up to 0.003% 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	0.0001 ppm	0.5 ppm	0.022%	X	
12 6-Methyl-2-heptanone	928-68-7	Not Detected	8 ppm	TIC	X	
13 3-Buten-2-one	78-94-4	0.0004 ppm	0.2 ppm	0.177%		Up to 0.1% of OEL for inlet values. All outlets ≤0.1%.
Aldehydes						
14 Formaldehyde	50-00-0	0.0110 ppm	0.3 ppm	0.595%		Up to 2.0% of OEL for inlet values. All outlets ≤3.7%.
15 Acetaldehyde	75-07-0	0.0124 ppm	25 ppm	0.005%		Up to 0.05% of OEL for inlet values. All outlets ≤0.03%.
16 Butanal	123-72-8	0.0006 ppm	25 ppm	0.002%		Up to 0.002% 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	0.956%	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	0.57 ppb	1 ppb	DL | RL[1] 24.3% | 121%[3]		Up to 57.3% of OEL for inlet values. All outlets <DL.
20 2,3-Dihydrofuran	1191-99-7	0.08 ppb	1 ppb	8.19% | 19.4%	X	
21 2,5-Dihydrofuran	1708-29-8	0.26 ppb	1 ppb	25.5% | 118%[3]	X	
22 2-Methylfuran	534-22-5	0.11 ppb	1 ppb	10.9% | 101%[3]	X	
23 2,5-Dimethylfuran	625-86-5	0.04 ppb	1 ppb	4.09% | 14.2%	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	3.09% | 9.86%	X	
28 2-Heptylfuran	3777-71-7	0.03 ppb	1 ppb	2.91% | 8.20%		All inlets <DL. All outlets ≤3.4%.
29 2-Propylfuran	4229-91-8	0.03 ppb	1 ppb	2.98% | 12.4%	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	0.0011 mg/m3	5 mg/m3	0.012%		Up to 0.02% of OEL for all inlet values. All outlets <DL.
Nitriles						
34 Acetonitrile	75-05-8	0.851 ppm	20 ppm	0.002%		Up to 0.07% of OEL for all inlet values. All outlets <4.3%.
35 Propanenitrile	107-12-0	0.0004 ppm	6 ppm	0.006%	X	
36 Butanenitrile	109-74-0	0.0002 ppm	8 ppm	0.002%		All inlet values <DL. All outlets ≤0.002%.
37 Pentanenitrile	110-59-8	0.0002 ppm	6 ppm	0.003%	X	
38 Hexanenitrile	628-73-9	0.0001 ppm	6 ppm	0.002%	X	
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	0.0047 ppm	5 ppm	0.095%	X	

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	9.39 ppb	0.3 ppb	6.72%		Up to 3130% of OEL for inlet values. All outlets <RL
44 N-Nitrosodiethylamine	55-18-5	0.01 ppb	0.1 ppb	13.2%	X	
45 N-Nitrosomethylethylamine	10595-95-6	0.07 ppb	0.3 ppb	5.27%		Up to 21.7% of OEL for inlet values. All outlets <RL.
46 N-Nitrosomorpholine	59-89-2	0.02 ppb	0.6 ppb	2.08%		Up to 3.3% of OEL for all inlet values. All outlets <RL.
Organophosphates						
47 Tributyl phosphate	126-73-8	0.07 ppb	200 ppb	0.036%	X	
48 Dibutyl butylphosphonate	78-46-6	0.03 ppb	7 ppb	0.384%	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	0.47 ppb	1000 ppb	0.047%	X	
52 2,4-Dimethylpyridine	108-47-4	0.27 ppb	500 ppb	0.054%	X	
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			

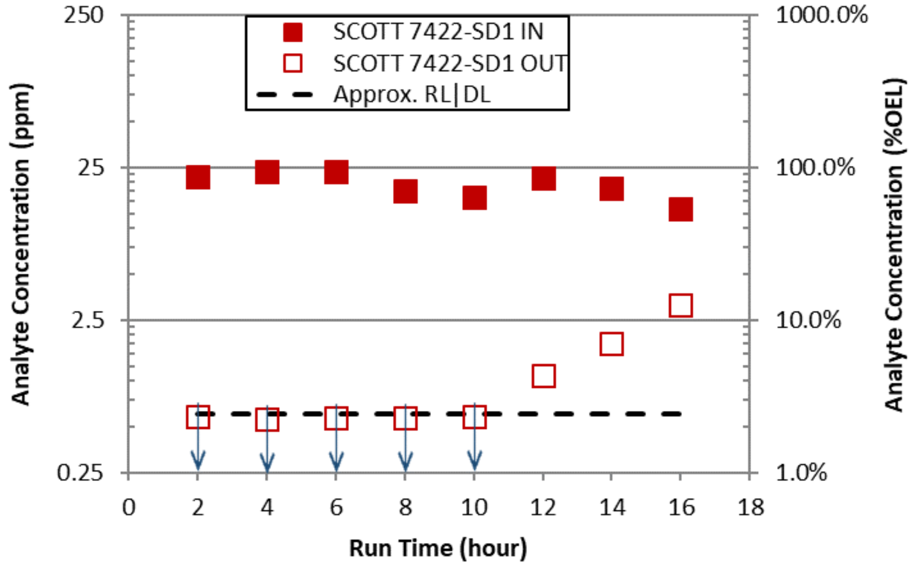
5.0 Plots of COPCs with Significant Detected Values

5.1 APR Cartridge Testing

This section provides details for the five COPCs from the APR testing identified in Table 1 with concentrations (inlet or outlet) >10% of the corresponding OEL. Plots of the corresponding data are given, as well as the associated analyses.

Ammonia *(see Figure 2)* – The DL for ammonia corresponds to approximately 2.4% of its OEL. For both the SCOTT 7422-SD1 and 7422-SC1 cartridges, the inlet ammonia concentrations ranged from 64% to 95% of the OEL. For the SCOTT 7422-SD1 cartridge, outlet concentrations were >10% of the OEL between 14 and 16 hours of testing. For the SCOTT 7422-SC1 cartridge, all cartridge outlet concentrations were <10% of the OEL, but the 14- and 16-hour concentrations showed evidence that breakthrough had begun.

Vendor-developed cartridge service life calculators were used to make estimations based on ammonia 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 multiple chemicals, the cartridge service life calculators are based only on a single ammonia component concentration (i.e., not for conditions with a mixture of chemicals). For the current study, ammonia measurements were consistent for the SCOTT 7422-SC1 cartridge—estimated service life of 26.4 hours versus the observed times of >16 hours to exceed 10% of the OEL. However, for the SCOTT 7422-SD1 cartridge, the estimated service life of 22.2 hours was longer than the observed time of 14 to 16 hours. Sensitivity analysis described in Appendix G indicates that at lower ammonia inlet concentrations (e.g., 100% of the OEL), the service-life estimates are particularly sensitive to small changes in ammonia concentration. For example, a 4-ppm increase (22%) in ammonia concentration results in a 3 hour shorter service-life projection. Therefore, the longer estimated service-life may be due to uncertainty between the average measured inlet concentration and actual concentration that the cartridge was subjected to over the 16-hour test period.



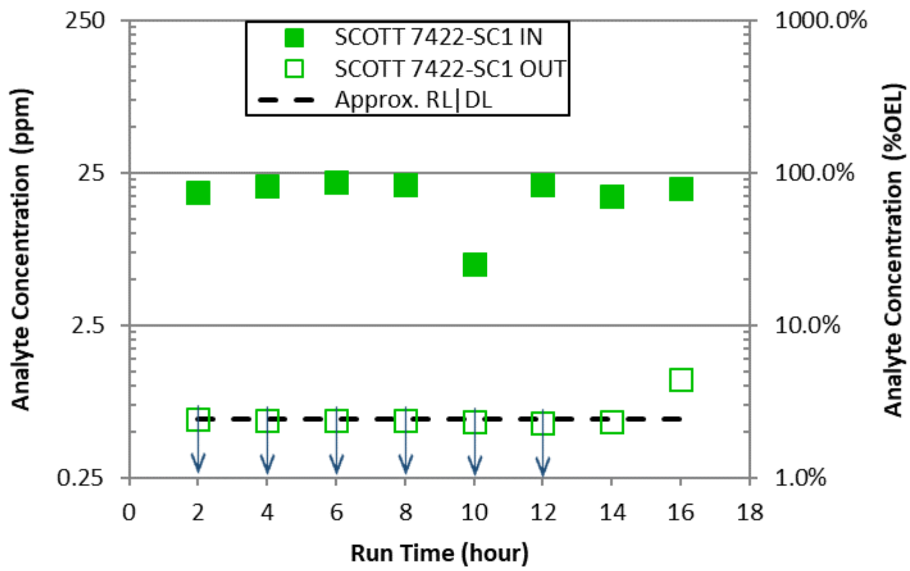


Figure 2. Plot of Measured Ammonia Concentrations for the Two APR Cartridges Tested (SCOTT 7422-SD1 and SCOTT 7422-SC1). Data points noted with ↓ indicate measurements less than the DL or RL.

Mercury *(see Figure 3)* – The DL for mercury corresponds to approximately 6.9% of the OEL. For both SCOTT 7422-SD1 and 7422-SC1 cartridges, the inlet mercury concentrations ranged from 6.7% to 16.2% of the OEL. For the SCOTT 7422-SD1 cartridge, all cartridge outlet concentrations were <10% of the OEL and DL. For the SCOTT 7422-SC1 cartridge, all outlet concentration measurements were less than the DL, except for the 16-hour concentration that was >10% of the OEL. This may indicate breakthrough occurring after 14 hours for the 7422-SC1 cartridge.

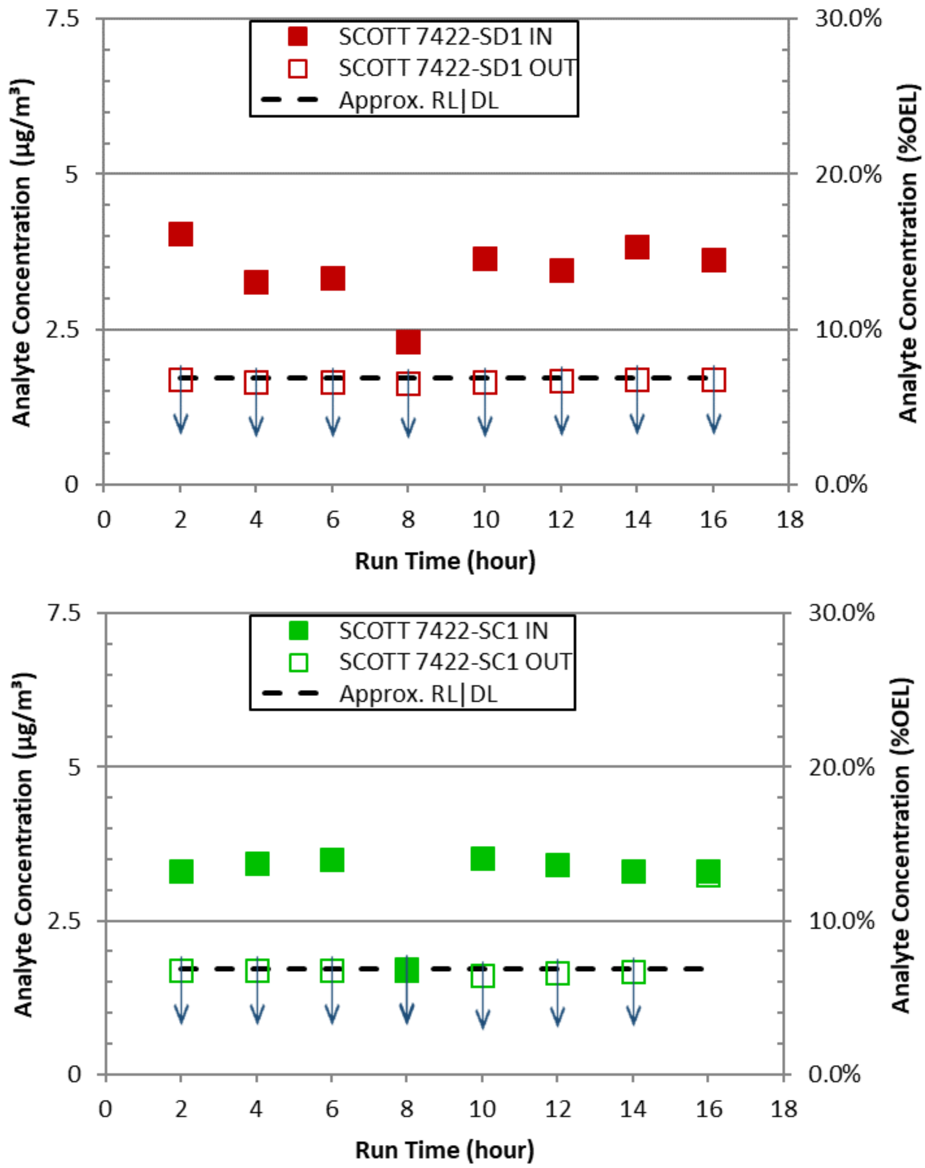


Figure 3. Plot of Measured Mercury Concentrations for the Two APR Respirator Cartridges Tested (SCOTT 7422-SD1 and SCOTT 7422-SC1). Data points noted with ↓ indicate measurements less than the DL or RL. Outlet data points not visible are obscured by the inlet data points.

Furan *(see Figure 4)* – The DL for furan corresponds to approximately 23% of the OEL, and the RL corresponds to 115%. Inlet concentrations measured throughout the testing period for the SCOTT 7422-SD1 cartridge started with an initial value less than the analytical DL, then varying between 49% and 104% of the OEL for the remainder of the test. The inlet concentrations measured for the SCOTT 7422-SC1 cartridge ranged from less than the analytical DL for the first three measurements, to 102% of the OEL, then concentrations above the DL for the remainder of the test. All of the outlet measurements were below the analytical DL for both respirator cartridges. Thus, there was no evidence of breakthrough over the measured time period for either cartridge tested.

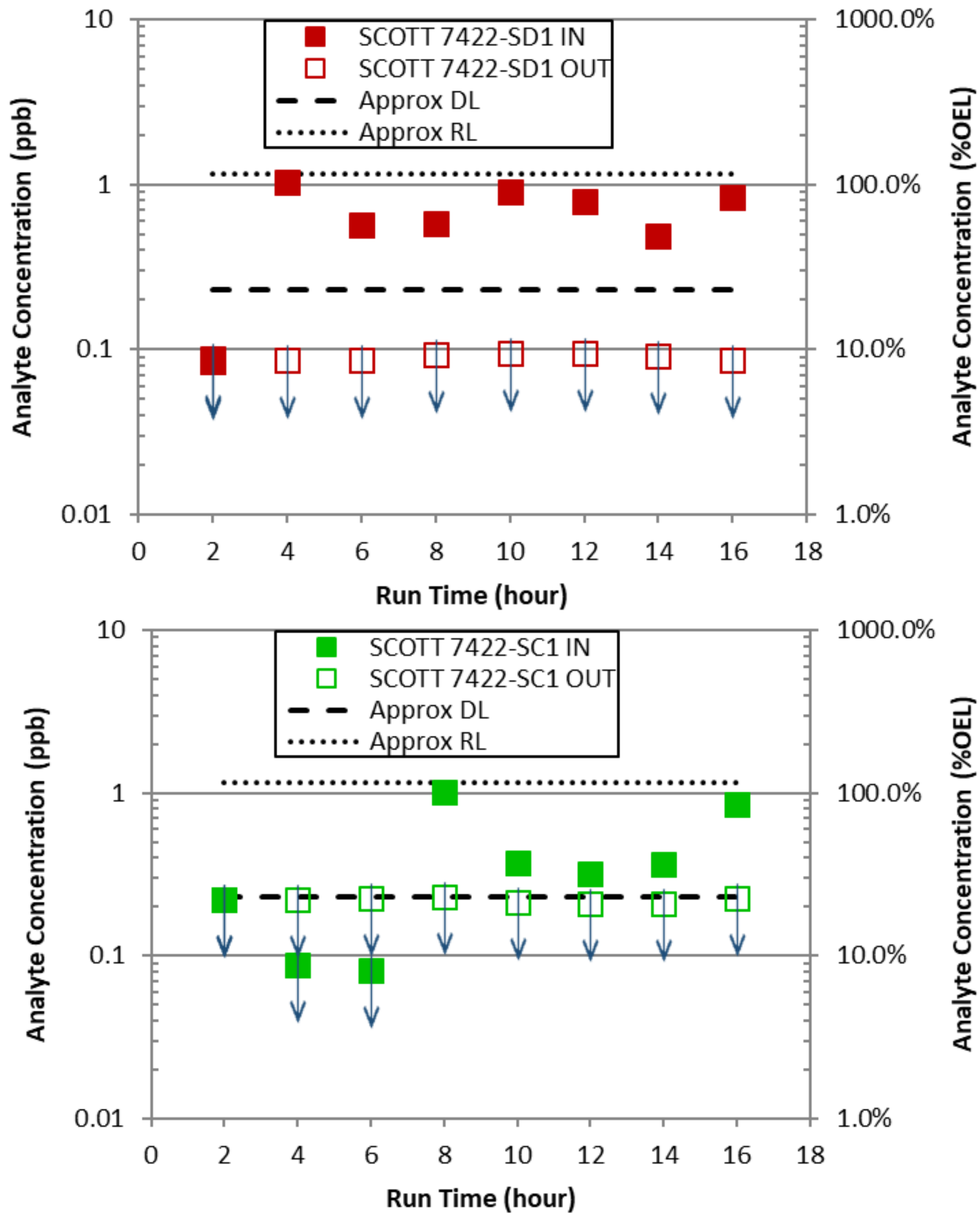


Figure 4. Plot of Measured Furan Concentrations for the Two Respirator Cartridges Tested (SCOTT 7422-SD1 and SCOTT 7422-SC1). Data points noted with ↓ indicates measurements less than the DL. Outlet data points not visible are obscured by the inlet data points.

***N-nitrosodimethylamine** (see Figure 5)* – The DL for NDMA corresponds to approximately 5.8% of its OEL. All inlet concentration measurements for both cartridge tests were significantly greater than the DL, ranging from 1090% to 2681% of the OEL. Inlet concentrations measured throughout the testing period for the SCOTT 7422-SD1 cartridge were relatively constant, with a maximum of 1732% of the OEL. For the SCOTT 7422-SC1 cartridge, inlet concentrations were higher, with a maximum of 2681% of the OEL. However, analytical flags on these inlet concentrations indicate that there were analyte recovery issues with laboratory control sample, indicating uncertainty in the absolute magnitude of these measurements. All outlet measurements from both cartridges tested were below the analytical DL, and there were no similar analytical flags on any outlet concentrations. Based on these data, there was no evidence of breakthrough >10% the OEL over the measured time period for either cartridge tested.

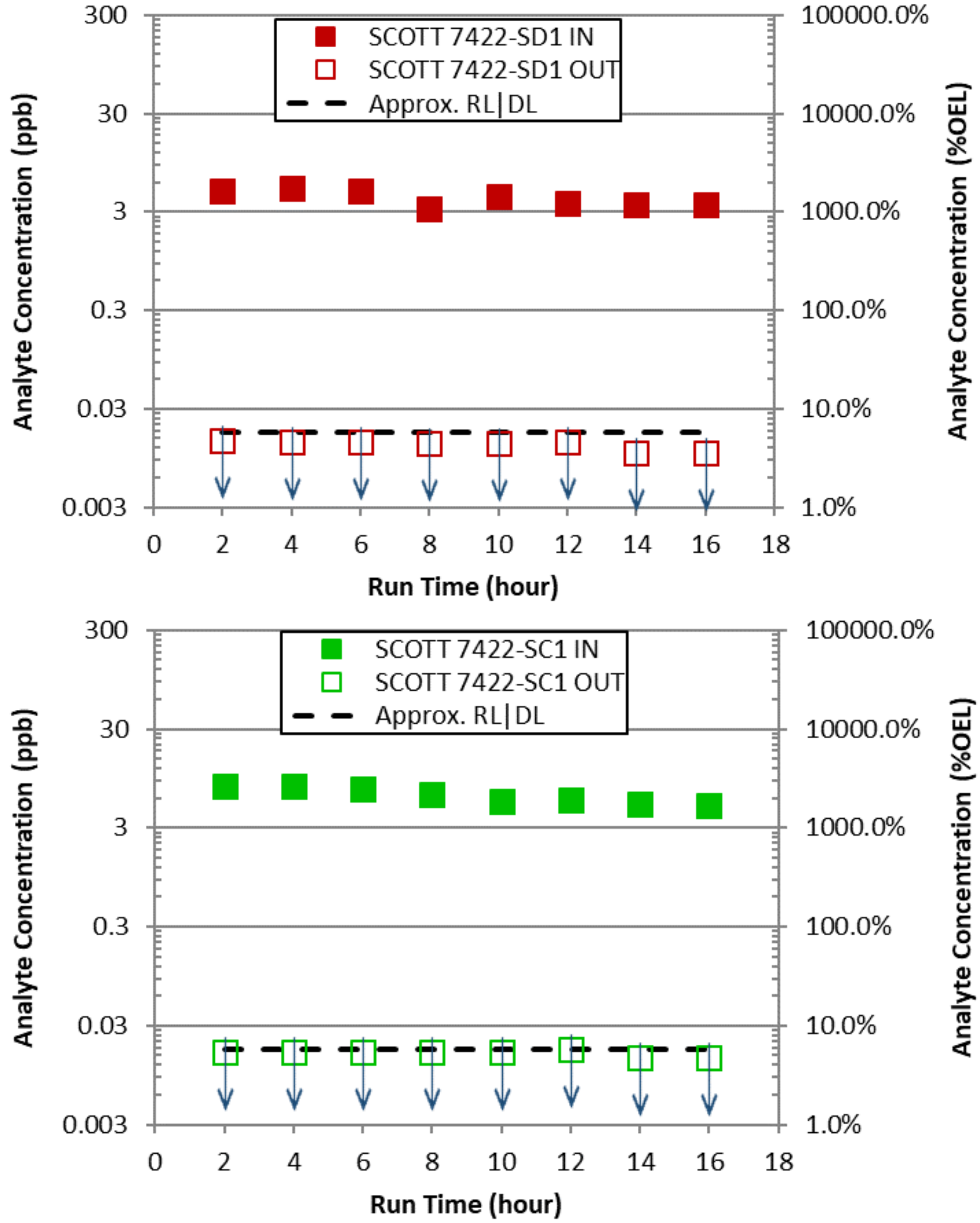
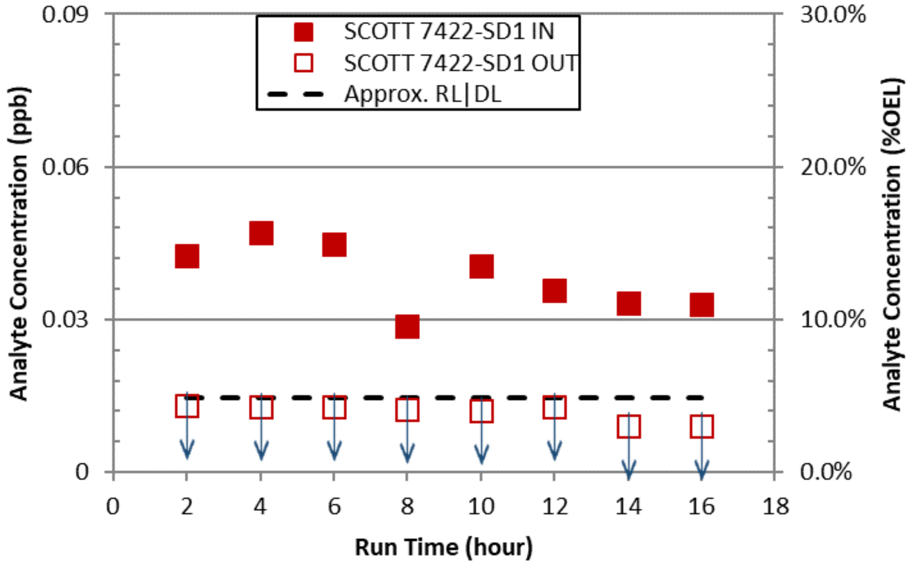


Figure 5. Plot of Measured N-nitrosodimethylamine Concentrations for the Two Respirator Cartridges Tested (SCOTT 7422-SD1 and SCOTT 7422-SC1). Data points noted with ↓ indicate measurements less than the DL or RL.

N-nitrosomethylethylamine *(see Figure 6)* – The DL for NMEA corresponds to approximately 4.8% of its OEL. All inlet concentration measurements for both cartridge tests were greater than the DL, ranging from 9.6% to 20.7% of the OEL. Inlet concentrations measured for the SCOTT 7422-SD1 cartridge ranged from 9.6% to 15.7% of the OEL. For the SCOTT 7422-SC1 cartridge, inlet concentrations were moderately higher, with a maximum of 20.7% of the OEL. Although analytical flags on all inlet concentrations for the SCOTT 7422-SC1 cartridge indicate an analyte recovery issue, these were the result of a change in sample extraction procedure, and the results are still considered quantitative. 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.



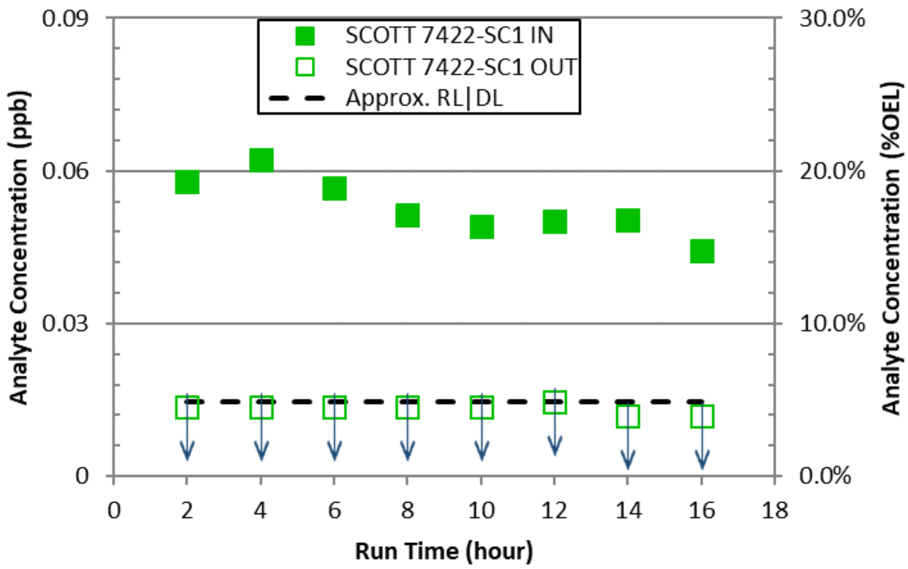


Figure 6. Plot of Measured N-nitrosomethylethylamine Concentrations for the Two Respirator Cartridges Tested (SCOTT 7422-SD1 and SCOTT 7422-SC1). Data points noted with ↓ indicate measurements less than the DL or RL.

5.2 PAPR Cartridge Testing

This section provides detail on the five COPCs from the PAPR testing identified in Table 2 with concentrations (inlet or outlet) >10% of the corresponding OEL. Plots of the corresponding data are given, as well as the associated analyses.

Ammonia *(see Figure 7)* – The DL for ammonia corresponds to approximately 2.5% of its OEL. For both MSA OptiFilter TL and 3M FR-57 cartridges, the inlet ammonia concentrations ranged between 67% and 102% of the OEL. All outlet concentrations from the MSA TL cartridge were less than the RL. For the 3M FR-57 cartridge, the outlet concentrations were >10% of the OEL between 4 and 6 hours of testing and increased to 57% by the end of the test.

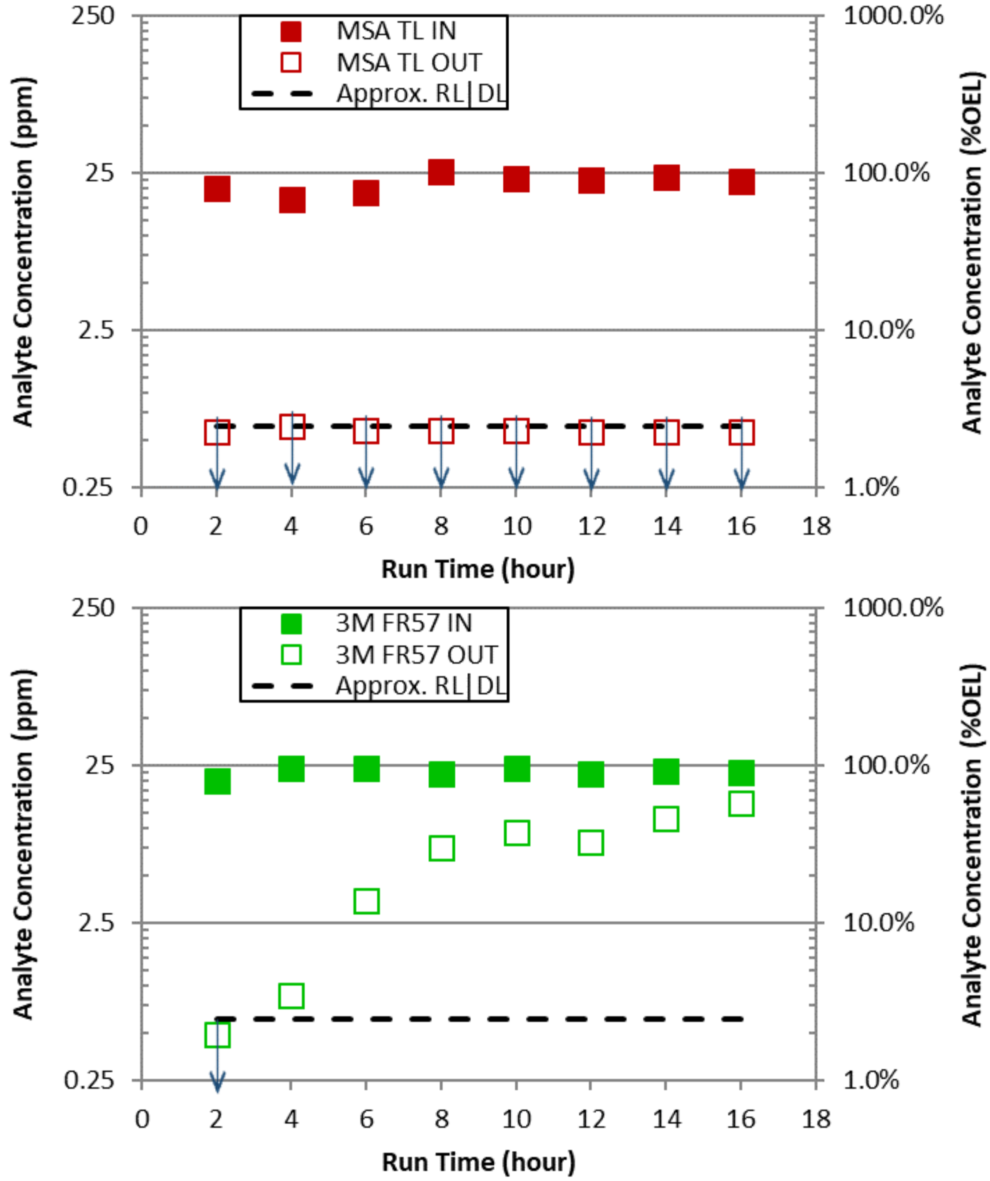


Figure 7. Plots of Measured Ammonia Concentrations for the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Outlet data points not visible are obscured by the inlet data points.

Vendor-developed service-life calculators were used to make ammonia 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 multiple 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, the service life estimates were generally consistent with actual measured breakthrough times, indicating that ammonia breakthrough is not significantly impacted by other vapor constituents under these Hanford tank waste conditions. For the current study, the ammonia service life estimation for the MSA TL PAPR cartridge was consistent at 15.6 hours (based on average inlet concentration) versus the observed time of >16 hours. The service-life estimation for the 3M FR-57 PAPR cartridge was also consistent at 5.4 hours (based on average inlet concentration) versus the observed time of 4 to 6 hours.

Mercury *(see Figure 8)* – The DL for mercury corresponds to approximately 7% of the OEL. Inlet concentrations measured throughout the testing period for the MSA TL and 3M FR-57 cartridges ranged from 8.2 and 12.4% 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.

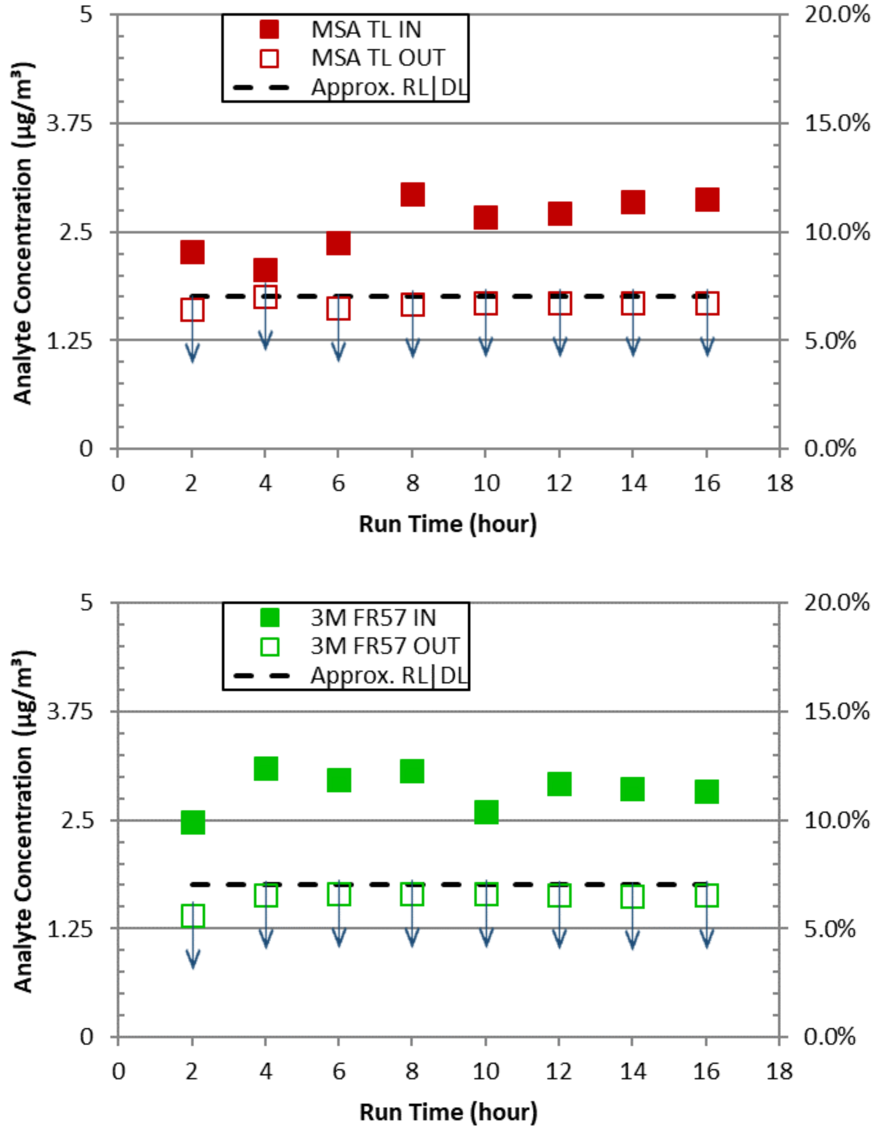


Figure 8. Plots of Measured Mercury Concentrations for the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Data points noted with ↓ indicate measurements less than the DL or RL.

Furan *(see Figure 9)* – The DL for furan corresponds to approximately 24% of the OEL and the RL is approximately 121%. The inlet concentrations measured throughout the testing period for the MSA TL and 3M FR-57 cartridges ranged between less than the DL and 57% of the OEL. Most of the inlet measurements for both cartridges tested were less than the DL, except for the three inlet measurements for the MSA TL cartridge at 8, 10, and 14 hours, and the first (2-hour) measurement for 3M FR-57. 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.

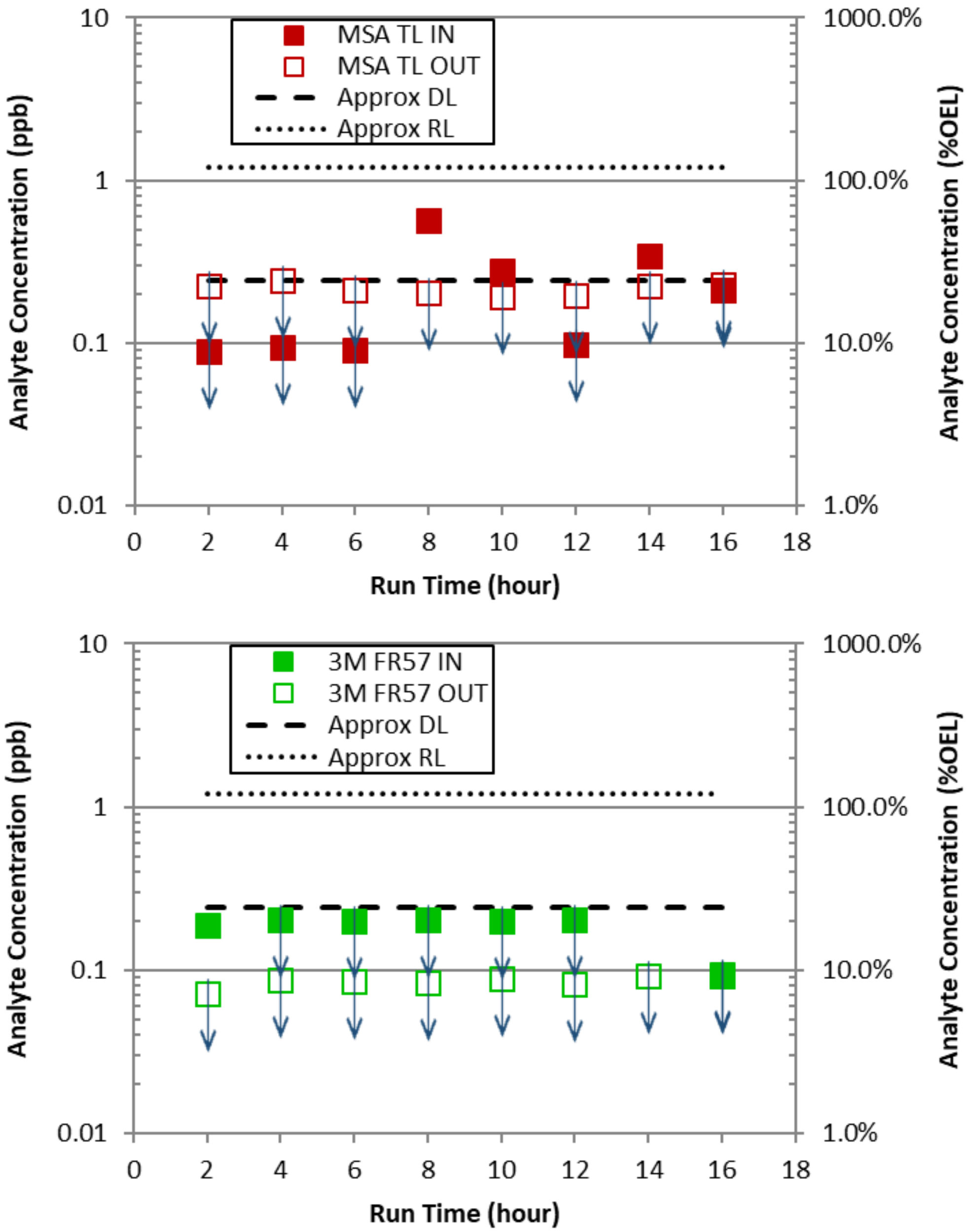


Figure 9. Plot of Measured Furan Concentrations for the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Data points noted with ↓ indicate measurements less than the DL. Outlet data points not visible are obscured by the inlet data points. Note that the 14-hour inlet measurement for 3M FR-57 was lost as a result of a broken sorbent tube.

***N-Nitrosodimethylamine** (see Figure 10)* – The DL for NDMA corresponds to approximately 7% of its OEL. All inlet concentrations for both the MSA TL and 3M FR-57 cartridges ranged from 1106% to 3130% of the OEL. Inlet concentrations measured for the MSA TL cartridge ranged from 2213% to 3130% of the OEL. However, analytical flags on these inlet concentrations report that there were analyte recovery issues with the laboratory control sample, indicating uncertainty in the absolute magnitude of these measurements. For the 3M FR-57 cartridge, inlet concentrations were lower, ranging from 1106% to 2127% of the OEL, but absent any analytical recovery flags. All outlet measurements from both cartridges tested were below the analytical DL, and there were no similar analytical flags on any outlet concentrations. Thus, there is no evidence of breakthrough over the measured time period for either cartridge tested.

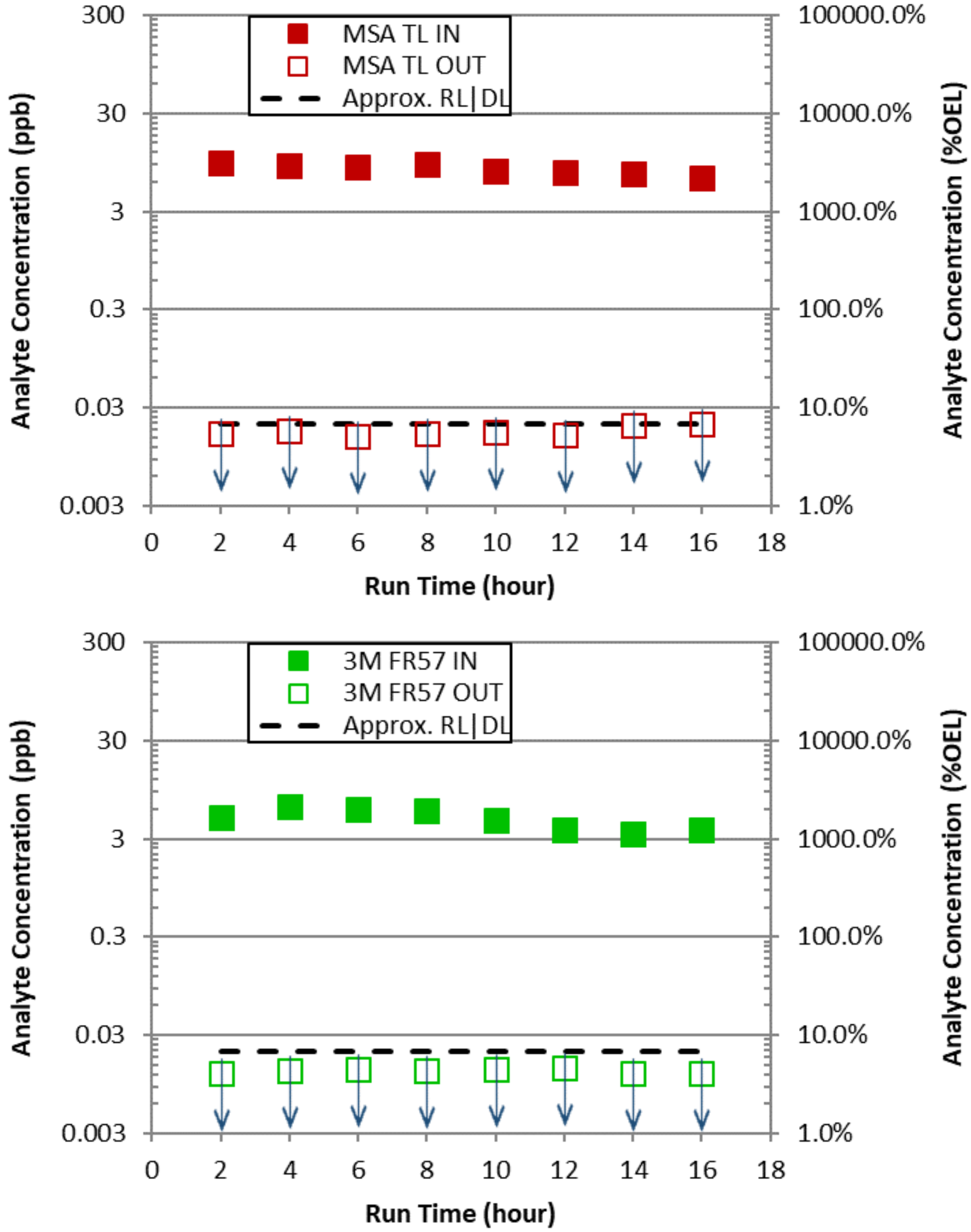


Figure 10. Plots of Measured N-nitrosodimethylamine Concentrations for the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Data points noted with ↓ indicate measurements less than the DL or RL.

N-nitrosomethylethylamine (see Figure 11) – The DL for NMEA corresponds to approximately 5% of its OEL. All inlet concentration measurements for both cartridge tests were greater than the DL, ranging from 10% to 22% of the OEL. All outlet measurements for both cartridges were less than the DL so there is no evidence of breakthrough over the measured time period.

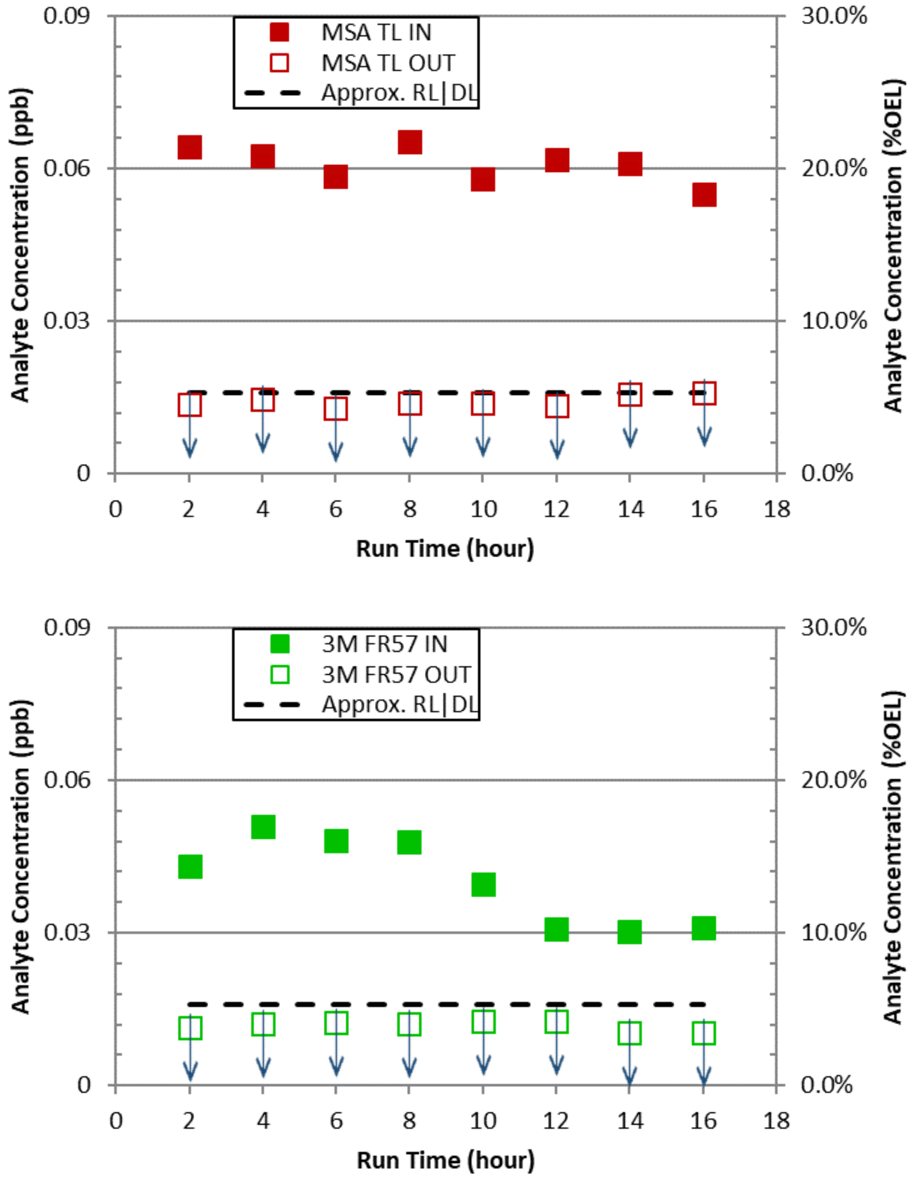


Figure 11. Plots of Measured N-nitrosomethylethylamine Concentrations for the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Data points noted with ↓ indicate measurements less than the DL or RL. Outlet data points not visible are obscured by the inlet data points.

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 AP exhauster 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 exhaust 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 AP exhauster APR and 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 AP exhauster data for COPCs with boiling points below 70°C.

Table 3. Historical AP Exhauster – 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	0	n/a	n/a	n/a	n/a	Not Measured	
1 Ammonia	7664-41-7	-28	25 ppm	40 (28)	103	36.1 (51.4)	412%	144% (206%)	94.9%	12.7%
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	6	0.0067	0.0047	2.24%	1.58%	1.0%	2.7%
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	1	<0.0107	<0.0107	<1.07%	<1.07%	6.6%	6.4%
42 Ethylamine	75-04-7	62	5 ppm	20 (1)	<0.0138 (0.0117)	0.0054 (0.0117)	<0.28% (0.23%)	0.11% (0.23%)	0.09% (RL)[2]	0.09% (RL)
15 Acetaldehyde	75-07-0	69	25 ppm	5 (4)	0.0236	0.0179 (0.0194)	0.094%	0.072% (0.078%)	0.06%	0.03%
19 Furan	110-00-9	88	1 ppb	42 (15)	7.15	2.26 (4.13)	715%	226% (413%)	104%[3]	23.0% (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	5	<0.0119	<0.0035	<11.9%	<3.48%	0.93% (DL)	0.93% (DL)
20 2,3-Dihydrofuran	1191-99-7	130	1 ppb	17	<0.732	<0.555	<73.2%	<55.5%	3.0% (DL)[4]	3.3% (DL)
22 2-Methylfuran	534-22-5	147	1 ppb	42	<2.47	<1.22	<247%	<122%	10.1% (DL)[3]	10.3% (DL)
8 Methanol	67-56-1	148	200 ppm	0	n/a	n/a	n/a	n/a	Not Measured	
21 2,5-Dihydrofuran	1708-29-8	152	1 ppb	42	<2.90	<1.43	<290%	<143%	25.0% (DL)[3]	25.8% (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.*

Table 4. Historical AP Exhauster – 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	0	n/a	n/a	n/a	n/a	Not Measured	
1 Ammonia	7664-41-7	-28	25 ppm	40 (28)	103	36.1 (51.4)	412%	144% (206%)	102%	57.3%
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	6	0.0067	0.0047	2.24%	1.58%	2.0%	3.7%
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	1	<0.0107	<0.0107	<1.07%	<1.07%	3.5%	2.4%
42 Ethylamine	75-04-7	62	5 ppm	20 (1)	<0.0138 (0.0117)	0.0054 (0.0117)	<0.28% (0.23%)	0.11% (0.23%)	0.09% (RL)[2]	0.09% (RL)
15 Acetaldehyde	75-07-0	69	25 ppm	5 (4)	0.0236	0.0179 (0.0194)	0.094%	0.072% (0.078%)	0.05%	0.03%
19 Furan	110-00-9	88	1 ppb	42 (15)	7.15	2.26 (4.13)	715%	226% (413%)	57.3%[3]	24.3% (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	5	<0.0119	<0.0035	<11.9%	<3.48%	0.93% (DL)	0.96% (DL)
20 2,3-Dihydrofuran	1191-99-7	130	1 ppb	17	<0.732	<0.555	<73.2%	<55.5%	8.2% (DL)[4]	8.0% (DL)
22 2-Methylfuran	534-22-5	147	1 ppb	42	<2.47	<1.22	<247%	<122%	6.9%[3]	10.9% (DL)
8 Methanol	67-56-1	148	200 ppm	0	n/a	n/a	n/a	n/a	0.60%	0.21% (RL)
21 2,5-Dihydrofuran	1708-29-8	152	1 ppb	42	<2.90	<1.43	<290%	<143%	25.2% (DL)[3]	25.5% (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

Three COPCs—ammonia, furan, and NDMA—were previously measured in the AP exhauster at concentrations above 100% of their OELs. Four additional COPCs—mercury, NDEA, NMEA, and N-nitrosomorpholine—were historically measured above 10% of their OELs. Of these seven COPCs, only furan and NDMA were measured at concentrations above 100% of their respective OELs in inlets to the APR cartridge testing. However, three more of these seven COPCs—ammonia, mercury, and NMEA—were detected in the inlets to the APR cartridge at concentrations exceeding 10% of their OELs. Following are the individual comparisons of cartridge source measurements and historical measurements for these seven COPCs:

- The maximum ammonia inlet concentration measured in the APR cartridge tests was 94.9% of the OEL, which is lower than the historic maximum of 412% of the OEL (January 2017) by approximately 0.23×.
- The maximum historic concentration of mercury in the AP exhauster was 31.6% of the OEL. The maximum APR cartridge inlet concentration was generally consistent[17] (16.2% of the OEL) with the historic maximum.

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

- The maximum historic concentration for furan in the AP exhauster was measured in March 2017, more than a month after a large waste transfer activity, reporting 715% of the OEL. In the APR cartridge test inlet, furan was significantly lower at 104% of the OEL, or approximately 0.15× the historic maximum.
- Nitrosamines including NDMA, NDEA, NMEA, and N-nitrosomorpholine had maximum historic exhauster concentrations of 5267%, 16.9%, 49.3%, and 15.7% of their OELs, respectively. APR cartridge testing inlet concentrations were lower than historic maximums. The NDMA maximum concentration of 2681% of its OEL was generally consistent with the historic maximum, whereas cartridge inlet concentrations of NMEA and N-nitrosomorpholine were lower at 0.4× (20.7%) and 0.2× (3.3%) of their historic maxima, respectively. The maximum cartridge inlet concentration of NDEA was less than the RL (<12.5%), but within analytical uncertainty compared to the historic maximum of 16.9%.

Overall, the available historic vapor surveys for the AP exhauster indicate that the same COPCs were detected above 10% of their OELs during both historic sampling and cartridge testing. For most COPCs, cartridge inlet concentrations were lower than the historic maxima. The historic maximum for furan was significantly higher than observed in cartridge testing. However, for mercury and NDMA, cartridge inlet concentrations were generally consistent with historic exhauster concentrations. Differences in maximum concentrations observed between cartridge and exhauster may be affected by differences in AP tank farm waste compositions due to regular waste transfer activities in and out of tanks in this farm. In addition, several historic COPC measurements may have been impacted by recent waste transfer activity prior to sampling, which could have temporarily elevated exhauster concentrations for ammonia and furan compared to the conditions during cartridge testing.

6.2 PAPR Cartridge Testing

Three COPCs—ammonia, furan, and NDMA—were previously measured in the AP exhauster at concentrations above 100% of their OELs. Four additional COPCs—mercury, NDEA, NMEA, and N-nitrosomorpholine—were historically measured above 10% of their OELs. Of these seven COPCs, only ammonia and NDMA were measured at concentrations above 100% of their respective OELs in inlets to the PAPR cartridge test stand. However, four more of these seven COPCs—furan, mercury, NDEA, and NMEA—were detected in the inlets to the PAPR cartridge at concentrations exceeding 10% of their OEL. Following are the individual comparisons of cartridge source measurements and historical measurements for these seven COPCs:

- The maximum ammonia inlet concentration measured in the PAPR cartridge tests was 102% of the OEL, approximately 0.25× the historic exhauster maximum of 412% of the OEL obtained in January 2017.
- The maximum concentration of mercury in the AP exhauster was 31.6% of the OEL. The maximum PAPR cartridge inlet concentration was lower, at approximately 0.4× (12.4% of the OEL) the historic maximum.
- The maximum historic concentration for furan in the AP exhauster was measured in March 2017, more than a month after a large waste transfer activity, reporting 715% of the OEL. In the PAPR cartridge test inlet, furan was significantly lower at 57% of the OEL, or approximately 0.08× the historic maximum. This inlet concentration was also lower than the maximum APR inlet concentration by approximately 0.6×.

- Nitrosamines including NDMA, NDEA, NMEA, and N-nitrosomorpholine had maximum historic exhauster concentrations of 5267%, 16.9%, 49.3%, and 15.7% of their OELs, respectively. PAPR cartridge testing inlet concentrations were lower than historic maxima. The NDMA maximum concentration of 3130% of the OEL was lower but generally consistent with the historic maximum, whereas the cartridge inlets of NMEA and N-nitrosomorpholine were lower at 0.4× (21.7%) and 0.2× (3.3%) of historic maxima, respectively. The maximum cartridge inlet concentration of NDEA was less than the RL (<13.2%), but within analytical uncertainty compared to the historic maximum of 16.9%.

Overall, the available historic vapor surveys for the AP exhauster indicate that the same COPCs have been detected above 10% of the OELs as those in the inlet to the cartridge test system—ammonia, mercury, furan, and the four nitrosamine compounds—but most of these COPCs were detected at lower concentrations in the cartridge inlet than the historic maximums. However, the maximum inlet PAPR cartridge concentrations for NDMA and NDEA were generally consistent with the historic maximum values. Ammonia, mercury, NMEA, and N-nitrosomorpholine all had lower cartridge inlet concentrations than historic maxima, generally between 0.2× to 0.4× the historic maximum concentrations. Only furan had significantly lower maximum cartridge inlet concentration compared with the historic sampling.

7.0 Conclusions

Cartridge testing on a slipstream from the Hanford AP tank farm exhauster was conducted during March 23–24, 2018. This testing focused on both APR and PAPR cartridges. Previous testing of APR cartridges was conducted on the AP exhauster in June 2016; however, an exhauster upgrade was completed in September 2016. In the most recent testing, slipstream vapors from the new AP exhauster were fed to two respirator cartridge test stands—one for the PAPR respirators and the other for the APR respirators. Both the APR and PAPR test stands were developed by WRPS in collaboration with HiLine Engineering (Richland, Washington). Multipurpose APR cartridges—SCOTT 7422-SD1 and SCOTT 7422-SC1 (SCOTT Safety, Monroe, North Carolina)—were assessed on separate days using an APR cartridge test stand. Multipurpose PAPR cartridges—MSA OptiFilter TL (MSA Safety Inc., Pittsburgh, Pennsylvania) and 3M FR-57 (3M Company, Maplewood, Minnesota)—were also tested using the PAPR cartridge test stand over the same two days at approximately the same time as the APR tests. 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 inlet vapor concentrations from the AP exhauster slipstream to the APR cartridges, two COPCs, furan and NDMA, exceeded their corresponding OELs.[18] Three COPCs—ammonia, mercury, and NMEA—had one or more inlet concentration measurements >10% of their OELs, but <100%. All other COPC inlet and outlet measurements did not exceed 10% of their OELs. Overviews of the five highest concentration COPCs are given below.

- Maximum ammonia concentrations at the inlets to the SCOTT 7422-SD1 and SCOTT 7422-SC1 cartridges were 95% and 87% of the OEL, respectively. These concentrations were lower than the historic maximum measurements from the AP exhauster (412% of the OEL). Ammonia breakthrough, above 10% of the OEL, appeared to occur in the SCOTT 7422-SD1 cartridge between 14 and 16 hours of run time. All outlet concentrations for the SCOTT 7422-SC1 cartridge were <10% of the OEL but increased above the RL for the last two measurements, indicating potential breakthrough after 16 hours. The observed ammonia breakthrough behavior for the SC1 cartridge is consistent with prior respirator cartridge tests on Hanford tank vapor sources with similar concentrations. For the SD1 cartridge, the estimated service life of 22 hours was longer than the 14 to 16 hours observed breakthrough time. At lower ammonia inlet concentrations (e.g., 100% of the OEL), the service-life estimates are particularly sensitive to small changes in ammonia concentration. Therefore, differences in estimated versus observed breakthrough are likely a result of uncertainty between the average measured inlet concentration and the actual concentration to which the cartridge was subjected over the duration of the test.
- Maximum mercury concentrations at the inlets to the SCOTT 7422-SD1 and SCOTT 7422-SC1 cartridges were 16% and 14% of the OEL, respectively. These concentrations were lower than the

[18] 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.

historical maximum of 32%. All the cartridge outlet concentrations for mercury were below the RL, except for the 16-hour measurement for the SCOTT 7244-SC1 cartridge, which exceeded 10% of the OEL. These data suggest that mercury breakthrough may have occurred between 14 and 16 hours for the SCOTT 7244-SC1. However, there was no evidence of breakthrough for the SCOTT 7244-SD1 cartridge.

- Maximum furan concentrations at the inlets to the SCOTT 7422-SD1 and SCOTT 7422-SC1 cartridges were 104% and 102% of the OEL, respectively. These concentrations were lower than the historic maximum of 715% of the OEL. Outlet concentrations from both cartridges were below the RL and DL so there was no evidence that breakthrough occurred.
- Maximum NDMA concentrations at the inlets to the SCOTT 7422-SD1 and SCOTT 7422-SC1 cartridges were 1733% and 2681% of the OEL, respectively. These concentrations were lower than the historic maximum of 5267% of the OEL. All the cartridge outlet concentrations from both cartridges tested were below the DL. Therefore, there was no evidence that breakthrough occurred.
- Most NMEA inlet concentrations were >10% of the OEL (up to 21%) but were lower than the historic maximum of 49% of the OEL. All outlet concentrations were below DL. Therefore, there was no evidence that breakthrough occurred.

7.2 PAPR Cartridge Testing

Based on measured inlet vapor concentrations to the PAPR cartridges, two COPCs—ammonia and NDMA—exceeded their corresponding OELs. Three COPCs—mercury, furan, and NMEA—had one or more inlet concentration measurements >10% of their respective OELs, but <100% of the OELs. None of the other COPC inlet and outlet measurements exceeded 10% of their OELs. Of the five COPCs with higher inlet concentrations, only ammonia showed clear evidence of breakthrough above 10% of its OEL. Overviews of the PAPR cartridge test results for the above COPCs are as follows:

- Maximum ammonia concentrations at the respirator cartridge inlet to the MSA OptiFilter TL and 3M FR-57 cartridges were 102% and 97% of the OEL, respectively. These concentrations were lower than the historic maximum measurements from the AP exhauster (412% of the OEL). All cartridge outlet concentrations from the MSA TL cartridge were less than the RL so there was no evidence breakthrough occurred. However, between 4 and 6 hours, ammonia breakthrough appeared to occur in the 3M FR-57 cartridge, above 10% of the OEL. The observed ammonia breakthrough behavior for both cartridges is consistent with service-life estimates and prior respirator cartridge tests on Hanford tank vapor sources with similar concentrations.
- Maximum mercury concentrations at the inlets to the MSA TL and 3M FR-57 cartridges were both 12% of the OEL, which is lower than the historical maximum of 32% of the OEL. All of the cartridge outlet concentrations for mercury were below the RL, indicating that no breakthrough occurred.
- Maximum furan concentrations at the inlets to the MSA TL and 3M FR-57 cartridges were 57% and 19% of the OEL, respectively. However, most inlet concentrations measured were below the DL. These concentrations were significantly lower than the historic AP exhauster maximum of 715% of the OEL. All the cartridge outlet concentrations for furan were below the DL of approximately 24% of the OEL, indicating that no breakthrough occurred.

- Maximum NDMA concentrations at the inlets to the MSA TL and 3M FR-57 cartridges were 3130% and 2127% of the OEL, respectively. These concentrations were lower, but generally consistent with the historic maximum of 5267% of the OEL. All cartridge outlet concentrations from both cartridges tested for NDMA were below the DL. Therefore, there was no evidence that breakthrough occurred.
- Maximum NMEA concentrations at the inlets to the MSA TL and 3M FR-57 cartridges were 22% and 17% of the OEL, respectively. These concentrations were lower than the historic maximum of 49% of the OEL. All the cartridge outlet concentrations from both cartridges tested for NDMA were below the DL. Therefore, there was no evidence that breakthrough occurred.

8.0 Recommendations

Based on the measurements in this study, ammonia exhibited breakthrough above 10% of its OEL in tests with the SCOTT 7422-SD1 APR and the 3M FR-57 PAPR cartridges. In addition, onset of breakthrough was exhibited with the SCOTT 7422-SC1 cartridge, where effluent concentrations rose above the DL but had not yet exceeded 10% of the OEL by the end of the test. This is consistent with prior tank vapor testing in which 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 accumulated for the MSA TL and 3M FR-57 PAPR cartridges to date also indicate that ammonia can be considered the leading indicator of breakthrough in those cartridges.

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 estimations for the current study were consistent for the SCOTT 7422-SC1 cartridge; that is, greater than 16 hours observed and estimated. However, for the SCOTT-7422-SD1 cartridge, the observed breakthrough time of 14 to 16 hours was lower than the estimated service life of 22 hours based on average inlet concentration. The reason for the slightly higher estimated service life for the SCOTT-7422-SD1 cartridge is believed to be slight differences in the average inlet concentration used for the estimation versus the actual value, because the service-life estimates are particularly sensitive to inlet concentrations at low concentrations such as those encountered in this study. For example, if the maximum concentration were used for the SCOTT-7422-SD1 cartridge (23.7 ppm) versus the average (19.4 ppm) the estimated breakthrough time would decrease by approximately 3 hours. Furthermore, it is important to note that the observed breakthrough time for the SCOTT-7422-SD1 cartridge is well beyond the practical maximum cartridge use time for tank farm applications.

Variations in humidity, temperature, or cartridge inlet concentration for any COPCs, especially ammonia, compared to those measured in the current study could impact breakthrough time, and should be used to inform an Industrial Hygiene determination of an appropriate respirator cartridge change-out schedule for adequate worker protection.

9.0 References

1. OSHA 29 CFR 1910.134, https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=12716.
2. OSHA Respirator Change Schedules – Decision Logic Flowcharts, https://www.osha.gov/SLTC/etools/respiratory/decisionlogic/flowcharti.html.
3. OSHA Respirator Change Schedules Mathematical Modeling, and Factors that Influence Cartridge Service Life, https://www.osha.gov/SLTC/etools/respiratory/change_schedule.html.
4. OSHA Standard Respirator Testing Procedures, http://www.cdc.gov/niosh/npptl/stps/aprespcbrn.html.
5. Wood GO. 1994. “Estimating Service Lives of Organic Vapor Cartridges.” *American Industrial Hygiene Association Journal* 55:11−15. DOI: 10.1202/0002-8894(1994)055<0011:ESLOOV>2.0.CO;2.
6. Wood GO. 2004. “Estimating Service Lives of Organic Vapor Cartridges II: A Single Vapor at All Humidities.” *Journal of Occupational and Environmental Hygiene* 1:472−492. https://doi.org/10.1080/15459620490467792.
7. Wood GO and JL Snyder. 2007. “Estimating Service Lives of Organic Vapor Cartridges III: Multiple Vapors at All Humidities.” *Journal of Occupational and Environmental Hygiene* 4:363−374. DOI: 10.1080/15459620701277468.
8. Janvier F, L Tuduri, D Cossement, D Drolet, and J Lara. 2016. “Systematic Evaluation of the Adsorption of Organic Vapors onto a Miniaturized Cartridge Device using Breakthrough Tests in Parallel Experiment with a Full Size Respirator Cartridge.” *Adsorption Science and Technology* 34:287-306. DOI: 10.1177/0263617416653119.
9. Yoon YH, JH Nelson, and J Lara. 1996. “Respirator Cartridge Service Life: Exposure to Mixtures.” *American Industrial Hygiene Association Journal 57*:809−819. https://doi.org/10.1080/15428119691014486.
10. 3M Service life software Version 3.3, http://extra8.3m.com/SLSWeb/serviceLifeDisclaimer.html?reglId=20&langCode=EN&countryName=United%20States.
11. SCOTT’s Surelife Cartridge Calculator, https://www.scottsurelife.com/DesktopUI/SelectRegion.aspx.
12. Respiratory Protection, Chapter 36 of the American Industrial Hygiene Association publication, *The Occupational Environment: Its Evaluation and Control and Management*, ISBN 1-931504-43-1.
13. Industrial Hygiene Sampling and Analysis plan for Respirator Cartridge Testing, TFC-PLN-168, REV A, June 16, 2016.
14. Air Purifying Respirator Cartridge Test Apparatus Special Tool and Equipment Evaluation, RPP-STE-59226, Rev 0, June 22, 2016.
15. Cohen HJ, SP Levine, and RP Garrison. 1991. “Development of a Field Method for Calculating the Service Lives of Organic Vapor Cartridges − Part IV. Results of Field Validation Trials. *American Industrial Hygiene Association Journal* 263−270. DOI: 10.1080/15298669191364712.

16. Nune SK, J Liu, CJ Freeman, and TM Brouns. 2020. *Analysis of Respirator Cartridge Performance Testing on a Hanford AP Tank Farm Primary Exhauster Slipstream*. PNNL-25860, Rev.1. Pacific Northwest National Laboratory, Richland, Washington.

17. Nune SK, J Liu, CJ Freeman, TM Brouns, and LA Mahoney. 2020. *Analysis of Respirator Cartridge Performance Testing on Hanford Tank SY-102*. PNNL-26041, Rev. 1. Pacific Northwest National Laboratory, Richland, Washington.

18. Nune SK, J Liu, CJ Freeman, TM Brouns, and LA Mahoney. 2020. *Analysis of Respirator Cartridge Performance Testing on Hanford Tank A-101.* PNNL-26131, Rev. 1. Pacific Northwest National Laboratory, Richland, Washington.

19. Nune SK, CK Clayton, J Liu, CJ Freeman, TM Brouns, and LA Mahoney. 2020. *Analysis of Respirator Cartridge Performance Testing on Hanford Tank BY-108.* PNNL-26180, Rev. 1. Pacific Northwest National Laboratory, Richland, Washington.

20. Nune SK, CK Clayton, J Liu, CJ Freeman, TM Brouns, and LA Mahoney. 2020. *Analysis of Respirator Cartridge Performance Testing on the 702-AZ Primary Exhauster for the Hanford AY/AZ Tank Farms*. PNNL-26243, Rev. 1. Pacific Northwest National Laboratory, Richland, Washington.

21. Nune SK, CK Clayton, J Liu, CJ Freeman, TM Brouns, and LA Mahoney. 2020. *Analysis of Respirator Cartridge Performance Testing on Hanford Tank AX-101.* PNNL-26254, Rev. 1. Pacific Northwest National Laboratory, Richland, Washington.

22. Nune SK, CK Clayton, J Liu, CJ Freeman, TM Brouns, and LA Mahoney. 2020. *Analysis of Respirator Cartridge Performance Testing on a Hanford AW Tank Farm Exhauster Slipstream*. PNNL-26337, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

23. Nune SK, CK Clayton, J Liu, CJ Freeman, TM Brouns, and LA Mahoney. 2020. *Analysis of Respirator Cartridge Performance Testing on a Hanford AN Tank Farm Exhauster Slipstream*. PNNL-26317 Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

24. Nune SK, CK Clayton, J Liu, CJ Freeman, TM Brouns, and LA Mahoney. 2020. *Analysis of Respirator Cartridge Performance Testing on the 702-AZ Primary Exhauster for the Hanford AY/AZ Tank Farms during a Waste-Disturbing Event.* PNNL-26863 Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

25. Freeman CJ, J Liu, C Clayton, SK Nune, LA Mahoney, CL Bottenus, TM Brouns, P Humble, and MJ Minette. 2020. *Overview of 2016 through 2018 Testing of Respirator Cartridge Performance on Multiple Hanford Tank Headspaces and Exhausters*. PNNL-26821 Rev. 1, Pacific Northwest National Laboratory, Richland, Washington.

26. NIOSH. 2008. *Determination of Ammonia Service Life Test, Powered Air-Purifying Respirators with Cartridges Standard Testing Procedure (STP).* TEB-APR-STP-0033C, National Institute for Occupational Safety and Health, National Personal Protective Technology Laboratory, Pittsburgh, Pennsylvania.

27. MSA Safety, Inc. *Response® Guide Cartridge Life Expectancy Calculator*. http://webapps2.msasafety.com/ResponseGuide/ChemicalCalculator.aspx

28. Scott Air Purifying Respirators (742 Twin Cartridges), https://www.scottsafety.com/en/us/DocumentandMedia1/Poster_742SelectionGuide_HS_6411_0313.pdf

29. MSA Safety, Inc. OptimAir® TL PAPR, http://us.msasafety.com/Air-Purifying-Respirators-%28APR%29/Powered-Air-Purifying-Respirators-%28PAPR%29/OptimAir%C2%AE-TL-PAPR/p/000100003000001600.

30. 3M High Efficiency Cartridge FR-57, 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.

31. Meacham JE, JO Honeyman, TJ Anderson, ML Zabel, and JL Huckaby. 2006. *Industrial Hygiene Chemical Vapor Technical Basis*. RPP-22491, Rev. 1, CH2M Hill Hanford Group, Inc., Richland, Washington. http://www.hanford.gov/tocpmm/files.cfm/IHTechBasis_RPP-22491Rev1.pdf.

32. Industrial Hygiene Exposure Assessment Strategy, TFC-PLN-34, REV E-6, Feb 22, 2013.

33. 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 1, Pacific Northwest National Laboratory, Richland, Washington.

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.

The test system uses 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.

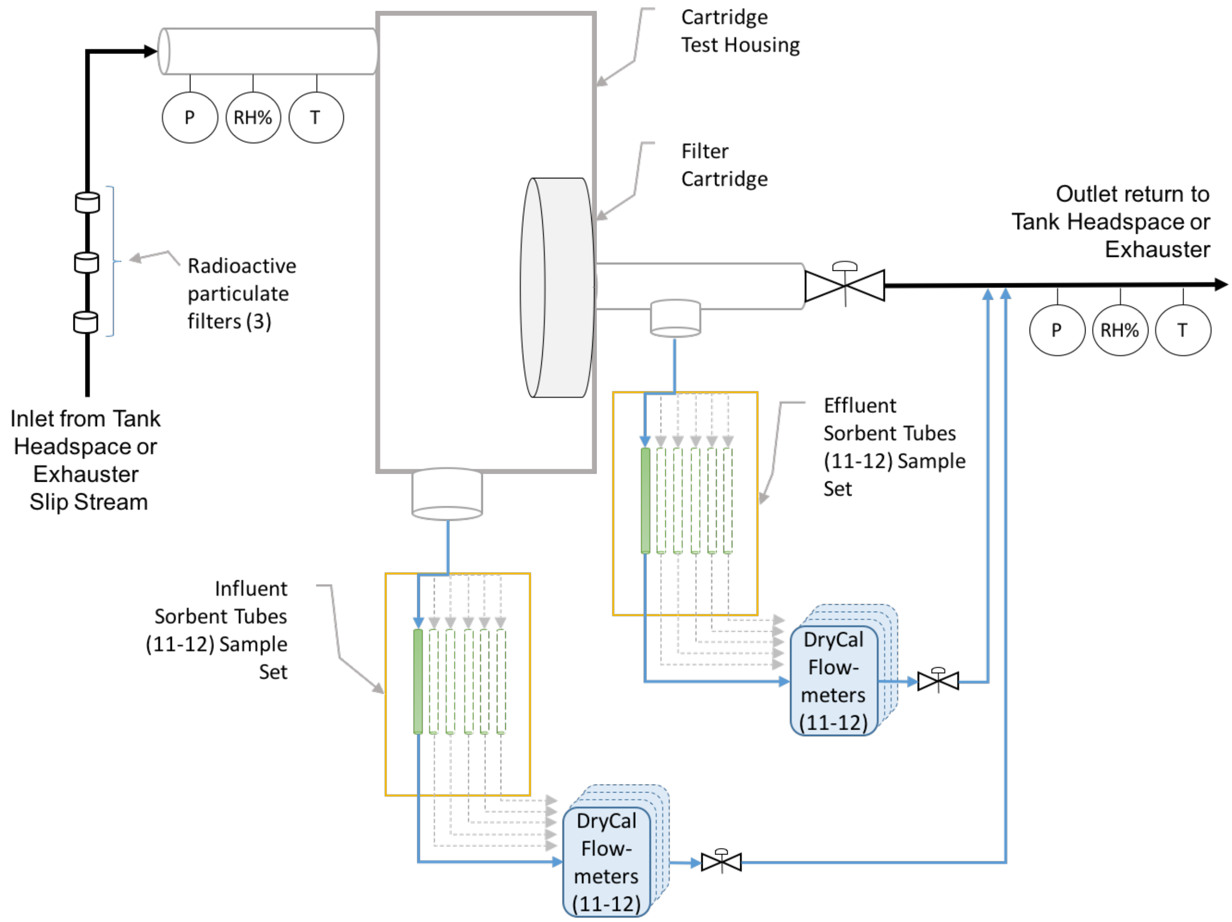


Figure A.1. General Schematic of Respirator Cartridge Test Apparatus

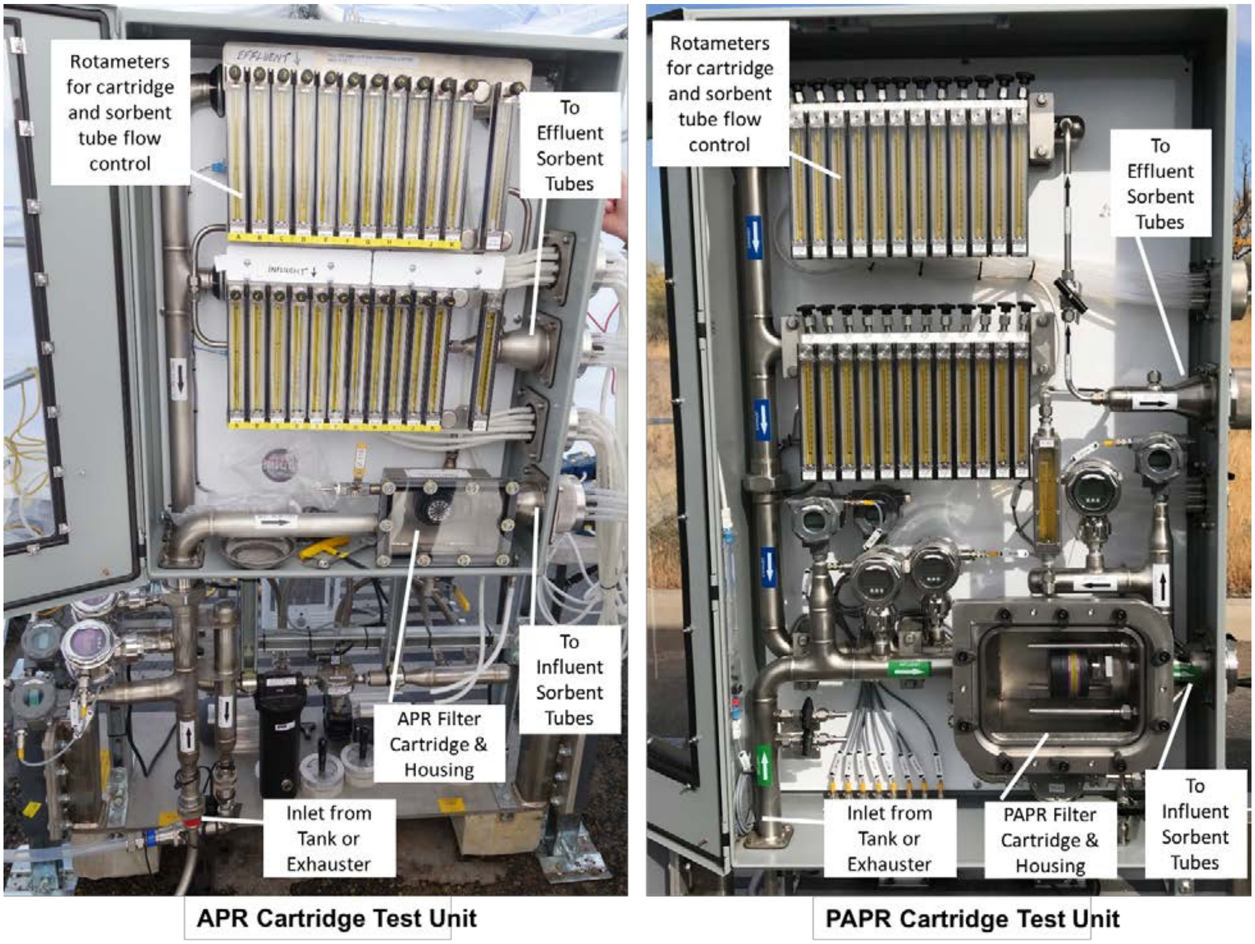


Figure A.2. Photographs of the APR (left) and PAPR (right) Cartridge Test Equipment

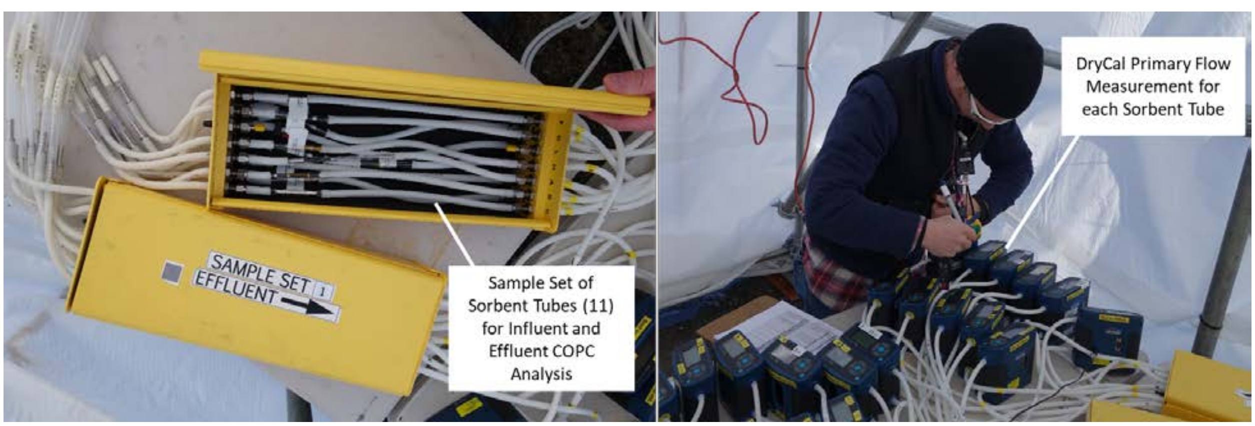


Figure A.3. Photographs of the Sorbent Tube Sampling Test Equipment

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 National Institute of Occupational Safety and Health-approved methods 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 to used 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 Hanford AP tank farm exhauster. 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 (COPC) 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 (fresh air versus 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 AP tank farm exhauster, the PAPR survey IDs included 18-02350 for TL1 and 18-02351 for TL2, and the APR survey IDs included 18-02348 for SD1 and 18-02349 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 18-02351-8-TL2-IN-1 corresponds to a particular cartridge survey (18-02351) 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 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
AP Exhauster	SCOTT 7422-SC1	AP Exhauster SC-1 3_23_18.xlsx
AP Exhauster	SCOTT 7422-SD1	AP Exhauster SD-1 3_24_18 .xlsx
AP Exhauster	MSA TL (TL1)	AP Exhauster TL 3_23_18 .xlsx
AP Exhauster	3M FR-57 (TL2)	AP Exhauster 3M FR-57 3_24_18.xlsx

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

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

Tank	Cartridge	Filename
AP Exhauster	SCOTT 7422-SC1	Temp Pressure Humidity AP Exhaust_SC1.xlsx
AP Exhauster	SCOTT 7422-SD1	Temp Pressure Humidity AP Exhaust_SD1_Corrected.xlsx
AP Exhauster	MSA TL (TL1)	Temp Pressure Humidity AP Exhaust_MSA TL.xlsx
AP Exhauster	3M FR-57 (TL2)	Temp Pressure Humidity AP Exhaust_FR-57.xlsx

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.

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	

COPC#	Analyte Name	Primary Analysis Method (Analyte Category ǀ Media ǀ Method)	Secondary Analysis Method (Analyte Category ǀ Media ǀ Method)
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 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] The 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.

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 powered air-purifying respirator 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-28680 Volume 2.

C.4 Raw Data

See PNNL-28680 Volume 2.

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.”

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). Within every survey, data are ranked in the order of inlet (IN) and outlet (EF) and following the time sequence (A though H indicate two 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 OEL. 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 via 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.

   - 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.
- 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.

<table>
<tr><th>Action</th><th>Flag</th><th>Flag Description</th></tr>
<tr><td rowspan="6">Retain (Result is treated in the analysis as a valid data point)</td><td>J</td><td>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 greater than or equal to the method DL 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.</td></tr>
<tr><td>E</td><td>The "E" flag is applied to each analyte that exceeded the calibration range of the instrument.</td></tr>
<tr><td>U</td><td>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.</td></tr>
<tr><td>N</td><td>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.</td></tr>
<tr><td>T</td><td>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 estimates only.</td></tr>
<tr><td>H</td><td>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.</td></tr>
<tr><td></td><td>D</td><td>The “D” flag is applied to all analytes in a sample that were diluted prior to analysis.</td></tr>
</table>

<table>
<tr><th>Action</th><th>Flag</th><th>Flag Description</th></tr>
<tr><td rowspan="8">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, Project Coordinator, 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></table></td></tr>
</table>

Action	Flag	Flag Description			
		High CCV/%D		Q[1]	Q
		Low CCV/%D	Q	Q	Q
		High I.S. recovery	Q	Q	Q
		Low I.S. recovery	Q	Q	Q
		1. Q flag is not required when results are reported to the RL, rather than the MDL.			
Delete (Result is seriously suspect and should be screened out and not reported)	N/A				

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 above 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 (SD1 for SCOTT 7422-SD cartridge, SC1 for SCOTT 7422-SC cartridge, TL1 for MSA TL cartridge, and TL2 for 3M FR-57 cartridge), IN or 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-filled row in each table indicates the beginning of analytical results from the secondary methods, when available.

Table D.1. APR Cartridge Testing 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	2.2E+01	25	87.5%			2.43%
1	Ammonia	4	SD1-IN-B	2.4E+01	25	94.9%			2.43%
1	Ammonia	6	SD1-IN-C	2.3E+01	25	93.7%			2.43%
1	Ammonia	8	SD1-IN-D	1.8E+01	25	70.1%			2.43%
1	Ammonia	10	SD1-IN-E	1.6E+01	25	64.0%			2.43%
1	Ammonia	12	SD1-IN-F	2.1E+01	25	85.3%			2.43%
1	Ammonia	14	SD1-IN-G	1.8E+01	25	72.6%			2.43%
1	Ammonia	16	SD1-IN-H	1.3E+01	25	53.8%			2.43%
1	Ammonia	2	SD1-EF-A	5.8E-01	25	2.34%	YES		2.43%
1	Ammonia	4	SD1-EF-B	5.7E-01	25	2.27%	YES		2.43%
1	Ammonia	6	SD1-EF-C	5.7E-01	25	2.28%	YES		2.43%
1	Ammonia	8	SD1-EF-D	5.8E-01	25	2.30%	YES		2.43%
1	Ammonia	10	SD1-EF-E	5.8E-01	25	2.32%	YES		2.43%
1	Ammonia	12	SD1-EF-F	1.1E+00	25	4.33%			2.43%
1	Ammonia	14	SD1-EF-G	1.7E+00	25	7.00%			2.43%
1	Ammonia	16	SD1-EF-H	3.2E+00	25	12.7%			2.43%
1	Ammonia	2	SC1-IN-A	1.9E+01	25	75.0%			2.43%
1	Ammonia	4	SC1-IN-B	2.0E+01	25	81.7%			2.43%
1	Ammonia	6	SC1-IN-C	2.2E+01	25	87.2%			2.43%
1	Ammonia	8	SC1-IN-D	2.1E+01	25	83.5%			2.43%
1	Ammonia	10	SC1-IN-E	6.3E+00	25	25.3%			2.43%
1	Ammonia	12	SC1-IN-F	2.1E+01	25	84.5%			2.43%
1	Ammonia	14	SC1-IN-G	1.8E+01	25	70.1%			2.43%
1	Ammonia	16	SC1-IN-H	2.0E+01	25	78.9%			2.43%
1	Ammonia	2	SC1-EF-A	6.1E-01	25	2.43%	YES		2.43%
1	Ammonia	4	SC1-EF-B	6.0E-01	25	2.38%	YES		2.43%
1	Ammonia	6	SC1-EF-C	5.9E-01	25	2.36%	YES		2.43%
1	Ammonia	8	SC1-EF-D	5.9E-01	25	2.36%	YES		2.43%
1	Ammonia	10	SC1-EF-E	5.8E-01	25	2.33%	YES		2.43%
1	Ammonia	12	SC1-EF-F	5.8E-01	25	2.31%	YES		2.43%
1	Ammonia	14	SC1-EF-G	5.9E-01	25	2.36%			2.43%
1	Ammonia	16	SC1-EF-H	1.1E+00	25	4.41%			2.43%
3	Mercury	2	SD1-IN-A	4.9E-04	0.003	16.2%			6.85%
3	Mercury	4	SD1-IN-B	3.9E-04	0.003	13.1%			6.85%
3	Mercury	6	SD1-IN-C	4.0E-04	0.003	13.3%			6.85%
3	Mercury	8	SD1-IN-D	2.8E-04	0.003	9.22%			6.85%
3	Mercury	10	SD1-IN-E	4.4E-04	0.003	14.6%			6.85%
3	Mercury	12	SD1-IN-F	4.2E-04	0.003	13.8%			6.85%
3	Mercury	14	SD1-IN-G	4.6E-04	0.003	15.3%			6.85%
3	Mercury	16	SD1-IN-H	4.4E-04	0.003	14.5%			6.85%
3	Mercury	2	SD1-EF-A	2.0E-04	0.003	6.77%	YES		6.85%
3	Mercury	4	SD1-EF-B	2.0E-04	0.003	6.59%	YES		6.85%
3	Mercury	6	SD1-EF-C	2.0E-04	0.003	6.61%	YES		6.85%
3	Mercury	8	SD1-EF-D	2.0E-04	0.003	6.54%	YES		6.85%
3	Mercury	10	SD1-EF-E	2.0E-04	0.003	6.60%	YES		6.85%
3	Mercury	12	SD1-EF-F	2.0E-04	0.003	6.68%	YES		6.85%
3	Mercury	14	SD1-EF-G	2.0E-04	0.003	6.75%	YES		6.85%
3	Mercury	16	SD1-EF-H	2.0E-04	0.003	6.81%	YES		6.85%
3	Mercury	2	SC1-IN-A	4.0E-04	0.003	13.3%			6.85%
3	Mercury	4	SC1-IN-B	4.1E-04	0.003	13.7%			6.85%
3	Mercury	6	SC1-IN-C	4.2E-04	0.003	14.0%			6.85%
3	Mercury	8	SC1-IN-D	2.0E-04	0.003	6.74%	YES		6.85%
3	Mercury	10	SC1-IN-E	4.2E-04	0.003	14.1%			6.85%
3	Mercury	12	SC1-IN-F	4.1E-04	0.003	13.6%			6.85%
3	Mercury	14	SC1-IN-G	4.0E-04	0.003	13.2%			6.85%
3	Mercury	16	SC1-IN-H	4.0E-04	0.003	13.2%			6.85%
3	Mercury	2	SC1-EF-A	2.0E-04	0.003	6.79%	YES		6.85%
3	Mercury	4	SC1-EF-B	2.0E-04	0.003	6.78%	YES		6.85%
3	Mercury	6	SC1-EF-C	2.0E-04	0.003	6.77%	YES		6.85%
3	Mercury	8	SC1-EF-D	2.1E-04	0.003	6.85%	YES		6.85%
3	Mercury	10	SC1-EF-E	1.9E-04	0.003	6.48%	YES		6.85%
3	Mercury	12	SC1-EF-F	2.0E-04	0.003	6.63%	YES		6.85%
3	Mercury	14	SC1-EF-G	2.0E-04	0.003	6.68%	YES		6.85%

Table D.1. APR Cartridge Testing 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	16	SC1-EF-H	3.9E-04	0.003	13.0%			6.85%
4	1,3-Butadiene	2	SD1-IN-A	1.8E-02	1.0	1.83%	YES		1.97%
4	1,3-Butadiene	4	SD1-IN-B	1.8E-02	1.0	1.81%	YES		1.97%
4	1,3-Butadiene	6	SD1-IN-C	1.8E-02	1.0	1.81%	YES		1.97%
4	1,3-Butadiene	8	SD1-IN-D	6.6E-02	1.0	6.55%			1.97%
4	1,3-Butadiene	10	SD1-IN-E	1.8E-02	1.0	1.78%	YES		1.97%
4	1,3-Butadiene	12	SD1-IN-F	2.0E-02	1.0	1.97%	YES		1.97%
4	1,3-Butadiene	14	SD1-IN-G	1.9E-02	1.0	1.90%	YES		1.97%
4	1,3-Butadiene	16	SD1-IN-H	1.8E-02	1.0	1.83%	YES		1.97%
4	1,3-Butadiene	2	SD1-EF-A	1.9E-02	1.0	1.87%	YES		1.97%
4	1,3-Butadiene	4	SD1-EF-B	1.8E-02	1.0	1.84%	YES		1.97%
4	1,3-Butadiene	6	SD1-EF-C	1.8E-02	1.0	1.84%	YES		1.97%
4	1,3-Butadiene	8	SD1-EF-D	1.8E-02	1.0	1.80%	YES		1.97%
4	1,3-Butadiene	10	SD1-EF-E	1.8E-02	1.0	1.85%	YES		1.97%
4	1,3-Butadiene	12	SD1-EF-F	1.9E-02	1.0	1.86%	YES		1.97%
4	1,3-Butadiene	14	SD1-EF-G	6.4E-02	1.0	6.39%			1.97%
4	1,3-Butadiene	16	SD1-EF-H	1.8E-02	1.0	1.82%	YES		1.97%
4	1,3-Butadiene	2	SC1-IN-A	1.9E-02	1.0	1.91%	YES		1.97%
4	1,3-Butadiene	4	SC1-IN-B	1.9E-02	1.0	1.89%	YES		1.97%
4	1,3-Butadiene	6	SC1-IN-C	1.8E-02	1.0	1.83%	YES		1.97%
4	1,3-Butadiene	8	SC1-IN-D	1.9E-02	1.0	1.85%	YES		1.97%
4	1,3-Butadiene	10	SC1-IN-E	1.9E-02	1.0	1.86%	YES		1.97%
4	1,3-Butadiene	12	SC1-IN-F	1.8E-02	1.0	1.83%	YES		1.97%
4	1,3-Butadiene	14	SC1-IN-G	1.8E-02	1.0	1.83%	YES		1.97%
4	1,3-Butadiene	16	SC1-IN-H	1.8E-02	1.0	1.84%	YES		1.97%
4	1,3-Butadiene	2	SC1-EF-A	2.0E-02	1.0	1.96%	YES		1.97%
4	1,3-Butadiene	4	SC1-EF-B	1.9E-02	1.0	1.92%	YES		1.97%
4	1,3-Butadiene	6	SC1-EF-C	1.8E-02	1.0	1.83%	YES		1.97%
4	1,3-Butadiene	8	SC1-EF-D	1.8E-02	1.0	1.84%	YES		1.97%
4	1,3-Butadiene	10	SC1-EF-E	1.8E-02	1.0	1.85%	YES		1.97%
4	1,3-Butadiene	12	SC1-EF-F	1.8E-02	1.0	1.85%	YES		1.97%
4	1,3-Butadiene	14	SC1-EF-G	1.8E-02	1.0	1.84%	YES		1.97%
4	1,3-Butadiene	16	SC1-EF-H	1.8E-02	1.0	1.83%	YES		1.97%
5	Benzene	2	SD1-IN-A	8.5E-05	0.50	0.017%	YES		0.0360%
5	Benzene	4	SD1-IN-B	2.0E-04	0.50	0.039%		J	0.0360%
5	Benzene	6	SD1-IN-C	1.8E-04	0.50	0.036%	YES	UY	0.0360%
5	Benzene	8	SD1-IN-D	2.0E-04	0.50	0.041%		J	0.0360%
5	Benzene	10	SD1-IN-E	2.8E-04	0.50	0.055%		J	0.0360%
5	Benzene	12	SD1-IN-F	3.2E-04	0.50	0.063%		J	0.0360%
5	Benzene	14	SD1-IN-G	2.5E-04	0.50	0.050%		J	0.0360%
5	Benzene	16	SD1-IN-H	2.2E-04	0.50	0.045%		J	0.0360%
5	Benzene	2	SD1-EF-A	2.4E-04	0.50	0.049%		J	0.0360%
5	Benzene	4	SD1-EF-B	2.3E-04	0.50	0.045%		J	0.0360%
5	Benzene	6	SD1-EF-C	2.7E-04	0.50	0.054%		J	0.0360%
5	Benzene	8	SD1-EF-D	2.6E-04	0.50	0.052%		J	0.0360%
5	Benzene	10	SD1-EF-E	4.3E-04	0.50	0.085%		J	0.0360%
5	Benzene	12	SD1-EF-F	5.0E-04	0.50	0.099%		J	0.0360%
5	Benzene	14	SD1-EF-G	3.9E-04	0.50	0.079%		J	0.0360%
5	Benzene	16	SD1-EF-H	3.8E-04	0.50	0.076%		J	0.0360%
5	Benzene	2	SC1-IN-A	1.8E-04	0.50	0.035%	YES		0.0360%
5	Benzene	4	SC1-IN-B	8.4E-05	0.50	0.017%		J	0.0360%
5	Benzene	6	SC1-IN-C	3.5E-05	0.50	0.007%	YES		0.0360%
5	Benzene	8	SC1-IN-D	2.1E-04	0.50	0.043%		J	0.0360%
5	Benzene	10	SC1-IN-E	2.4E-04	0.50	0.047%		J	0.0360%
5	Benzene	12	SC1-IN-F	1.3E-04	0.50	0.027%		J	0.0360%
5	Benzene	14	SC1-IN-G	2.7E-04	0.50	0.054%		J	0.0360%
5	Benzene	16	SC1-IN-H	2.9E-04	0.50	0.058%		J	0.0360%
5	Benzene	2	SC1-EF-A	2.4E-04	0.50	0.048%		J	0.0360%
5	Benzene	4	SC1-EF-B	2.3E-04	0.50	0.045%		J	0.0360%
5	Benzene	6	SC1-EF-C	3.1E-04	0.50	0.063%		J	0.0360%
5	Benzene	8	SC1-EF-D	4.7E-04	0.50	0.093%		J	0.0360%
5	Benzene	10	SC1-EF-E	5.0E-04	0.50	0.099%		J	0.0360%

Table D.1. APR Cartridge Testing 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	12	SC1-EF-F	3.4E-04	0.50	0.068%		J	0.0360%
5	Benzene	14	SC1-EF-G	5.3E-04	0.50	0.106%		J	0.0360%
5	Benzene	16	SC1-EF-H	3.5E-04	0.50	0.070%		J	0.0360%
6	Biphenyl	2	SD1-IN-A	5.0E-05	0.20	0.025%	YES	U	0.0456%
6	Biphenyl	4	SD1-IN-B		0.20				0.0456%
6	Biphenyl	6	SD1-IN-C	4.7E-05	0.20	0.024%	YES	U	0.0456%
6	Biphenyl	8	SD1-IN-D	4.7E-05	0.20	0.024%	YES	U	0.0456%
6	Biphenyl	10	SD1-IN-E	4.7E-05	0.20	0.023%	YES	U	0.0456%
6	Biphenyl	12	SD1-IN-F	4.7E-05	0.20	0.023%	YES	U	0.0456%
6	Biphenyl	14	SD1-IN-G	4.7E-05	0.20	0.023%	YES	U	0.0456%
6	Biphenyl	16	SD1-IN-H	5.0E-05	0.20	0.025%	YES	U	0.0456%
6	Biphenyl	2	SD1-EF-A	4.6E-05	0.20	0.023%	YES	U	0.0456%
6	Biphenyl	4	SD1-EF-B	4.4E-05	0.20	0.022%	YES	U	0.0456%
6	Biphenyl	6	SD1-EF-C	4.5E-05	0.20	0.023%	YES	U	0.0456%
6	Biphenyl	8	SD1-EF-D	4.6E-05	0.20	0.023%	YES	U	0.0456%
6	Biphenyl	10	SD1-EF-E	4.6E-05	0.20	0.023%	YES	U	0.0456%
6	Biphenyl	12	SD1-EF-F	4.7E-05	0.20	0.023%	YES	U, S*	0.0456%
6	Biphenyl	14	SD1-EF-G	4.5E-05	0.20	0.023%	YES	U	0.0456%
6	Biphenyl	16	SD1-EF-H	4.6E-05	0.20	0.023%	YES	U	0.0456%
6	Biphenyl	2	SC1-IN-A	4.8E-05	0.20	0.024%	YES	U	0.0456%
6	Biphenyl	4	SC1-IN-B	4.9E-05	0.20	0.025%	YES	U	0.0456%
6	Biphenyl	6	SC1-IN-C	5.0E-05	0.20	0.025%	YES	U	0.0456%
6	Biphenyl	8	SC1-IN-D	5.0E-05	0.20	0.025%	YES	U	0.0456%
6	Biphenyl	10	SC1-IN-E	4.8E-05	0.20	0.024%	YES	U	0.0456%
6	Biphenyl	12	SC1-IN-F	4.7E-05	0.20	0.024%	YES	U	0.0456%
6	Biphenyl	14	SC1-IN-G	4.9E-05	0.20	0.024%	YES	U	0.0456%
6	Biphenyl	16	SC1-IN-H	9.1E-05	0.20	0.046%	YES	U	0.0456%
6	Biphenyl	2	SC1-EF-A	4.4E-05	0.20	0.022%	YES	U	0.0456%
6	Biphenyl	4	SC1-EF-B	4.7E-05	0.20	0.024%	YES	U	0.0456%
6	Biphenyl	6	SC1-EF-C	4.5E-05	0.20	0.022%	YES	U	0.0456%
6	Biphenyl	8	SC1-EF-D	4.5E-05	0.20	0.022%	YES	U	0.0456%
6	Biphenyl	10	SC1-EF-E	4.4E-05	0.20	0.022%	YES	U	0.0456%
6	Biphenyl	12	SC1-EF-F	4.7E-05	0.20	0.024%	YES	U, S*	0.0456%
6	Biphenyl	14	SC1-EF-G	4.6E-05	0.20	0.023%	YES	U	0.0456%
6	Biphenyl	16	SC1-EF-H	4.6E-05	0.20	0.023%	YES	U	0.0456%
7	1-Butanol	2	SD1-IN-A	4.0E-04	20	0.002%	YES		0.0215%
7	1-Butanol	4	SD1-IN-B	7.5E-03	20	0.037%		J	0.0215%
7	1-Butanol	6	SD1-IN-C	6.4E-03	20	0.032%		JY	0.0215%
7	1-Butanol	8	SD1-IN-D	6.3E-03	20	0.031%		J	0.0215%
7	1-Butanol	10	SD1-IN-E	1.0E-02	20	0.050%			0.0215%
7	1-Butanol	12	SD1-IN-F	1.2E-02	20	0.058%			0.0215%
7	1-Butanol	14	SD1-IN-G	1.2E-02	20	0.058%			0.0215%
7	1-Butanol	16	SD1-IN-H	5.2E-03	20	0.026%			0.0215%
7	1-Butanol	2	SD1-EF-A	3.8E-04	20	0.002%	YES		0.0215%
7	1-Butanol	4	SD1-EF-B	3.9E-04	20	0.002%	YES		0.0215%
7	1-Butanol	6	SD1-EF-C	3.9E-04	20	0.002%	YES		0.0215%
7	1-Butanol	8	SD1-EF-D	4.2E-04	20	0.002%	YES		0.0215%
7	1-Butanol	10	SD1-EF-E	4.2E-04	20	0.002%	YES		0.0215%
7	1-Butanol	12	SD1-EF-F	4.3E-04	20	0.002%	YES		0.0215%
7	1-Butanol	14	SD1-EF-G	4.1E-04	20	0.002%	YES		0.0215%
7	1-Butanol	16	SD1-EF-H	3.9E-04	20	0.002%	YES		0.0215%
7	1-Butanol	2	SC1-IN-A	4.2E-03	20	0.021%	YES		0.0215%
7	1-Butanol	4	SC1-IN-B	2.6E-04	20	0.001%	YES	L	0.0215%
7	1-Butanol	6	SC1-IN-C	2.4E-04	20	0.001%	YES	L	0.0215%
7	1-Butanol	8	SC1-IN-D	6.6E-03	20	0.033%		L	0.0215%
7	1-Butanol	10	SC1-IN-E	5.6E-03	20	0.028%		L	0.0215%
7	1-Butanol	12	SC1-IN-F	3.0E-03	20	0.015%		L	0.0215%
7	1-Butanol	14	SC1-IN-G	9.2E-03	20	0.046%		L	0.0215%
7	1-Butanol	16	SC1-IN-H	1.0E-02	20	0.051%			0.0215%
7	1-Butanol	2	SC1-EF-A	4.2E-03	20	0.021%	YES		0.0215%
7	1-Butanol	4	SC1-EF-B	4.2E-03	20	0.021%	YES		0.0215%
7	1-Butanol	6	SC1-EF-C	4.3E-03	20	0.021%	YES		0.0215%

Table D.1. APR Cartridge Testing 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	SC1-EF-D	4.3E-03	20	0.022%	YES		0.0215%
7	1-Butanol	10	SC1-EF-E	4.0E-03	20	0.020%	YES		0.0215%
7	1-Butanol	12	SC1-EF-F	3.9E-03	20	0.020%	YES		0.0215%
7	1-Butanol	14	SC1-EF-G	3.9E-03	20	0.020%	YES		0.0215%
7	1-Butanol	16	SC1-EF-H	4.2E-03	20	0.021%	YES		0.0215%
9	2-Hexanone	2	SD1-IN-A	9.0E-05	5.0	0.002%	YES		0.00194%
9	2-Hexanone	4	SD1-IN-B	8.2E-05	5.0	0.002%		J	0.00194%
9	2-Hexanone	6	SD1-IN-C	8.9E-05	5.0	0.002%	YES	UY	0.00194%
9	2-Hexanone	8	SD1-IN-D	8.6E-05	5.0	0.002%	YES	U	0.00194%
9	2-Hexanone	10	SD1-IN-E	1.0E-04	5.0	0.002%		J	0.00194%
9	2-Hexanone	12	SD1-IN-F	1.0E-04	5.0	0.002%		J	0.00194%
9	2-Hexanone	14	SD1-IN-G	2.5E-04	5.0	0.005%		J	0.00194%
9	2-Hexanone	16	SD1-IN-H	9.4E-05	5.0	0.002%	YES		0.00194%
9	2-Hexanone	2	SD1-EF-A	8.7E-05	5.0	0.002%	YES		0.00194%
9	2-Hexanone	4	SD1-EF-B	8.8E-05	5.0	0.002%	YES		0.00194%
9	2-Hexanone	6	SD1-EF-C	8.7E-05	5.0	0.002%	YES		0.00194%
9	2-Hexanone	8	SD1-EF-D	9.4E-05	5.0	0.002%	YES		0.00194%
9	2-Hexanone	10	SD1-EF-E	9.6E-05	5.0	0.002%	YES		0.00194%
9	2-Hexanone	12	SD1-EF-F	9.7E-05	5.0	0.002%	YES		0.00194%
9	2-Hexanone	14	SD1-EF-G	9.2E-05	5.0	0.002%	YES		0.00194%
9	2-Hexanone	16	SD1-EF-H	8.8E-05	5.0	0.002%	YES		0.00194%
9	2-Hexanone	2	SC1-IN-A	8.8E-05	5.0	0.002%	YES		0.00194%
9	2-Hexanone	4	SC1-IN-B	5.7E-05	5.0	0.001%	YES		0.00194%
9	2-Hexanone	6	SC1-IN-C	5.3E-05	5.0	0.001%	YES		0.00194%
9	2-Hexanone	8	SC1-IN-D	5.8E-05	5.0	0.001%		J	0.00194%
9	2-Hexanone	10	SC1-IN-E	6.5E-05	5.0	0.001%		J	0.00194%
9	2-Hexanone	12	SC1-IN-F	5.5E-05	5.0	0.001%	YES		0.00194%
9	2-Hexanone	14	SC1-IN-G	9.9E-05	5.0	0.002%		J	0.00194%
9	2-Hexanone	16	SC1-IN-H	1.1E-04	5.0	0.002%		J	0.00194%
9	2-Hexanone	2	SC1-EF-A	8.8E-05	5.0	0.002%	YES		0.00194%
9	2-Hexanone	4	SC1-EF-B	8.8E-05	5.0	0.002%	YES		0.00194%
9	2-Hexanone	6	SC1-EF-C	9.0E-05	5.0	0.002%	YES		0.00194%
9	2-Hexanone	8	SC1-EF-D	9.1E-05	5.0	0.002%	YES		0.00194%
9	2-Hexanone	10	SC1-EF-E	8.5E-05	5.0	0.002%	YES		0.00194%
9	2-Hexanone	12	SC1-EF-F	8.3E-05	5.0	0.002%	YES		0.00194%
9	2-Hexanone	14	SC1-EF-G	8.3E-05	5.0	0.002%	YES		0.00194%
9	2-Hexanone	16	SC1-EF-H	8.9E-05	5.0	0.002%	YES		0.00194%
11	4-Methyl-2-hexanone	2	SD1-IN-A	6.8E-05	0.50	0.014%	YES		0.0205%
11	4-Methyl-2-hexanone	4	SD1-IN-B	9.3E-05	0.50	0.019%	YES	U	0.0205%
11	4-Methyl-2-hexanone	6	SD1-IN-C	1.0E-04	0.50	0.020%	YES	UY	0.0205%
11	4-Methyl-2-hexanone	8	SD1-IN-D	9.6E-05	0.50	0.019%	YES	U	0.0205%
11	4-Methyl-2-hexanone	10	SD1-IN-E	9.7E-05	0.50	0.019%	YES	U	0.0205%
11	4-Methyl-2-hexanone	12	SD1-IN-F	9.7E-05	0.50	0.019%	YES	U	0.0205%
11	4-Methyl-2-hexanone	14	SD1-IN-G	9.7E-05	0.50	0.019%	YES	U	0.0205%
11	4-Methyl-2-hexanone	16	SD1-IN-H	7.1E-05	0.50	0.014%	YES		0.0205%
11	4-Methyl-2-hexanone	2	SD1-EF-A	6.6E-05	0.50	0.013%	YES		0.0205%
11	4-Methyl-2-hexanone	4	SD1-EF-B	6.7E-05	0.50	0.013%	YES		0.0205%
11	4-Methyl-2-hexanone	6	SD1-EF-C	6.6E-05	0.50	0.013%	YES		0.0205%
11	4-Methyl-2-hexanone	8	SD1-EF-D	7.2E-05	0.50	0.014%	YES		0.0205%
11	4-Methyl-2-hexanone	10	SD1-EF-E	7.3E-05	0.50	0.015%	YES		0.0205%
11	4-Methyl-2-hexanone	12	SD1-EF-F	7.4E-05	0.50	0.015%	YES		0.0205%
11	4-Methyl-2-hexanone	14	SD1-EF-G	7.0E-05	0.50	0.014%	YES		0.0205%
11	4-Methyl-2-hexanone	16	SD1-EF-H	6.7E-05	0.50	0.013%	YES		0.0205%
11	4-Methyl-2-hexanone	2	SC1-IN-A	9.9E-05	0.50	0.020%	YES		0.0205%
11	4-Methyl-2-hexanone	4	SC1-IN-B	4.4E-05	0.50	0.009%	YES		0.0205%
11	4-Methyl-2-hexanone	6	SC1-IN-C	4.1E-05	0.50	0.008%	YES		0.0205%
11	4-Methyl-2-hexanone	8	SC1-IN-D	4.3E-05	0.50	0.009%	YES		0.0205%
11	4-Methyl-2-hexanone	10	SC1-IN-E	4.4E-05	0.50	0.009%	YES		0.0205%
11	4-Methyl-2-hexanone	12	SC1-IN-F	4.2E-05	0.50	0.008%	YES		0.0205%
11	4-Methyl-2-hexanone	14	SC1-IN-G	4.6E-05	0.50	0.009%	YES		0.0205%
11	4-Methyl-2-hexanone	16	SC1-IN-H	9.9E-05	0.50	0.020%	YES		0.0205%
11	4-Methyl-2-hexanone	2	SC1-EF-A	9.9E-05	0.50	0.020%	YES		0.0205%

Table D.1. APR Cartridge Testing 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	4	SC1-EF-B	1.0E-04	0.50	0.020%	YES		0.0205%
11	4-Methyl-2-hexanone	6	SC1-EF-C	1.0E-04	0.50	0.020%	YES		0.0205%
11	4-Methyl-2-hexanone	8	SC1-EF-D	1.0E-04	0.50	0.021%	YES		0.0205%
11	4-Methyl-2-hexanone	10	SC1-EF-E	9.6E-05	0.50	0.019%	YES		0.0205%
11	4-Methyl-2-hexanone	12	SC1-EF-F	9.4E-05	0.50	0.019%	YES		0.0205%
11	4-Methyl-2-hexanone	14	SC1-EF-G	9.3E-05	0.50	0.019%	YES		0.0205%
11	4-Methyl-2-hexanone	16	SC1-EF-H	1.0E-04	0.50	0.020%	YES		0.0205%
13	3-Buten-2-one	2	SD1-IN-A	1.8E-04	0.20	0.090%		J	0.167%
13	3-Buten-2-one	4	SD1-IN-B	3.0E-04	0.20	0.151%	YES	U	0.167%
13	3-Buten-2-one	6	SD1-IN-C	3.3E-04	0.20	0.164%	YES	UY	0.167%
13	3-Buten-2-one	8	SD1-IN-D	3.1E-04	0.20	0.157%	YES	U	0.167%
13	3-Buten-2-one	10	SD1-IN-E	3.5E-04	0.20	0.176%		J	0.167%
13	3-Buten-2-one	12	SD1-IN-F	3.8E-04	0.20	0.190%		J	0.167%
13	3-Buten-2-one	14	SD1-IN-G	3.7E-04	0.20	0.184%		J	0.167%
13	3-Buten-2-one	16	SD1-IN-H	8.1E-04	0.20	0.406%		J	0.167%
13	3-Buten-2-one	2	SD1-EF-A	1.2E-04	0.20	0.062%	YES		0.167%
13	3-Buten-2-one	4	SD1-EF-B	1.3E-04	0.20	0.063%	YES		0.167%
13	3-Buten-2-one	6	SD1-EF-C	1.2E-04	0.20	0.062%	YES		0.167%
13	3-Buten-2-one	8	SD1-EF-D	1.3E-04	0.20	0.067%	YES		0.167%
13	3-Buten-2-one	10	SD1-EF-E	1.4E-04	0.20	0.068%	YES		0.167%
13	3-Buten-2-one	12	SD1-EF-F	1.4E-04	0.20	0.069%	YES		0.167%
13	3-Buten-2-one	14	SD1-EF-G	1.3E-04	0.20	0.066%	YES		0.167%
13	3-Buten-2-one	16	SD1-EF-H	1.5E-04	0.20	0.076%		J	0.167%
13	3-Buten-2-one	2	SC1-IN-A	3.2E-04	0.20	0.162%	YES		0.167%
13	3-Buten-2-one	4	SC1-IN-B	9.3E-05	0.20	0.047%	YES		0.167%
13	3-Buten-2-one	6	SC1-IN-C	8.7E-05	0.20	0.044%	YES		0.167%
13	3-Buten-2-one	8	SC1-IN-D	3.3E-04	0.20	0.165%		J	0.167%
13	3-Buten-2-one	10	SC1-IN-E	2.5E-04	0.20	0.127%		J	0.167%
13	3-Buten-2-one	12	SC1-IN-F	1.9E-04	0.20	0.095%		J	0.167%
13	3-Buten-2-one	14	SC1-IN-G	3.8E-04	0.20	0.191%		J	0.167%
13	3-Buten-2-one	16	SC1-IN-H	4.1E-04	0.20	0.206%		J	0.167%
13	3-Buten-2-one	2	SC1-EF-A	3.2E-04	0.20	0.161%	YES		0.167%
13	3-Buten-2-one	4	SC1-EF-B	3.2E-04	0.20	0.162%	YES		0.167%
13	3-Buten-2-one	6	SC1-EF-C	3.3E-04	0.20	0.165%	YES		0.167%
13	3-Buten-2-one	8	SC1-EF-D	3.3E-04	0.20	0.167%	YES		0.167%
13	3-Buten-2-one	10	SC1-EF-E	3.1E-04	0.20	0.156%	YES		0.167%
13	3-Buten-2-one	12	SC1-EF-F	3.1E-04	0.20	0.153%	YES		0.167%
13	3-Buten-2-one	14	SC1-EF-G	3.0E-04	0.20	0.152%	YES		0.167%
13	3-Buten-2-one	16	SC1-EF-H	3.3E-04	0.20	0.164%	YES		0.167%
14	Formaldehyde	2	SD1-IN-A	2.0E-03	0.30	0.668%			0.579%
14	Formaldehyde	4	SD1-IN-B	1.9E-03	0.30	0.640%			0.579%
14	Formaldehyde	6	SD1-IN-C	1.6E-03	0.30	0.540%	YES		0.579%
14	Formaldehyde	8	SD1-IN-D	1.7E-03	0.30	0.555%	YES		0.579%
14	Formaldehyde	10	SD1-IN-E	1.7E-03	0.30	0.558%	YES		0.579%
14	Formaldehyde	12	SD1-IN-F	1.7E-03	0.30	0.562%	YES		0.579%
14	Formaldehyde	14	SD1-IN-G	1.7E-03	0.30	0.561%	YES		0.579%
14	Formaldehyde	16	SD1-IN-H	1.7E-03	0.30	0.560%	YES		0.579%
14	Formaldehyde	2	SD1-EF-A	1.7E-03	0.30	0.571%	YES		0.579%
14	Formaldehyde	4	SD1-EF-B	1.7E-03	0.30	0.553%	YES		0.579%
14	Formaldehyde	6	SD1-EF-C	1.7E-03	0.30	0.561%	YES		0.579%
14	Formaldehyde	8	SD1-EF-D	1.6E-03	0.30	0.547%	YES		0.579%
14	Formaldehyde	10	SD1-EF-E	2.3E-03	0.30	0.753%			0.579%
14	Formaldehyde	12	SD1-EF-F	2.0E-03	0.30	0.681%			0.579%
14	Formaldehyde	14	SD1-EF-G	1.7E-03	0.30	0.560%	YES		0.579%
14	Formaldehyde	16	SD1-EF-H	1.7E-03	0.30	0.573%	YES		0.579%
14	Formaldehyde	2	SC1-IN-A	3.0E-03	0.30	1.01%			0.579%
14	Formaldehyde	4	SC1-IN-B	1.7E-03	0.30	0.573%	YES		0.579%
14	Formaldehyde	6	SC1-IN-C	1.7E-03	0.30	0.570%	YES		0.579%
14	Formaldehyde	8	SC1-IN-D	1.7E-03	0.30	0.579%	YES		0.579%
14	Formaldehyde	10	SC1-IN-E	1.7E-03	0.30	0.556%	YES		0.579%
14	Formaldehyde	12	SC1-IN-F	1.7E-03	0.30	0.553%	YES		0.579%
14	Formaldehyde	14	SC1-IN-G	1.7E-03	0.30	0.555%	YES		0.579%

Table D.1. APR Cartridge Testing 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	SC1-IN-H	1.7E-03	0.30	0.553%	YES		0.579%
14	Formaldehyde	2	SC1-EF-A	1.7E-03	0.30	0.561%	YES		0.579%
14	Formaldehyde	4	SC1-EF-B	1.7E-03	0.30	0.568%	YES		0.579%
14	Formaldehyde	6	SC1-EF-C	1.7E-03	0.30	0.574%	YES		0.579%
14	Formaldehyde	8	SC1-EF-D	1.7E-03	0.30	0.574%	YES		0.579%
14	Formaldehyde	10	SC1-EF-E	2.0E-03	0.30	0.678%			0.579%
14	Formaldehyde	12	SC1-EF-F	5.8E-03	0.30	1.95%			0.579%
14	Formaldehyde	14	SC1-EF-G	8.0E-03	0.30	2.66%			0.579%
14	Formaldehyde	16	SC1-EF-H	5.4E-03	0.30	1.79%			0.579%
15	Acetaldehyde	2	SD1-IN-A	1.2E-02	25	0.047%			0.00474%
15	Acetaldehyde	4	SD1-IN-B	1.2E-02	25	0.048%			0.00474%
15	Acetaldehyde	6	SD1-IN-C	1.1E-02	25	0.046%			0.00474%
15	Acetaldehyde	8	SD1-IN-D	9.3E-03	25	0.037%			0.00474%
15	Acetaldehyde	10	SD1-IN-E	1.3E-02	25	0.050%			0.00474%
15	Acetaldehyde	12	SD1-IN-F	1.2E-02	25	0.049%			0.00474%
15	Acetaldehyde	14	SD1-IN-G	1.2E-02	25	0.050%			0.00474%
15	Acetaldehyde	16	SD1-IN-H	1.2E-02	25	0.049%			0.00474%
15	Acetaldehyde	2	SD1-EF-A	2.8E-03	25	0.011%			0.00474%
15	Acetaldehyde	4	SD1-EF-B	6.3E-03	25	0.025%			0.00474%
15	Acetaldehyde	6	SD1-EF-C	5.0E-03	25	0.020%			0.00474%
15	Acetaldehyde	8	SD1-EF-D	4.5E-03	25	0.018%			0.00474%
15	Acetaldehyde	10	SD1-EF-E	4.9E-03	25	0.020%			0.00474%
15	Acetaldehyde	12	SD1-EF-F	3.7E-03	25	0.015%			0.00474%
15	Acetaldehyde	14	SD1-EF-G	3.7E-03	25	0.015%			0.00474%
15	Acetaldehyde	16	SD1-EF-H	4.0E-03	25	0.016%			0.00474%
15	Acetaldehyde	2	SC1-IN-A	1.5E-02	25	0.062%			0.00474%
15	Acetaldehyde	4	SC1-IN-B	1.2E-02	25	0.047%			0.00474%
15	Acetaldehyde	6	SC1-IN-C	1.1E-02	25	0.046%			0.00474%
15	Acetaldehyde	8	SC1-IN-D	1.0E-02	25	0.042%			0.00474%
15	Acetaldehyde	10	SC1-IN-E	1.2E-02	25	0.047%			0.00474%
15	Acetaldehyde	12	SC1-IN-F	1.2E-02	25	0.046%			0.00474%
15	Acetaldehyde	14	SC1-IN-G	1.2E-02	25	0.047%			0.00474%
15	Acetaldehyde	16	SC1-IN-H	1.2E-02	25	0.049%			0.00474%
15	Acetaldehyde	2	SC1-EF-A	3.4E-03	25	0.014%			0.00474%
15	Acetaldehyde	4	SC1-EF-B	4.6E-03	25	0.019%			0.00474%
15	Acetaldehyde	6	SC1-EF-C	4.9E-03	25	0.020%			0.00474%
15	Acetaldehyde	8	SC1-EF-D	5.2E-03	25	0.021%			0.00474%
15	Acetaldehyde	10	SC1-EF-E	4.4E-03	25	0.018%			0.00474%
15	Acetaldehyde	12	SC1-EF-F	5.8E-03	25	0.023%			0.00474%
15	Acetaldehyde	14	SC1-EF-G	5.4E-03	25	0.022%			0.00474%
15	Acetaldehyde	16	SC1-EF-H	3.9E-03	25	0.016%			0.00474%
16	Butanal/Butyraldehyde	2	SD1-IN-A	4.2E-04	25	0.002%	YES		0.00183%
16	Butanal/Butyraldehyde	4	SD1-IN-B	6.4E-04	25	0.003%		JQY	0.00183%
16	Butanal/Butyraldehyde	6	SD1-IN-C	6.3E-04	25	0.003%		JQY	0.00183%
16	Butanal/Butyraldehyde	8	SD1-IN-D	4.3E-04	25	0.002%		JQY	0.00183%
16	Butanal/Butyraldehyde	10	SD1-IN-E	7.5E-04	25	0.003%		JQY	0.00183%
16	Butanal/Butyraldehyde	12	SD1-IN-F	6.0E-04	25	0.002%		JQY	0.00183%
16	Butanal/Butyraldehyde	14	SD1-IN-G	5.7E-04	25	0.002%		JQY	0.00183%
16	Butanal/Butyraldehyde	16	SD1-IN-H	4.4E-04	25	0.002%	YES		0.00183%
16	Butanal/Butyraldehyde	2	SD1-EF-A	4.1E-04	25	0.002%	YES		0.00183%
16	Butanal/Butyraldehyde	4	SD1-EF-B	4.2E-04	25	0.002%	YES		0.00183%
16	Butanal/Butyraldehyde	6	SD1-EF-C	4.1E-04	25	0.002%	YES		0.00183%
16	Butanal/Butyraldehyde	8	SD1-EF-D	4.5E-04	25	0.002%	YES		0.00183%
16	Butanal/Butyraldehyde	10	SD1-EF-E	4.5E-04	25	0.002%	YES		0.00183%
16	Butanal/Butyraldehyde	12	SD1-EF-F	4.6E-04	25	0.002%	YES		0.00183%
16	Butanal/Butyraldehyde	14	SD1-EF-G	4.4E-04	25	0.002%	YES		0.00183%
16	Butanal/Butyraldehyde	16	SD1-EF-H	4.2E-04	25	0.002%	YES		0.00183%
16	Butanal/Butyraldehyde	2	SC1-IN-A	3.3E-04	25	0.001%	YES		0.00183%
16	Butanal/Butyraldehyde	4	SC1-IN-B	1.6E-04	25	0.001%		J	0.00183%
16	Butanal/Butyraldehyde	6	SC1-IN-C	1.2E-04	25	0.000%	YES		0.00183%
16	Butanal/Butyraldehyde	8	SC1-IN-D	7.1E-04	25	0.003%		J	0.00183%
16	Butanal/Butyraldehyde	10	SC1-IN-E	4.6E-04	25	0.002%		J	0.00183%

Table D.1. APR Cartridge Testing 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	12	SC1-IN-F	3.3E-04	25	0.001%		J	0.00183%
16	Butanal/Butyraldehyde	14	SC1-IN-G	5.5E-04	25	0.002%		J	0.00183%
16	Butanal/Butyraldehyde	16	SC1-IN-H	7.9E-04	25	0.003%		JQY	0.00183%
16	Butanal/Butyraldehyde	2	SC1-EF-A	3.3E-04	25	0.001%	YES		0.00183%
16	Butanal/Butyraldehyde	4	SC1-EF-B	3.3E-04	25	0.001%	YES		0.00183%
16	Butanal/Butyraldehyde	6	SC1-EF-C	3.4E-04	25	0.001%	YES		0.00183%
16	Butanal/Butyraldehyde	8	SC1-EF-D	3.4E-04	25	0.001%	YES		0.00183%
16	Butanal/Butyraldehyde	10	SC1-EF-E	3.2E-04	25	0.001%	YES		0.00183%
16	Butanal/Butyraldehyde	12	SC1-EF-F	3.1E-04	25	0.001%	YES		0.00183%
16	Butanal/Butyraldehyde	14	SC1-EF-G	3.1E-04	25	0.001%	YES		0.00183%
16	Butanal/Butyraldehyde	16	SC1-EF-H	3.4E-04	25	0.001%	YES		0.00183%
19	2-Propenal/Acrolein	2	SD1-IN-A	8.8E-04	0.100	0.880%	YES		0.931%
19	2-Propenal/Acrolein	4	SD1-IN-B	8.7E-04	0.100	0.871%	YES		0.931%
19	2-Propenal/Acrolein	6	SD1-IN-C	8.7E-04	0.100	0.867%	YES		0.931%
19	2-Propenal/Acrolein	8	SD1-IN-D	8.9E-04	0.100	0.892%	YES		0.931%
19	2-Propenal/Acrolein	10	SD1-IN-E	9.0E-04	0.100	0.896%	YES		0.931%
19	2-Propenal/Acrolein	12	SD1-IN-F	9.0E-04	0.100	0.903%	YES		0.931%
19	2-Propenal/Acrolein	14	SD1-IN-G	9.0E-04	0.100	0.901%	YES		0.931%
19	2-Propenal/Acrolein	16	SD1-IN-H	9.0E-04	0.100	0.901%	YES		0.931%
19	2-Propenal/Acrolein	2	SD1-EF-A	9.2E-04	0.100	0.917%	YES		0.931%
19	2-Propenal/Acrolein	4	SD1-EF-B	8.9E-04	0.100	0.888%	YES		0.931%
19	2-Propenal/Acrolein	6	SD1-EF-C	9.0E-04	0.100	0.902%	YES		0.931%
19	2-Propenal/Acrolein	8	SD1-EF-D	8.8E-04	0.100	0.879%	YES		0.931%
19	2-Propenal/Acrolein	10	SD1-EF-E	8.8E-04	0.100	0.876%	YES		0.931%
19	2-Propenal/Acrolein	12	SD1-EF-F	9.0E-04	0.100	0.896%	YES		0.931%
19	2-Propenal/Acrolein	14	SD1-EF-G	9.0E-04	0.100	0.899%	YES		0.931%
19	2-Propenal/Acrolein	16	SD1-EF-H	9.2E-04	0.100	0.921%	YES		0.931%
19	2-Propenal/Acrolein	2	SC1-IN-A	9.0E-04	0.100	0.902%	YES		0.931%
19	2-Propenal/Acrolein	4	SC1-IN-B	9.2E-04	0.100	0.920%	YES		0.931%
19	2-Propenal/Acrolein	6	SC1-IN-C	9.2E-04	0.100	0.916%	YES		0.931%
19	2-Propenal/Acrolein	8	SC1-IN-D	9.3E-04	0.100	0.930%	YES		0.931%
19	2-Propenal/Acrolein	10	SC1-IN-E	8.9E-04	0.100	0.894%	YES		0.931%
19	2-Propenal/Acrolein	12	SC1-IN-F	8.9E-04	0.100	0.889%	YES		0.931%
19	2-Propenal/Acrolein	14	SC1-IN-G	8.9E-04	0.100	0.892%	YES		0.931%
19	2-Propenal/Acrolein	16	SC1-IN-H	8.9E-04	0.100	0.889%	YES		0.931%
19	2-Propenal/Acrolein	2	SC1-EF-A	9.0E-04	0.100	0.902%	YES		0.931%
19	2-Propenal/Acrolein	4	SC1-EF-B	9.1E-04	0.100	0.912%	YES		0.931%
19	2-Propenal/Acrolein	6	SC1-EF-C	9.2E-04	0.100	0.922%	YES		0.931%
19	2-Propenal/Acrolein	8	SC1-EF-D	9.2E-04	0.100	0.922%	YES		0.931%
19	2-Propenal/Acrolein	10	SC1-EF-E	8.6E-04	0.100	0.865%	YES		0.931%
19	2-Propenal/Acrolein	12	SC1-EF-F	8.7E-04	0.100	0.870%	YES		0.931%
19	2-Propenal/Acrolein	14	SC1-EF-G	9.3E-04	0.100	0.931%	YES		0.931%
19	2-Propenal/Acrolein	16	SC1-EF-H	9.0E-04	0.100	0.897%	YES		0.931%
20	Furan	2	SD1-IN-A	8.8E-05	0.001	8.82%	YES		23.0%
20	Furan	4	SD1-IN-B	1.0E-03	0.001	103.821%		J	23.0%
20	Furan	6	SD1-IN-C	5.7E-04	0.001	57.3%		JY	23.0%
20	Furan	8	SD1-IN-D	5.8E-04	0.001	57.5%		J	23.0%
20	Furan	10	SD1-IN-E	9.0E-04	0.001	90.4%		J	23.0%
20	Furan	12	SD1-IN-F	7.8E-04	0.001	78.1%		J	23.0%
20	Furan	14	SD1-IN-G	4.9E-04	0.001	48.7%		J	23.0%
20	Furan	16	SD1-IN-H	8.4E-04	0.001	83.7%		J	23.0%
20	Furan	2	SD1-EF-A	8.5E-05	0.001	8.51%	YES		23.0%
20	Furan	4	SD1-EF-B	8.6E-05	0.001	8.63%	YES		23.0%
20	Furan	6	SD1-EF-C	8.6E-05	0.001	8.57%	YES		23.0%
20	Furan	8	SD1-EF-D	9.3E-05	0.001	9.26%	YES		23.0%
20	Furan	10	SD1-EF-E	9.4E-05	0.001	9.39%	YES		23.0%
20	Furan	12	SD1-EF-F	9.5E-05	0.001	9.50%	YES		23.0%
20	Furan	14	SD1-EF-G	9.1E-05	0.001	9.06%	YES		23.0%
20	Furan	16	SD1-EF-H	8.7E-05	0.001	8.67%	YES		23.0%
20	Furan	2	SC1-IN-A	2.2E-04	0.001	22.2%	YES		23.0%
20	Furan	4	SC1-IN-B	8.7E-05	0.001	8.73%	YES		23.0%
20	Furan	6	SC1-IN-C	8.2E-05	0.001	8.18%	YES		23.0%

Table D.1. APR Cartridge Testing 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	SC1-IN-D	1.0E-03	0.001	101.898%			23.0%
20	Furan	10	SC1-IN-E	3.7E-04	0.001	37.4%		J	23.0%
20	Furan	12	SC1-IN-F	3.2E-04	0.001	32.2%		J	23.0%
20	Furan	14	SC1-IN-G	3.7E-04	0.001	36.5%		J	23.0%
20	Furan	16	SC1-IN-H	8.6E-04	0.001	85.7%		J	23.0%
20	Furan	2	SC1-EF-A	2.2E-04	0.001	22.1%	YES		23.0%
20	Furan	4	SC1-EF-B	2.2E-04	0.001	22.3%	YES		23.0%
20	Furan	6	SC1-EF-C	2.3E-04	0.001	22.7%	YES		23.0%
20	Furan	8	SC1-EF-D	2.3E-04	0.001	23.0%	YES		23.0%
20	Furan	10	SC1-EF-E	2.1E-04	0.001	21.4%	YES		23.0%
20	Furan	12	SC1-EF-F	2.1E-04	0.001	21.0%	YES		23.0%
20	Furan	14	SC1-EF-G	2.1E-04	0.001	20.9%	YES		23.0%
20	Furan	16	SC1-EF-H	2.2E-04	0.001	22.5%	YES		23.0%
21	2,3-Dihydrofuran	2	SD1-IN-A	3.0E-05	0.001	3.03%	YES		3.28%
21	2,3-Dihydrofuran	4	SD1-IN-B	2.9E-05	0.001	2.95%	YES		3.28%
21	2,3-Dihydrofuran	6	SD1-IN-C	2.9E-05	0.001	2.94%	YES		3.28%
21	2,3-Dihydrofuran	8	SD1-IN-D	2.9E-05	0.001	2.91%	YES		3.28%
21	2,3-Dihydrofuran	10	SD1-IN-E	2.9E-05	0.001	2.95%	YES		3.28%
21	2,3-Dihydrofuran	12	SD1-IN-F	2.9E-05	0.001	2.94%	YES		3.28%
21	2,3-Dihydrofuran	14	SD1-IN-G	2.9E-05	0.001	2.93%	YES		3.28%
21	2,3-Dihydrofuran	16	SD1-IN-H	2.9E-05	0.001	2.94%	YES		3.28%
21	2,3-Dihydrofuran	2	SD1-EF-A	3.2E-05	0.001	3.20%	YES		3.28%
21	2,3-Dihydrofuran	4	SD1-EF-B	3.2E-05	0.001	3.16%	YES		3.28%
21	2,3-Dihydrofuran	6	SD1-EF-C	3.2E-05	0.001	3.18%	YES		3.28%
21	2,3-Dihydrofuran	8	SD1-EF-D	3.0E-05	0.001	2.96%	YES		3.28%
21	2,3-Dihydrofuran	10	SD1-EF-E	3.3E-05	0.001	3.28%	YES		3.28%
21	2,3-Dihydrofuran	12	SD1-EF-F	3.1E-05	0.001	3.10%	YES		3.28%
21	2,3-Dihydrofuran	14	SD1-EF-G	3.1E-05	0.001	3.07%	YES		3.28%
21	2,3-Dihydrofuran	16	SD1-EF-H	3.0E-05	0.001	3.00%	YES		3.28%
21	2,3-Dihydrofuran	2	SC1-IN-A	3.0E-05	0.001	3.03%	YES	U	3.28%
21	2,3-Dihydrofuran	4	SC1-IN-B	3.0E-05	0.001	3.05%	YES	U	3.28%
21	2,3-Dihydrofuran	6	SC1-IN-C	2.9E-05	0.001	2.91%	YES	U	3.28%
21	2,3-Dihydrofuran	8	SC1-IN-D	2.9E-05	0.001	2.91%	YES	U	3.28%
21	2,3-Dihydrofuran	10	SC1-IN-E	2.9E-05	0.001	2.94%	YES	U	3.28%
21	2,3-Dihydrofuran	12	SC1-IN-F	2.9E-05	0.001	2.95%	YES	U	3.28%
21	2,3-Dihydrofuran	14	SC1-IN-G	3.0E-05	0.001	2.96%	YES	U	3.28%
21	2,3-Dihydrofuran	16	SC1-IN-H	2.9E-05	0.001	2.94%	YES	U	3.28%
21	2,3-Dihydrofuran	2	SC1-EF-A	3.3E-05	0.001	3.27%	YES	U	3.28%
21	2,3-Dihydrofuran	4	SC1-EF-B	2.6E-05	0.001	2.58%	YES	U	3.28%
21	2,3-Dihydrofuran	6	SC1-EF-C	2.9E-05	0.001	2.88%	YES	U	3.28%
21	2,3-Dihydrofuran	8	SC1-EF-D	2.9E-05	0.001	2.89%	YES	U	3.28%
21	2,3-Dihydrofuran	10	SC1-EF-E	2.9E-05	0.001	2.92%	YES	U	3.28%
21	2,3-Dihydrofuran	12	SC1-EF-F	2.9E-05	0.001	2.91%	YES	U	3.28%
21	2,3-Dihydrofuran	14	SC1-EF-G	3.0E-05	0.001	2.99%	YES	U	3.28%
21	2,3-Dihydrofuran	16	SC1-EF-H	3.0E-05	0.001	2.96%	YES	U	3.28%
22	2,5-Dihydrofuran	2	SD1-IN-A	2.4E-04	0.001	24.0%	YES		25.8%
22	2,5-Dihydrofuran	4	SD1-IN-B	1.2E-04	0.001	11.8%	YES	U	25.8%
22	2,5-Dihydrofuran	6	SD1-IN-C	1.3E-04	0.001	12.8%	YES	UY	25.8%
22	2,5-Dihydrofuran	8	SD1-IN-D	1.2E-04	0.001	12.2%	YES	U	25.8%
22	2,5-Dihydrofuran	10	SD1-IN-E	1.2E-04	0.001	12.3%	YES	U	25.8%
22	2,5-Dihydrofuran	12	SD1-IN-F	1.2E-04	0.001	12.3%	YES	U	25.8%
22	2,5-Dihydrofuran	14	SD1-IN-G	1.2E-04	0.001	12.3%	YES	U	25.8%
22	2,5-Dihydrofuran	16	SD1-IN-H	2.5E-04	0.001	25.0%	YES		25.8%
22	2,5-Dihydrofuran	2	SD1-EF-A	2.3E-04	0.001	23.1%	YES		25.8%
22	2,5-Dihydrofuran	4	SD1-EF-B	2.3E-04	0.001	23.5%	YES		25.8%
22	2,5-Dihydrofuran	6	SD1-EF-C	2.3E-04	0.001	23.3%	YES		25.8%
22	2,5-Dihydrofuran	8	SD1-EF-D	2.5E-04	0.001	25.2%	YES		25.8%
22	2,5-Dihydrofuran	10	SD1-EF-E	2.6E-04	0.001	25.5%	YES		25.8%
22	2,5-Dihydrofuran	12	SD1-EF-F	2.6E-04	0.001	25.8%	YES		25.8%
22	2,5-Dihydrofuran	14	SD1-EF-G	2.5E-04	0.001	24.6%	YES		25.8%
22	2,5-Dihydrofuran	16	SD1-EF-H	2.4E-04	0.001	23.6%	YES		25.8%
22	2,5-Dihydrofuran	2	SC1-IN-A	1.3E-04	0.001	12.6%	YES		25.8%

Table D.1. APR Cartridge Testing 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	4	SC1-IN-B	5.0E-05	0.001	5.00%	YES		25.8%
22	2,5-Dihydrofuran	6	SC1-IN-C	4.7E-05	0.001	4.69%	YES		25.8%
22	2,5-Dihydrofuran	8	SC1-IN-D	4.9E-05	0.001	4.87%	YES		25.8%
22	2,5-Dihydrofuran	10	SC1-IN-E	5.0E-05	0.001	4.99%	YES		25.8%
22	2,5-Dihydrofuran	12	SC1-IN-F	4.9E-05	0.001	4.85%	YES		25.8%
22	2,5-Dihydrofuran	14	SC1-IN-G	5.2E-05	0.001	5.23%	YES		25.8%
22	2,5-Dihydrofuran	16	SC1-IN-H	1.3E-04	0.001	12.5%	YES		25.8%
22	2,5-Dihydrofuran	2	SC1-EF-A	1.3E-04	0.001	12.5%	YES		25.8%
22	2,5-Dihydrofuran	4	SC1-EF-B	1.3E-04	0.001	12.6%	YES		25.8%
22	2,5-Dihydrofuran	6	SC1-EF-C	1.3E-04	0.001	12.8%	YES		25.8%
22	2,5-Dihydrofuran	8	SC1-EF-D	1.3E-04	0.001	13.0%	YES		25.8%
22	2,5-Dihydrofuran	10	SC1-EF-E	1.2E-04	0.001	12.1%	YES		25.8%
22	2,5-Dihydrofuran	12	SC1-EF-F	1.2E-04	0.001	11.9%	YES		25.8%
22	2,5-Dihydrofuran	14	SC1-EF-G	1.2E-04	0.001	11.8%	YES		25.8%
22	2,5-Dihydrofuran	16	SC1-EF-H	1.3E-04	0.001	12.7%	YES		25.8%
23	2-Methylfuran	2	SD1-IN-A	8.0E-05	0.001	8.05%	YES		10.3%
23	2-Methylfuran	4	SD1-IN-B	9.3E-05	0.001	9.33%	YES	U	10.3%
23	2-Methylfuran	6	SD1-IN-C	1.0E-04	0.001	10.1%	YES	UY	10.3%
23	2-Methylfuran	8	SD1-IN-D	9.7E-05	0.001	9.69%	YES	U	10.3%
23	2-Methylfuran	10	SD1-IN-E	9.7E-05	0.001	9.75%	YES	U	10.3%
23	2-Methylfuran	12	SD1-IN-F	9.8E-05	0.001	9.78%	YES	U	10.3%
23	2-Methylfuran	14	SD1-IN-G	9.7E-05	0.001	9.72%	YES	U	10.3%
23	2-Methylfuran	16	SD1-IN-H	8.4E-05	0.001	8.38%	YES		10.3%
23	2-Methylfuran	2	SD1-EF-A	7.8E-05	0.001	7.76%	YES		10.3%
23	2-Methylfuran	4	SD1-EF-B	7.9E-05	0.001	7.87%	YES		10.3%
23	2-Methylfuran	6	SD1-EF-C	7.8E-05	0.001	7.81%	YES		10.3%
23	2-Methylfuran	8	SD1-EF-D	8.5E-05	0.001	8.45%	YES		10.3%
23	2-Methylfuran	10	SD1-EF-E	8.6E-05	0.001	8.57%	YES		10.3%
23	2-Methylfuran	12	SD1-EF-F	8.7E-05	0.001	8.66%	YES		10.3%
23	2-Methylfuran	14	SD1-EF-G	8.3E-05	0.001	8.27%	YES		10.3%
23	2-Methylfuran	16	SD1-EF-H	7.9E-05	0.001	7.91%	YES		10.3%
23	2-Methylfuran	2	SC1-IN-A	1.0E-04	0.001	9.97%	YES		10.3%
23	2-Methylfuran	4	SC1-IN-B	5.7E-05	0.001	5.72%	YES		10.3%
23	2-Methylfuran	6	SC1-IN-C	5.4E-05	0.001	5.36%	YES		10.3%
23	2-Methylfuran	8	SC1-IN-D	5.6E-05	0.001	5.56%	YES		10.3%
23	2-Methylfuran	10	SC1-IN-E	5.7E-05	0.001	5.70%	YES		10.3%
23	2-Methylfuran	12	SC1-IN-F	5.5E-05	0.001	5.55%	YES		10.3%
23	2-Methylfuran	14	SC1-IN-G	6.0E-05	0.001	5.98%	YES		10.3%
23	2-Methylfuran	16	SC1-IN-H	9.9E-05	0.001	9.93%	YES		10.3%
23	2-Methylfuran	2	SC1-EF-A	9.9E-05	0.001	9.95%	YES		10.3%
23	2-Methylfuran	4	SC1-EF-B	1.0E-04	0.001	10.0%	YES		10.3%
23	2-Methylfuran	6	SC1-EF-C	1.0E-04	0.001	10.2%	YES		10.3%
23	2-Methylfuran	8	SC1-EF-D	1.0E-04	0.001	10.3%	YES		10.3%
23	2-Methylfuran	10	SC1-EF-E	9.6E-05	0.001	9.59%	YES		10.3%
23	2-Methylfuran	12	SC1-EF-F	9.4E-05	0.001	9.41%	YES		10.3%
23	2-Methylfuran	14	SC1-EF-G	9.4E-05	0.001	9.37%	YES		10.3%
23	2-Methylfuran	16	SC1-EF-H	1.0E-04	0.001	10.1%	YES		10.3%
24	2,5-Dimethylfuran	2	SD1-IN-A	2.8E-05	0.001	2.85%	YES		3.09%
24	2,5-Dimethylfuran	4	SD1-IN-B	2.8E-05	0.001	2.77%	YES		3.09%
24	2,5-Dimethylfuran	6	SD1-IN-C	2.8E-05	0.001	2.76%	YES		3.09%
24	2,5-Dimethylfuran	8	SD1-IN-D	2.7E-05	0.001	2.74%	YES		3.09%
24	2,5-Dimethylfuran	10	SD1-IN-E	2.8E-05	0.001	2.77%	YES		3.09%
24	2,5-Dimethylfuran	12	SD1-IN-F	2.8E-05	0.001	2.76%	YES		3.09%
24	2,5-Dimethylfuran	14	SD1-IN-G	2.8E-05	0.001	2.75%	YES		3.09%
24	2,5-Dimethylfuran	16	SD1-IN-H	2.8E-05	0.001	2.76%	YES		3.09%
24	2,5-Dimethylfuran	2	SD1-EF-A	3.0E-05	0.001	3.01%	YES		3.09%
24	2,5-Dimethylfuran	4	SD1-EF-B	3.0E-05	0.001	2.97%	YES		3.09%
24	2,5-Dimethylfuran	6	SD1-EF-C	3.0E-05	0.001	2.98%	YES		3.09%
24	2,5-Dimethylfuran	8	SD1-EF-D	2.8E-05	0.001	2.78%	YES		3.09%
24	2,5-Dimethylfuran	10	SD1-EF-E	3.1E-05	0.001	3.09%	YES		3.09%
24	2,5-Dimethylfuran	12	SD1-EF-F	2.9E-05	0.001	2.91%	YES		3.09%
24	2,5-Dimethylfuran	14	SD1-EF-G	2.9E-05	0.001	2.89%	YES		3.09%

Table D.1. APR Cartridge Testing 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	16	SD1-EF-H	2.8E-05	0.001	2.82%	YES		3.09%
24	2,5-Dimethylfuran	2	SC1-IN-A	2.8E-05	0.001	2.85%	YES	U	3.09%
24	2,5-Dimethylfuran	4	SC1-IN-B	2.9E-05	0.001	2.86%	YES	U	3.09%
24	2,5-Dimethylfuran	6	SC1-IN-C	2.7E-05	0.001	2.74%	YES	U	3.09%
24	2,5-Dimethylfuran	8	SC1-IN-D	2.7E-05	0.001	2.74%	YES	U	3.09%
24	2,5-Dimethylfuran	10	SC1-IN-E	2.8E-05	0.001	2.76%	YES	U	3.09%
24	2,5-Dimethylfuran	12	SC1-IN-F	2.8E-05	0.001	2.77%	YES	U	3.09%
24	2,5-Dimethylfuran	14	SC1-IN-G	2.8E-05	0.001	2.78%	YES	U	3.09%
24	2,5-Dimethylfuran	16	SC1-IN-H	2.8E-05	0.001	2.76%	YES	U	3.09%
24	2,5-Dimethylfuran	2	SC1-EF-A	3.1E-05	0.001	3.07%	YES	U	3.09%
24	2,5-Dimethylfuran	4	SC1-EF-B	2.4E-05	0.001	2.43%	YES	U	3.09%
24	2,5-Dimethylfuran	6	SC1-EF-C	2.7E-05	0.001	2.71%	YES	U	3.09%
24	2,5-Dimethylfuran	8	SC1-EF-D	2.7E-05	0.001	2.72%	YES	U	3.09%
24	2,5-Dimethylfuran	10	SC1-EF-E	2.7E-05	0.001	2.74%	YES	U	3.09%
24	2,5-Dimethylfuran	12	SC1-EF-F	2.7E-05	0.001	2.73%	YES	U	3.09%
24	2,5-Dimethylfuran	14	SC1-EF-G	2.8E-05	0.001	2.81%	YES	U	3.09%
24	2,5-Dimethylfuran	16	SC1-EF-H	2.8E-05	0.001	2.78%	YES	U	3.09%
28	2-Pentylfuran	2	SD1-IN-A	2.9E-05	0.001	2.87%	YES		3.11%
28	2-Pentylfuran	4	SD1-IN-B	2.8E-05	0.001	2.79%	YES		3.11%
28	2-Pentylfuran	6	SD1-IN-C	2.8E-05	0.001	2.78%	YES		3.11%
28	2-Pentylfuran	8	SD1-IN-D	2.8E-05	0.001	2.76%	YES		3.11%
28	2-Pentylfuran	10	SD1-IN-E	2.8E-05	0.001	2.79%	YES		3.11%
28	2-Pentylfuran	12	SD1-IN-F	2.8E-05	0.001	2.78%	YES		3.11%
28	2-Pentylfuran	14	SD1-IN-G	2.8E-05	0.001	2.77%	YES		3.11%
28	2-Pentylfuran	16	SD1-IN-H	2.8E-05	0.001	2.78%	YES		3.11%
28	2-Pentylfuran	2	SD1-EF-A	3.0E-05	0.001	3.03%	YES		3.11%
28	2-Pentylfuran	4	SD1-EF-B	3.0E-05	0.001	2.99%	YES		3.11%
28	2-Pentylfuran	6	SD1-EF-C	3.0E-05	0.001	3.00%	YES		3.11%
28	2-Pentylfuran	8	SD1-EF-D	2.8E-05	0.001	2.80%	YES		3.11%
28	2-Pentylfuran	10	SD1-EF-E	3.1E-05	0.001	3.11%	YES		3.11%
28	2-Pentylfuran	12	SD1-EF-F	2.9E-05	0.001	2.93%	YES		3.11%
28	2-Pentylfuran	14	SD1-EF-G	2.9E-05	0.001	2.91%	YES		3.11%
28	2-Pentylfuran	16	SD1-EF-H	2.8E-05	0.001	2.84%	YES		3.11%
28	2-Pentylfuran	2	SC1-IN-A	2.9E-05	0.001	2.87%	YES	U	3.11%
28	2-Pentylfuran	4	SC1-IN-B	2.9E-05	0.001	2.88%	YES	U	3.11%
28	2-Pentylfuran	6	SC1-IN-C	2.8E-05	0.001	2.76%	YES	U	3.11%
28	2-Pentylfuran	8	SC1-IN-D	2.8E-05	0.001	2.75%	YES	U	3.11%
28	2-Pentylfuran	10	SC1-IN-E	2.8E-05	0.001	2.78%	YES	U	3.11%
28	2-Pentylfuran	12	SC1-IN-F	2.8E-05	0.001	2.79%	YES	U	3.11%
28	2-Pentylfuran	14	SC1-IN-G	2.8E-05	0.001	2.80%	YES	U	3.11%
28	2-Pentylfuran	16	SC1-IN-H	2.8E-05	0.001	2.78%	YES	U	3.11%
28	2-Pentylfuran	2	SC1-EF-A	3.1E-05	0.001	3.10%	YES	U	3.11%
28	2-Pentylfuran	4	SC1-EF-B	2.4E-05	0.001	2.44%	YES	U	3.11%
28	2-Pentylfuran	6	SC1-EF-C	2.7E-05	0.001	2.73%	YES	U	3.11%
28	2-Pentylfuran	8	SC1-EF-D	2.7E-05	0.001	2.74%	YES	U	3.11%
28	2-Pentylfuran	10	SC1-EF-E	2.8E-05	0.001	2.76%	YES	U	3.11%
28	2-Pentylfuran	12	SC1-EF-F	2.8E-05	0.001	2.75%	YES	U	3.11%
28	2-Pentylfuran	14	SC1-EF-G	2.8E-05	0.001	2.83%	YES	U	3.11%
28	2-Pentylfuran	16	SC1-EF-H	2.8E-05	0.001	2.80%	YES	U	3.11%
29	2-Heptylfuran	2	SD1-IN-A	2.7E-05	0.001	2.70%	YES		2.93%
29	2-Heptylfuran	4	SD1-IN-B	2.6E-05	0.001	2.63%	YES		2.93%
29	2-Heptylfuran	6	SD1-IN-C	2.6E-05	0.001	2.62%	YES		2.93%
29	2-Heptylfuran	8	SD1-IN-D	2.6E-05	0.001	2.60%	YES		2.93%
29	2-Heptylfuran	10	SD1-IN-E	2.6E-05	0.001	2.63%	YES		2.93%
29	2-Heptylfuran	12	SD1-IN-F	2.6E-05	0.001	2.62%	YES		2.93%
29	2-Heptylfuran	14	SD1-IN-G	2.6E-05	0.001	2.61%	YES		2.93%
29	2-Heptylfuran	16	SD1-IN-H	2.6E-05	0.001	2.62%	YES		2.93%
29	2-Heptylfuran	2	SD1-EF-A	2.9E-05	0.001	2.85%	YES		2.93%
29	2-Heptylfuran	4	SD1-EF-B	2.8E-05	0.001	2.82%	YES		2.93%
29	2-Heptylfuran	6	SD1-EF-C	2.8E-05	0.001	2.83%	YES		2.93%
29	2-Heptylfuran	8	SD1-EF-D	2.6E-05	0.001	2.64%	YES		2.93%
29	2-Heptylfuran	10	SD1-EF-E	2.9E-05	0.001	2.93%	YES		2.93%

Table D.1. APR Cartridge Testing 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	12	SD1-EF-F	2.8E-05	0.001	2.77%	YES		2.93%
29	2-Heptylfuran	14	SD1-EF-G	2.7E-05	0.001	2.74%	YES		2.93%
29	2-Heptylfuran	16	SD1-EF-H	2.7E-05	0.001	2.68%	YES		2.93%
29	2-Heptylfuran	2	SC1-IN-A	2.7E-05	0.001	2.70%	YES	U	2.93%
29	2-Heptylfuran	4	SC1-IN-B	2.7E-05	0.001	2.72%	YES	U	2.93%
29	2-Heptylfuran	6	SC1-IN-C	2.6E-05	0.001	2.60%	YES	U	2.93%
29	2-Heptylfuran	8	SC1-IN-D	2.6E-05	0.001	2.60%	YES	U	2.93%
29	2-Heptylfuran	10	SC1-IN-E	2.6E-05	0.001	2.62%	YES	U	2.93%
29	2-Heptylfuran	12	SC1-IN-F	2.6E-05	0.001	2.63%	YES	U	2.93%
29	2-Heptylfuran	14	SC1-IN-G	2.6E-05	0.001	2.64%	YES	U	2.93%
29	2-Heptylfuran	16	SC1-IN-H	2.6E-05	0.001	2.62%	YES	U	2.93%
29	2-Heptylfuran	2	SC1-EF-A	2.9E-05	0.001	2.92%	YES	U	2.93%
29	2-Heptylfuran	4	SC1-EF-B	2.3E-05	0.001	2.30%	YES	U	2.93%
29	2-Heptylfuran	6	SC1-EF-C	2.6E-05	0.001	2.57%	YES	U	2.93%
29	2-Heptylfuran	8	SC1-EF-D	2.6E-05	0.001	2.58%	YES	U	2.93%
29	2-Heptylfuran	10	SC1-EF-E	2.6E-05	0.001	2.60%	YES	U	2.93%
29	2-Heptylfuran	12	SC1-EF-F	2.6E-05	0.001	2.59%	YES	U	2.93%
29	2-Heptylfuran	14	SC1-EF-G	2.7E-05	0.001	2.66%	YES	U	2.93%
29	2-Heptylfuran	16	SC1-EF-H	2.6E-05	0.001	2.64%	YES	U	2.93%
30	2-Propylfuran	2	SD1-IN-A	1.7E-05	0.001	1.71%	YES		1.85%
30	2-Propylfuran	4	SD1-IN-B	1.7E-05	0.001	1.66%	YES		1.85%
30	2-Propylfuran	6	SD1-IN-C	1.7E-05	0.001	1.65%	YES		1.85%
30	2-Propylfuran	8	SD1-IN-D	1.6E-05	0.001	1.64%	YES		1.85%
30	2-Propylfuran	10	SD1-IN-E	1.7E-05	0.001	1.66%	YES		1.85%
30	2-Propylfuran	12	SD1-IN-F	1.7E-05	0.001	1.66%	YES		1.85%
30	2-Propylfuran	14	SD1-IN-G	1.7E-05	0.001	1.65%	YES		1.85%
30	2-Propylfuran	16	SD1-IN-H	1.7E-05	0.001	1.65%	YES		1.85%
30	2-Propylfuran	2	SD1-EF-A	1.8E-05	0.001	1.80%	YES		1.85%
30	2-Propylfuran	4	SD1-EF-B	1.8E-05	0.001	1.78%	YES		1.85%
30	2-Propylfuran	6	SD1-EF-C	1.8E-05	0.001	1.79%	YES		1.85%
30	2-Propylfuran	8	SD1-EF-D	1.7E-05	0.001	1.66%	YES		1.85%
30	2-Propylfuran	10	SD1-EF-E	1.8E-05	0.001	1.85%	YES		1.85%
30	2-Propylfuran	12	SD1-EF-F	1.7E-05	0.001	1.75%	YES		1.85%
30	2-Propylfuran	14	SD1-EF-G	1.7E-05	0.001	1.73%	YES		1.85%
30	2-Propylfuran	16	SD1-EF-H	1.7E-05	0.001	1.69%	YES		1.85%
30	2-Propylfuran	2	SC1-IN-A	1.7E-05	0.001	1.70%	YES	U	1.85%
30	2-Propylfuran	4	SC1-IN-B	1.7E-05	0.001	1.71%	YES	U	1.85%
30	2-Propylfuran	6	SC1-IN-C	1.6E-05	0.001	1.64%	YES	U	1.85%
30	2-Propylfuran	8	SC1-IN-D	1.6E-05	0.001	1.64%	YES	U	1.85%
30	2-Propylfuran	10	SC1-IN-E	1.7E-05	0.001	1.65%	YES	U	1.85%
30	2-Propylfuran	12	SC1-IN-F	1.7E-05	0.001	1.66%	YES	U	1.85%
30	2-Propylfuran	14	SC1-IN-G	1.7E-05	0.001	1.67%	YES	U	1.85%
30	2-Propylfuran	16	SC1-IN-H	1.7E-05	0.001	1.65%	YES	U	1.85%
30	2-Propylfuran	2	SC1-EF-A	1.8E-05	0.001	1.84%	YES	U	1.85%
30	2-Propylfuran	4	SC1-EF-B	1.5E-05	0.001	1.45%	YES	U	1.85%
30	2-Propylfuran	6	SC1-EF-C	1.6E-05	0.001	1.62%	YES	U	1.85%
30	2-Propylfuran	8	SC1-EF-D	1.6E-05	0.001	1.63%	YES	U	1.85%
30	2-Propylfuran	10	SC1-EF-E	1.6E-05	0.001	1.64%	YES	U	1.85%
30	2-Propylfuran	12	SC1-EF-F	1.6E-05	0.001	1.64%	YES	U	1.85%
30	2-Propylfuran	14	SC1-EF-G	1.7E-05	0.001	1.68%	YES	U	1.85%
30	2-Propylfuran	16	SC1-EF-H	1.7E-05	0.001	1.66%	YES	U	1.85%
34	Diethylphthalate	2	SD1-IN-A	5.7E-05	0.54	0.011%	YES	U	0.0194%
34	Diethylphthalate	4	SD1-IN-B		0.54				0.0194%
34	Diethylphthalate	6	SD1-IN-C	5.4E-05	0.54	0.010%	YES	U	0.0194%
34	Diethylphthalate	8	SD1-IN-D	8.2E-05	0.54	0.015%		J	0.0194%
34	Diethylphthalate	10	SD1-IN-E	5.4E-05	0.54	0.0100%	YES	U	0.0194%
34	Diethylphthalate	12	SD1-IN-F	5.4E-05	0.54	0.010%	YES	U	0.0194%
34	Diethylphthalate	14	SD1-IN-G	5.4E-05	0.54	0.010%	YES	U	0.0194%
34	Diethylphthalate	16	SD1-IN-H	5.7E-05	0.54	0.011%	YES	U	0.0194%
34	Diethylphthalate	2	SD1-EF-A	5.3E-05	0.54	0.010%	YES	U	0.0194%
34	Diethylphthalate	4	SD1-EF-B	5.1E-05	0.54	0.009%	YES	U	0.0194%
34	Diethylphthalate	6	SD1-EF-C	5.2E-05	0.54	0.010%	YES	U	0.0194%

Table D.1. APR Cartridge Testing 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	8	SD1-EF-D	5.3E-05	0.54	0.010%	YES	U	0.0194%
34	Diethylphthalate	10	SD1-EF-E	5.3E-05	0.54	0.010%	YES	U	0.0194%
34	Diethylphthalate	12	SD1-EF-F	5.4E-05	0.54	0.010%	YES	U, S*	0.0194%
34	Diethylphthalate	14	SD1-EF-G	5.2E-05	0.54	0.010%	YES	U	0.0194%
34	Diethylphthalate	16	SD1-EF-H	5.3E-05	0.54	0.010%	YES	U	0.0194%
34	Diethylphthalate	2	SC1-IN-A	5.6E-05	0.54	0.010%	YES	U	0.0194%
34	Diethylphthalate	4	SC1-IN-B	5.7E-05	0.54	0.011%	YES	U	0.0194%
34	Diethylphthalate	6	SC1-IN-C	5.8E-05	0.54	0.011%	YES	U	0.0194%
34	Diethylphthalate	8	SC1-IN-D	7.2E-05	0.54	0.013%		J	0.0194%
34	Diethylphthalate	10	SC1-IN-E	5.6E-05	0.54	0.010%	YES	U	0.0194%
34	Diethylphthalate	12	SC1-IN-F	5.4E-05	0.54	0.010%	YES	U	0.0194%
34	Diethylphthalate	14	SC1-IN-G	5.6E-05	0.54	0.010%	YES	U	0.0194%
34	Diethylphthalate	16	SC1-IN-H	1.1E-04	0.54	0.019%	YES	U	0.0194%
34	Diethylphthalate	2	SC1-EF-A	1.2E-04	0.54	0.022%		J	0.0194%
34	Diethylphthalate	4	SC1-EF-B	5.4E-05	0.54	0.010%	YES	U	0.0194%
34	Diethylphthalate	6	SC1-EF-C	5.2E-05	0.54	0.010%	YES	U	0.0194%
34	Diethylphthalate	8	SC1-EF-D	5.2E-05	0.54	0.010%	YES	U	0.0194%
34	Diethylphthalate	10	SC1-EF-E	5.1E-05	0.54	0.009%	YES	U	0.0194%
34	Diethylphthalate	12	SC1-EF-F	6.0E-05	0.54	0.011%		J, S*	0.0194%
34	Diethylphthalate	14	SC1-EF-G	5.4E-05	0.54	0.010%	YES	U	0.0194%
34	Diethylphthalate	16	SC1-EF-H	5.3E-05	0.54	0.010%	YES	U	0.0194%
35	Acetonitrile	2	SD1-IN-A	3.4E-03	20	0.017%			0.00159%
35	Acetonitrile	4	SD1-IN-B	3.2E-03	20	0.016%			0.00159%
35	Acetonitrile	6	SD1-IN-C	2.3E-03	20	0.012%		Y	0.00159%
35	Acetonitrile	8	SD1-IN-D	1.0E-02	20	0.051%			0.00159%
35	Acetonitrile	10	SD1-IN-E	3.6E-03	20	0.018%			0.00159%
35	Acetonitrile	12	SD1-IN-F	4.2E-03	20	0.021%			0.00159%
35	Acetonitrile	14	SD1-IN-G	4.6E-03	20	0.023%			0.00159%
35	Acetonitrile	16	SD1-IN-H	3.5E-03	20	0.018%			0.00159%
35	Acetonitrile	2	SD1-EF-A	6.8E-03	20	0.034%			0.00159%
35	Acetonitrile	4	SD1-EF-B	3.7E-03	20	0.019%			0.00159%
35	Acetonitrile	6	SD1-EF-C	2.6E-03	20	0.013%			0.00159%
35	Acetonitrile	8	SD1-EF-D	4.5E-02	20	0.223%			0.00159%
35	Acetonitrile	10	SD1-EF-E	2.6E-03	20	0.013%			0.00159%
35	Acetonitrile	12	SD1-EF-F	7.1E-03	20	0.035%			0.00159%
35	Acetonitrile	14	SD1-EF-G	3.5E-03	20	0.017%			0.00159%
35	Acetonitrile	16	SD1-EF-H	1.4E-02	20	0.069%			0.00159%
35	Acetonitrile	2	SC1-IN-A	1.7E-03	20	0.008%		J	0.00159%
35	Acetonitrile	4	SC1-IN-B	1.4E-03	20	0.007%		J	0.00159%
35	Acetonitrile	6	SC1-IN-C	2.6E-04	20	0.001%		J	0.00159%
35	Acetonitrile	8	SC1-IN-D	1.8E-03	20	0.009%			0.00159%
35	Acetonitrile	10	SC1-IN-E	3.2E-03	20	0.016%			0.00159%
35	Acetonitrile	12	SC1-IN-F	1.7E-03	20	0.008%		J	0.00159%
35	Acetonitrile	14	SC1-IN-G	3.6E-03	20	0.018%			0.00159%
35	Acetonitrile	16	SC1-IN-H	2.4E-03	20	0.012%			0.00159%
35	Acetonitrile	2	SC1-EF-A	4.9E-03	20	0.024%			0.00159%
35	Acetonitrile	4	SC1-EF-B	3.4E-03	20	0.017%			0.00159%
35	Acetonitrile	6	SC1-EF-C	1.3E-03	20	0.007%		J	0.00159%
35	Acetonitrile	8	SC1-EF-D	7.8E-04	20	0.004%		J	0.00159%
35	Acetonitrile	10	SC1-EF-E	9.6E-04	20	0.005%		J	0.00159%
35	Acetonitrile	12	SC1-EF-F	9.4E-04	20	0.005%		J	0.00159%
35	Acetonitrile	14	SC1-EF-G	2.9E-03	20	0.014%			0.00159%
35	Acetonitrile	16	SC1-EF-H	1.1E-03	20	0.006%		J	0.00159%
36	Propanenitrile	2	SD1-IN-A	1.5E-04	6.0	0.003%	YES		0.00552%
36	Propanenitrile	4	SD1-IN-B	3.0E-04	6.0	0.005%	YES	U	0.00552%
36	Propanenitrile	6	SD1-IN-C	3.2E-04	6.0	0.005%	YES	UY	0.00552%
36	Propanenitrile	8	SD1-IN-D	3.1E-04	6.0	0.005%	YES	U	0.00552%
36	Propanenitrile	10	SD1-IN-E	3.1E-04	6.0	0.005%	YES	U	0.00552%
36	Propanenitrile	12	SD1-IN-F	3.1E-04	6.0	0.005%	YES	U	0.00552%
36	Propanenitrile	14	SD1-IN-G	3.1E-04	6.0	0.005%	YES	U	0.00552%
36	Propanenitrile	16	SD1-IN-H	1.6E-04	6.0	0.003%	YES		0.00552%
36	Propanenitrile	2	SD1-EF-A	1.5E-04	6.0	0.002%	YES		0.00552%

Table D.1. APR Cartridge Testing 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)
36	Propanenitrile	4	SD1-EF-B	1.5E-04	6.0	0.002%	YES		0.00552%
36	Propanenitrile	6	SD1-EF-C	1.5E-04	6.0	0.002%	YES		0.00552%
36	Propanenitrile	8	SD1-EF-D	1.6E-04	6.0	0.003%	YES		0.00552%
36	Propanenitrile	10	SD1-EF-E	1.6E-04	6.0	0.003%	YES		0.00552%
36	Propanenitrile	12	SD1-EF-F	1.6E-04	6.0	0.003%	YES		0.00552%
36	Propanenitrile	14	SD1-EF-G	1.6E-04	6.0	0.003%	YES		0.00552%
36	Propanenitrile	16	SD1-EF-H	1.5E-04	6.0	0.003%	YES		0.00552%
36	Propanenitrile	2	SC1-IN-A	3.2E-04	6.0	0.005%	YES		0.00552%
36	Propanenitrile	4	SC1-IN-B	4.0E-05	6.0	0.001%	YES		0.00552%
36	Propanenitrile	6	SC1-IN-C	3.7E-05	6.0	0.001%	YES		0.00552%
36	Propanenitrile	8	SC1-IN-D	3.9E-05	6.0	0.001%	YES		0.00552%
36	Propanenitrile	10	SC1-IN-E	4.0E-05	6.0	0.001%	YES		0.00552%
36	Propanenitrile	12	SC1-IN-F	3.9E-05	6.0	0.001%	YES		0.00552%
36	Propanenitrile	14	SC1-IN-G	4.2E-05	6.0	0.001%	YES		0.00552%
36	Propanenitrile	16	SC1-IN-H	3.2E-04	6.0	0.005%	YES		0.00552%
36	Propanenitrile	2	SC1-EF-A	3.2E-04	6.0	0.005%	YES		0.00552%
36	Propanenitrile	4	SC1-EF-B	3.2E-04	6.0	0.005%	YES		0.00552%
36	Propanenitrile	6	SC1-EF-C	3.3E-04	6.0	0.005%	YES		0.00552%
36	Propanenitrile	8	SC1-EF-D	3.3E-04	6.0	0.006%	YES		0.00552%
36	Propanenitrile	10	SC1-EF-E	3.1E-04	6.0	0.005%	YES		0.00552%
36	Propanenitrile	12	SC1-EF-F	3.0E-04	6.0	0.005%	YES		0.00552%
36	Propanenitrile	14	SC1-EF-G	3.0E-04	6.0	0.005%	YES		0.00552%
36	Propanenitrile	16	SC1-EF-H	3.2E-04	6.0	0.005%	YES		0.00552%
37	Butanenitrile	2	SD1-IN-A	1.3E-04	8.0	0.002%	YES		0.00212%
37	Butanenitrile	4	SD1-IN-B	1.5E-04	8.0	0.002%	YES	U	0.00212%
37	Butanenitrile	6	SD1-IN-C	1.7E-04	8.0	0.002%	YES	UY	0.00212%
37	Butanenitrile	8	SD1-IN-D	1.6E-04	8.0	0.002%	YES	U	0.00212%
37	Butanenitrile	10	SD1-IN-E	1.6E-04	8.0	0.002%	YES	U	0.00212%
37	Butanenitrile	12	SD1-IN-F	1.6E-04	8.0	0.002%	YES	U	0.00212%
37	Butanenitrile	14	SD1-IN-G	1.6E-04	8.0	0.002%	YES	U	0.00212%
37	Butanenitrile	16	SD1-IN-H	1.4E-04	8.0	0.002%	YES		0.00212%
37	Butanenitrile	2	SD1-EF-A	1.3E-04	8.0	0.002%	YES		0.00212%
37	Butanenitrile	4	SD1-EF-B	1.3E-04	8.0	0.002%	YES		0.00212%
37	Butanenitrile	6	SD1-EF-C	1.3E-04	8.0	0.002%	YES		0.00212%
37	Butanenitrile	8	SD1-EF-D	1.4E-04	8.0	0.002%	YES		0.00212%
37	Butanenitrile	10	SD1-EF-E	1.4E-04	8.0	0.002%	YES		0.00212%
37	Butanenitrile	12	SD1-EF-F	1.4E-04	8.0	0.002%	YES		0.00212%
37	Butanenitrile	14	SD1-EF-G	1.3E-04	8.0	0.002%	YES		0.00212%
37	Butanenitrile	16	SD1-EF-H	1.3E-04	8.0	0.002%	YES		0.00212%
37	Butanenitrile	2	SC1-IN-A	1.6E-04	8.0	0.002%	YES		0.00212%
37	Butanenitrile	4	SC1-IN-B	4.0E-05	8.0	0.000%	YES		0.00212%
37	Butanenitrile	6	SC1-IN-C	3.7E-05	8.0	0.000%	YES		0.00212%
37	Butanenitrile	8	SC1-IN-D	3.8E-05	8.0	0.000%	YES		0.00212%
37	Butanenitrile	10	SC1-IN-E	3.9E-05	8.0	0.000%	YES		0.00212%
37	Butanenitrile	12	SC1-IN-F	3.8E-05	8.0	0.000%	YES		0.00212%
37	Butanenitrile	14	SC1-IN-G	4.1E-05	8.0	0.001%	YES		0.00212%
37	Butanenitrile	16	SC1-IN-H	1.6E-04	8.0	0.002%	YES		0.00212%
37	Butanenitrile	2	SC1-EF-A	1.6E-04	8.0	0.002%	YES		0.00212%
37	Butanenitrile	4	SC1-EF-B	1.6E-04	8.0	0.002%	YES		0.00212%
37	Butanenitrile	6	SC1-EF-C	1.7E-04	8.0	0.002%	YES		0.00212%
37	Butanenitrile	8	SC1-EF-D	1.7E-04	8.0	0.002%	YES		0.00212%
37	Butanenitrile	10	SC1-EF-E	1.6E-04	8.0	0.002%	YES		0.00212%
37	Butanenitrile	12	SC1-EF-F	1.5E-04	8.0	0.002%	YES		0.00212%
37	Butanenitrile	14	SC1-EF-G	1.5E-04	8.0	0.002%	YES		0.00212%
37	Butanenitrile	16	SC1-EF-H	1.7E-04	8.0	0.002%	YES		0.00212%
38	Pentanenitrile	2	SD1-IN-A	1.1E-04	6.0	0.002%	YES		0.00261%
38	Pentanenitrile	4	SD1-IN-B	1.4E-04	6.0	0.002%	YES	U	0.00261%
38	Pentanenitrile	6	SD1-IN-C	1.5E-04	6.0	0.003%	YES	UY	0.00261%
38	Pentanenitrile	8	SD1-IN-D	1.5E-04	6.0	0.002%	YES	U	0.00261%
38	Pentanenitrile	10	SD1-IN-E	1.5E-04	6.0	0.002%	YES	U	0.00261%
38	Pentanenitrile	12	SD1-IN-F	1.5E-04	6.0	0.002%	YES	U	0.00261%
38	Pentanenitrile	14	SD1-IN-G	1.5E-04	6.0	0.002%	YES	U	0.00261%

Table D.1. APR Cartridge Testing 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	16	SD1-IN-H	1.1E-04	6.0	0.002%	YES		0.00261%
38	Pentanenitrile	2	SD1-EF-A	1.0E-04	6.0	0.002%	YES		0.00261%
38	Pentanenitrile	4	SD1-EF-B	1.1E-04	6.0	0.002%	YES		0.00261%
38	Pentanenitrile	6	SD1-EF-C	1.1E-04	6.0	0.002%	YES		0.00261%
38	Pentanenitrile	8	SD1-EF-D	1.1E-04	6.0	0.002%	YES		0.00261%
38	Pentanenitrile	10	SD1-EF-E	1.2E-04	6.0	0.002%	YES		0.00261%
38	Pentanenitrile	12	SD1-EF-F	1.2E-04	6.0	0.002%	YES		0.00261%
38	Pentanenitrile	14	SD1-EF-G	1.1E-04	6.0	0.002%	YES		0.00261%
38	Pentanenitrile	16	SD1-EF-H	1.1E-04	6.0	0.002%	YES		0.00261%
38	Pentanenitrile	2	SC1-IN-A	1.5E-04	6.0	0.003%	YES		0.00261%
38	Pentanenitrile	4	SC1-IN-B	4.2E-05	6.0	0.001%	YES		0.00261%
38	Pentanenitrile	6	SC1-IN-C	4.0E-05	6.0	0.001%	YES		0.00261%
38	Pentanenitrile	8	SC1-IN-D	4.1E-05	6.0	0.001%	YES		0.00261%
38	Pentanenitrile	10	SC1-IN-E	4.2E-05	6.0	0.001%	YES		0.00261%
38	Pentanenitrile	12	SC1-IN-F	4.1E-05	6.0	0.001%	YES		0.00261%
38	Pentanenitrile	14	SC1-IN-G	4.4E-05	6.0	0.001%	YES		0.00261%
38	Pentanenitrile	16	SC1-IN-H	1.5E-04	6.0	0.003%	YES		0.00261%
38	Pentanenitrile	2	SC1-EF-A	1.5E-04	6.0	0.003%	YES		0.00261%
38	Pentanenitrile	4	SC1-EF-B	1.5E-04	6.0	0.003%	YES		0.00261%
38	Pentanenitrile	6	SC1-EF-C	1.5E-04	6.0	0.003%	YES		0.00261%
38	Pentanenitrile	8	SC1-EF-D	1.6E-04	6.0	0.003%	YES		0.00261%
38	Pentanenitrile	10	SC1-EF-E	1.5E-04	6.0	0.002%	YES		0.00261%
38	Pentanenitrile	12	SC1-EF-F	1.4E-04	6.0	0.002%	YES		0.00261%
38	Pentanenitrile	14	SC1-EF-G	1.4E-04	6.0	0.002%	YES		0.00261%
38	Pentanenitrile	16	SC1-EF-H	1.5E-04	6.0	0.003%	YES		0.00261%
39	Hexanenitrile	2	SD1-IN-A	9.3E-05	6.0	0.002%	YES		0.00201%
39	Hexanenitrile	4	SD1-IN-B	1.1E-04	6.0	0.002%	YES	U	0.00201%
39	Hexanenitrile	6	SD1-IN-C	1.2E-04	6.0	0.002%	YES	UY	0.00201%
39	Hexanenitrile	8	SD1-IN-D	1.1E-04	6.0	0.002%	YES	U	0.00201%
39	Hexanenitrile	10	SD1-IN-E	1.1E-04	6.0	0.002%	YES	U	0.00201%
39	Hexanenitrile	12	SD1-IN-F	1.1E-04	6.0	0.002%	YES	U	0.00201%
39	Hexanenitrile	14	SD1-IN-G	1.1E-04	6.0	0.002%	YES	U	0.00201%
39	Hexanenitrile	16	SD1-IN-H	9.7E-05	6.0	0.002%	YES		0.00201%
39	Hexanenitrile	2	SD1-EF-A	8.9E-05	6.0	0.001%	YES		0.00201%
39	Hexanenitrile	4	SD1-EF-B	9.1E-05	6.0	0.002%	YES		0.00201%
39	Hexanenitrile	6	SD1-EF-C	9.0E-05	6.0	0.002%	YES		0.00201%
39	Hexanenitrile	8	SD1-EF-D	9.7E-05	6.0	0.002%	YES		0.00201%
39	Hexanenitrile	10	SD1-EF-E	9.9E-05	6.0	0.002%	YES		0.00201%
39	Hexanenitrile	12	SD1-EF-F	1.0E-04	6.0	0.002%	YES		0.00201%
39	Hexanenitrile	14	SD1-EF-G	9.5E-05	6.0	0.002%	YES		0.00201%
39	Hexanenitrile	16	SD1-EF-H	9.1E-05	6.0	0.002%	YES		0.00201%
39	Hexanenitrile	2	SC1-IN-A	1.2E-04	6.0	0.002%	YES		0.00201%
39	Hexanenitrile	4	SC1-IN-B	3.3E-05	6.0	0.001%	YES		0.00201%
39	Hexanenitrile	6	SC1-IN-C	3.1E-05	6.0	0.001%	YES		0.00201%
39	Hexanenitrile	8	SC1-IN-D	3.2E-05	6.0	0.001%	YES		0.00201%
39	Hexanenitrile	10	SC1-IN-E	3.3E-05	6.0	0.001%	YES		0.00201%
39	Hexanenitrile	12	SC1-IN-F	3.2E-05	6.0	0.001%	YES		0.00201%
39	Hexanenitrile	14	SC1-IN-G	3.5E-05	6.0	0.001%	YES		0.00201%
39	Hexanenitrile	16	SC1-IN-H	1.2E-04	6.0	0.002%	YES		0.00201%
39	Hexanenitrile	2	SC1-EF-A	1.2E-04	6.0	0.002%	YES		0.00201%
39	Hexanenitrile	4	SC1-EF-B	1.2E-04	6.0	0.002%	YES		0.00201%
39	Hexanenitrile	6	SC1-EF-C	1.2E-04	6.0	0.002%	YES		0.00201%
39	Hexanenitrile	8	SC1-EF-D	1.2E-04	6.0	0.002%	YES		0.00201%
39	Hexanenitrile	10	SC1-EF-E	1.1E-04	6.0	0.002%	YES		0.00201%
39	Hexanenitrile	12	SC1-EF-F	1.1E-04	6.0	0.002%	YES		0.00201%
39	Hexanenitrile	14	SC1-EF-G	1.1E-04	6.0	0.002%	YES		0.00201%
39	Hexanenitrile	16	SC1-EF-H	1.2E-04	6.0	0.002%	YES		0.00201%
43	Ethylamine	2	SD1-IN-A	4.7E-03	5.0	0.093%	YES		0.0935%
43	Ethylamine	4	SD1-IN-B	4.5E-03	5.0	0.090%	YES		0.0935%
43	Ethylamine	6	SD1-IN-C	4.4E-03	5.0	0.087%	YES		0.0935%
43	Ethylamine	8	SD1-IN-D	4.4E-03	5.0	0.087%	YES		0.0935%
43	Ethylamine	10	SD1-IN-E	4.5E-03	5.0	0.090%	YES		0.0935%

Table D.1. APR Cartridge Testing 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	12	SD1-IN-F	4.4E-03	5.0	0.088%	YES		0.0935%
43	Ethylamine	14	SD1-IN-G	4.4E-03	5.0	0.089%	YES		0.0935%
43	Ethylamine	16	SD1-IN-H	4.5E-03	5.0	0.090%	YES		0.0935%
43	Ethylamine	2	SD1-EF-A	4.6E-03	5.0	0.092%	YES		0.0935%
43	Ethylamine	4	SD1-EF-B	4.5E-03	5.0	0.090%	YES		0.0935%
43	Ethylamine	6	SD1-EF-C	4.4E-03	5.0	0.088%	YES		0.0935%
43	Ethylamine	8	SD1-EF-D	4.4E-03	5.0	0.089%	YES		0.0935%
43	Ethylamine	10	SD1-EF-E	4.5E-03	5.0	0.090%	YES		0.0935%
43	Ethylamine	12	SD1-EF-F	4.5E-03	5.0	0.091%	YES		0.0935%
43	Ethylamine	14	SD1-EF-G	4.5E-03	5.0	0.090%	YES		0.0935%
43	Ethylamine	16	SD1-EF-H	4.5E-03	5.0	0.090%	YES		0.0935%
43	Ethylamine	2	SC1-IN-A	4.4E-03	5.0	0.089%	YES		0.0935%
43	Ethylamine	4	SC1-IN-B	4.5E-03	5.0	0.090%	YES		0.0935%
43	Ethylamine	6	SC1-IN-C	4.5E-03	5.0	0.091%	YES		0.0935%
43	Ethylamine	8	SC1-IN-D	4.6E-03	5.0	0.092%	YES		0.0935%
43	Ethylamine	10	SC1-IN-E	4.5E-03	5.0	0.090%	YES		0.0935%
43	Ethylamine	12	SC1-IN-F	4.4E-03	5.0	0.088%	YES		0.0935%
43	Ethylamine	14	SC1-IN-G	4.5E-03	5.0	0.089%	YES		0.0935%
43	Ethylamine	16	SC1-IN-H	4.5E-03	5.0	0.089%	YES		0.0935%
43	Ethylamine	2	SC1-EF-A	4.6E-03	5.0	0.091%	YES		0.0935%
43	Ethylamine	4	SC1-EF-B	4.6E-03	5.0	0.092%	YES		0.0935%
43	Ethylamine	6	SC1-EF-C	4.7E-03	5.0	0.093%	YES		0.0935%
43	Ethylamine	8	SC1-EF-D	4.7E-03	5.0	0.094%	YES		0.0935%
43	Ethylamine	10	SC1-EF-E	4.4E-03	5.0	0.087%	YES		0.0935%
43	Ethylamine	12	SC1-EF-F	4.3E-03	5.0	0.086%	YES		0.0935%
43	Ethylamine	14	SC1-EF-G	4.2E-03	5.0	0.084%	YES		0.0935%
43	Ethylamine	16	SC1-EF-H	4.6E-03	5.0	0.092%	YES		0.0935%
44	N-Nitrosodimethylamine	2	SD1-IN-A	4.8E-03	0.000	1614.232%		D	5.76%
44	N-Nitrosodimethylamine	4	SD1-IN-B	5.2E-03	0.000	1732.986%		D	5.76%
44	N-Nitrosodimethylamine	6	SD1-IN-C	4.9E-03	0.000	1623.352%		D	5.76%
44	N-Nitrosodimethylamine	8	SD1-IN-D	3.3E-03	0.000	1089.835%		D	5.76%
44	N-Nitrosodimethylamine	10	SD1-IN-E	4.3E-03	0.000	1424.357%		D	5.76%
44	N-Nitrosodimethylamine	12	SD1-IN-F	3.7E-03	0.000	1219.096%		D	5.76%
44	N-Nitrosodimethylamine	14	SD1-IN-G	3.6E-03	0.000	1187.164%		D	5.76%
44	N-Nitrosodimethylamine	16	SD1-IN-H	3.5E-03	0.000	1167.651%		D	5.76%
44	N-Nitrosodimethylamine	2	SD1-EF-A	1.4E-05	0.000	4.69%	YES		5.76%
44	N-Nitrosodimethylamine	4	SD1-EF-B	1.4E-05	0.000	4.59%	YES		5.76%
44	N-Nitrosodimethylamine	6	SD1-EF-C	1.4E-05	0.000	4.64%	YES		5.76%
44	N-Nitrosodimethylamine	8	SD1-EF-D	1.3E-05	0.000	4.49%	YES		5.76%
44	N-Nitrosodimethylamine	10	SD1-EF-E	1.3E-05	0.000	4.40%	YES		5.76%
44	N-Nitrosodimethylamine	12	SD1-EF-F	1.4E-05	0.000	4.65%	YES		5.76%
44	N-Nitrosodimethylamine	14	SD1-EF-G	1.1E-05	0.000	3.57%	YES		5.76%
44	N-Nitrosodimethylamine	16	SD1-EF-H	1.1E-05	0.000	3.58%	YES		5.76%
44	N-Nitrosodimethylamine	2	SC1-IN-A	8.0E-03	0.000	2680.077%		DLa	5.76%
44	N-Nitrosodimethylamine	4	SC1-IN-B	8.0E-03	0.000	2680.782%		DLa	5.76%
44	N-Nitrosodimethylamine	6	SC1-IN-C	7.3E-03	0.000	2446.731%		DLa	5.76%
44	N-Nitrosodimethylamine	8	SC1-IN-D	6.5E-03	0.000	2157.927%		DLa	5.76%
44	N-Nitrosodimethylamine	10	SC1-IN-E	5.6E-03	0.000	1855.682%		DLa	5.76%
44	N-Nitrosodimethylamine	12	SC1-IN-F	5.7E-03	0.000	1900.827%		DLa	5.76%
44	N-Nitrosodimethylamine	14	SC1-IN-G	5.2E-03	0.000	1740.684%		Da	5.76%
44	N-Nitrosodimethylamine	16	SC1-IN-H	5.0E-03	0.000	1666.207%		DLa	5.76%
44	N-Nitrosodimethylamine	2	SC1-EF-A	1.6E-05	0.000	5.37%	YES		5.76%
44	N-Nitrosodimethylamine	4	SC1-EF-B	1.6E-05	0.000	5.43%	YES		5.76%
44	N-Nitrosodimethylamine	6	SC1-EF-C	1.6E-05	0.000	5.44%	YES		5.76%
44	N-Nitrosodimethylamine	8	SC1-EF-D	1.6E-05	0.000	5.39%	YES		5.76%
44	N-Nitrosodimethylamine	10	SC1-EF-E	1.6E-05	0.000	5.43%	YES		5.76%
44	N-Nitrosodimethylamine	12	SC1-EF-F	1.7E-05	0.000	5.76%	YES		5.76%
44	N-Nitrosodimethylamine	14	SC1-EF-G	1.4E-05	0.000	4.71%	YES		5.76%
44	N-Nitrosodimethylamine	16	SC1-EF-H	1.4E-05	0.000	4.73%	YES		5.76%
45	N-Nitrosodiethylamine	2	SD1-IN-A	8.9E-06	0.000	8.93%	YES		12.5%
45	N-Nitrosodiethylamine	4	SD1-IN-B	8.9E-06	0.000	8.91%	YES		12.5%
45	N-Nitrosodiethylamine	6	SD1-IN-C	8.9E-06	0.000	8.93%	YES		12.5%

Table D.1. APR Cartridge Testing 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	8	SD1-IN-D	8.9E-06	0.000	8.93%	YES		12.5%
45	N-Nitrosodiethylamine	10	SD1-IN-E	9.0E-06	0.000	9.00%	YES		12.5%
45	N-Nitrosodiethylamine	12	SD1-IN-F	9.0E-06	0.000	8.98%	YES		12.5%
45	N-Nitrosodiethylamine	14	SD1-IN-G	8.9E-06	0.000	8.91%	YES		12.5%
45	N-Nitrosodiethylamine	16	SD1-IN-H	8.9E-06	0.000	8.86%	YES		12.5%
45	N-Nitrosodiethylamine	2	SD1-EF-A	1.1E-05	0.000	11.2%	YES		12.5%
45	N-Nitrosodiethylamine	4	SD1-EF-B	1.1E-05	0.000	11.0%	YES		12.5%
45	N-Nitrosodiethylamine	6	SD1-EF-C	1.1E-05	0.000	11.1%	YES		12.5%
45	N-Nitrosodiethylamine	8	SD1-EF-D	1.1E-05	0.000	10.8%	YES		12.5%
45	N-Nitrosodiethylamine	10	SD1-EF-E	1.1E-05	0.000	10.5%	YES		12.5%
45	N-Nitrosodiethylamine	12	SD1-EF-F	1.1E-05	0.000	11.1%	YES		12.5%
45	N-Nitrosodiethylamine	14	SD1-EF-G	8.7E-06	0.000	8.73%	YES		12.5%
45	N-Nitrosodiethylamine	16	SD1-EF-H	8.8E-06	0.000	8.75%	YES		12.5%
45	N-Nitrosodiethylamine	2	SC1-IN-A	1.1E-05	0.000	10.8%	YES	a	12.5%
45	N-Nitrosodiethylamine	4	SC1-IN-B	1.1E-05	0.000	10.7%	YES	a	12.5%
45	N-Nitrosodiethylamine	6	SC1-IN-C	1.1E-05	0.000	10.8%	YES	a	12.5%
45	N-Nitrosodiethylamine	8	SC1-IN-D	1.1E-05	0.000	10.8%	YES	a	12.5%
45	N-Nitrosodiethylamine	10	SC1-IN-E	1.1E-05	0.000	10.9%	YES	a	12.5%
45	N-Nitrosodiethylamine	12	SC1-IN-F	1.1E-05	0.000	10.8%	YES	a	12.5%
45	N-Nitrosodiethylamine	14	SC1-IN-G	1.1E-05	0.000	11.1%	YES	a	12.5%
45	N-Nitrosodiethylamine	16	SC1-IN-H	1.1E-05	0.000	10.8%	YES	a	12.5%
45	N-Nitrosodiethylamine	2	SC1-EF-A	1.2E-05	0.000	11.7%	YES		12.5%
45	N-Nitrosodiethylamine	4	SC1-EF-B	1.2E-05	0.000	11.8%	YES		12.5%
45	N-Nitrosodiethylamine	6	SC1-EF-C	1.2E-05	0.000	11.8%	YES		12.5%
45	N-Nitrosodiethylamine	8	SC1-EF-D	1.2E-05	0.000	11.7%	YES		12.5%
45	N-Nitrosodiethylamine	10	SC1-EF-E	1.2E-05	0.000	11.8%	YES		12.5%
45	N-Nitrosodiethylamine	12	SC1-EF-F	1.3E-05	0.000	12.5%	YES		12.5%
45	N-Nitrosodiethylamine	14	SC1-EF-G	1.0E-05	0.000	10.2%	YES		12.5%
45	N-Nitrosodiethylamine	16	SC1-EF-H	1.0E-05	0.000	10.3%	YES		12.5%
46	N-Nitrosomethylethylamine	2	SD1-IN-A	4.3E-05	0.000	14.2%			4.84%
46	N-Nitrosomethylethylamine	4	SD1-IN-B	4.7E-05	0.000	15.7%			4.84%
46	N-Nitrosomethylethylamine	6	SD1-IN-C	4.5E-05	0.000	15.0%			4.84%
46	N-Nitrosomethylethylamine	8	SD1-IN-D	2.9E-05	0.000	9.58%			4.84%
46	N-Nitrosomethylethylamine	10	SD1-IN-E	4.1E-05	0.000	13.5%			4.84%
46	N-Nitrosomethylethylamine	12	SD1-IN-F	3.6E-05	0.000	11.9%			4.84%
46	N-Nitrosomethylethylamine	14	SD1-IN-G	3.3E-05	0.000	11.1%			4.84%
46	N-Nitrosomethylethylamine	16	SD1-IN-H	3.3E-05	0.000	11.0%			4.84%
46	N-Nitrosomethylethylamine	2	SD1-EF-A	1.3E-05	0.000	4.34%	YES		4.84%
46	N-Nitrosomethylethylamine	4	SD1-EF-B	1.3E-05	0.000	4.25%	YES		4.84%
46	N-Nitrosomethylethylamine	6	SD1-EF-C	1.3E-05	0.000	4.29%	YES		4.84%
46	N-Nitrosomethylethylamine	8	SD1-EF-D	1.2E-05	0.000	4.15%	YES		4.84%
46	N-Nitrosomethylethylamine	10	SD1-EF-E	1.2E-05	0.000	4.07%	YES		4.84%
46	N-Nitrosomethylethylamine	12	SD1-EF-F	1.3E-05	0.000	4.30%	YES		4.84%
46	N-Nitrosomethylethylamine	14	SD1-EF-G	9.0E-06	0.000	3.00%	YES		4.84%
46	N-Nitrosomethylethylamine	16	SD1-EF-H	9.0E-06	0.000	3.01%	YES		4.84%
46	N-Nitrosomethylethylamine	2	SC1-IN-A	5.8E-05	0.000	19.3%		a	4.84%
46	N-Nitrosomethylethylamine	4	SC1-IN-B	6.2E-05	0.000	20.7%		a	4.84%
46	N-Nitrosomethylethylamine	6	SC1-IN-C	5.7E-05	0.000	18.9%		a	4.84%
46	N-Nitrosomethylethylamine	8	SC1-IN-D	5.1E-05	0.000	17.1%		a	4.84%
46	N-Nitrosomethylethylamine	10	SC1-IN-E	4.9E-05	0.000	16.4%		a	4.84%
46	N-Nitrosomethylethylamine	12	SC1-IN-F	5.0E-05	0.000	16.7%		a	4.84%
46	N-Nitrosomethylethylamine	14	SC1-IN-G	5.0E-05	0.000	16.8%		a	4.84%
46	N-Nitrosomethylethylamine	16	SC1-IN-H	4.4E-05	0.000	14.8%		a	4.84%
46	N-Nitrosomethylethylamine	2	SC1-EF-A	1.4E-05	0.000	4.51%	YES		4.84%
46	N-Nitrosomethylethylamine	4	SC1-EF-B	1.4E-05	0.000	4.57%	YES		4.84%
46	N-Nitrosomethylethylamine	6	SC1-EF-C	1.4E-05	0.000	4.58%	YES		4.84%
46	N-Nitrosomethylethylamine	8	SC1-EF-D	1.4E-05	0.000	4.53%	YES		4.84%
46	N-Nitrosomethylethylamine	10	SC1-EF-E	1.4E-05	0.000	4.57%	YES		4.84%
46	N-Nitrosomethylethylamine	12	SC1-EF-F	1.5E-05	0.000	4.84%	YES		4.84%
46	N-Nitrosomethylethylamine	14	SC1-EF-G	1.2E-05	0.000	3.96%	YES		4.84%
46	N-Nitrosomethylethylamine	16	SC1-EF-H	1.2E-05	0.000	3.98%	YES		4.84%
47	N-Nitrosomorpholine	2	SD1-IN-A	7.0E-06	0.001	1.16%	YES		1.84%

Table D.1. APR Cartridge Testing 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	4	SD1-IN-B	7.0E-06	0.001	1.16%	YES		1.84%
47	N-Nitrosomorpholine	6	SD1-IN-C	7.0E-06	0.001	1.16%	YES		1.84%
47	N-Nitrosomorpholine	8	SD1-IN-D	7.0E-06	0.001	1.16%	YES		1.84%
47	N-Nitrosomorpholine	10	SD1-IN-E	7.0E-06	0.001	1.17%	YES		1.84%
47	N-Nitrosomorpholine	12	SD1-IN-F	7.0E-06	0.001	1.17%	YES		1.84%
47	N-Nitrosomorpholine	14	SD1-IN-G	7.0E-06	0.001	1.16%	YES		1.84%
47	N-Nitrosomorpholine	16	SD1-IN-H	6.9E-06	0.001	1.15%	YES		1.84%
47	N-Nitrosomorpholine	2	SD1-EF-A	9.9E-06	0.001	1.65%	YES		1.84%
47	N-Nitrosomorpholine	4	SD1-EF-B	9.7E-06	0.001	1.61%	YES		1.84%
47	N-Nitrosomorpholine	6	SD1-EF-C	9.8E-06	0.001	1.63%	YES		1.84%
47	N-Nitrosomorpholine	8	SD1-EF-D	9.5E-06	0.001	1.58%	YES		1.84%
47	N-Nitrosomorpholine	10	SD1-EF-E	9.3E-06	0.001	1.55%	YES		1.84%
47	N-Nitrosomorpholine	12	SD1-EF-F	9.8E-06	0.001	1.63%	YES		1.84%
47	N-Nitrosomorpholine	14	SD1-EF-G	6.8E-06	0.001	1.14%	YES		1.84%
47	N-Nitrosomorpholine	16	SD1-EF-H	6.8E-06	0.001	1.14%	YES		1.84%
47	N-Nitrosomorpholine	2	SC1-IN-A	1.9E-05	0.001	3.16%		a	1.84%
47	N-Nitrosomorpholine	4	SC1-IN-B	2.0E-05	0.001	3.28%		a	1.84%
47	N-Nitrosomorpholine	6	SC1-IN-C	1.2E-05	0.001	2.01%		a	1.84%
47	N-Nitrosomorpholine	8	SC1-IN-D	9.5E-06	0.001	1.58%	YES	a	1.84%
47	N-Nitrosomorpholine	10	SC1-IN-E	9.6E-06	0.001	1.59%	YES	a	1.84%
47	N-Nitrosomorpholine	12	SC1-IN-F	9.5E-06	0.001	1.59%		a	1.84%
47	N-Nitrosomorpholine	14	SC1-IN-G	9.8E-06	0.001	1.63%	YES	a	1.84%
47	N-Nitrosomorpholine	16	SC1-IN-H	9.5E-06	0.001	1.58%	YES	a	1.84%
47	N-Nitrosomorpholine	2	SC1-EF-A	1.0E-05	0.001	1.71%	YES		1.84%
47	N-Nitrosomorpholine	4	SC1-EF-B	1.0E-05	0.001	1.73%	YES		1.84%
47	N-Nitrosomorpholine	6	SC1-EF-C	1.0E-05	0.001	1.74%	YES		1.84%
47	N-Nitrosomorpholine	8	SC1-EF-D	1.0E-05	0.001	1.72%	YES		1.84%
47	N-Nitrosomorpholine	10	SC1-EF-E	1.0E-05	0.001	1.73%	YES		1.84%
47	N-Nitrosomorpholine	12	SC1-EF-F	1.1E-05	0.001	1.84%	YES		1.84%
47	N-Nitrosomorpholine	14	SC1-EF-G	9.0E-06	0.001	1.50%	YES		1.84%
47	N-Nitrosomorpholine	16	SC1-EF-H	9.1E-06	0.001	1.51%	YES		1.84%
48	Tributyl phosphate	2	SD1-IN-A	6.5E-05	0.20	0.032%	YES	U	0.0595%
48	Tributyl phosphate	4	SD1-IN-B		0.20				0.0595%
48	Tributyl phosphate	6	SD1-IN-C	6.1E-05	0.20	0.031%	YES	U	0.0595%
48	Tributyl phosphate	8	SD1-IN-D	6.1E-05	0.20	0.031%	YES	U	0.0595%
48	Tributyl phosphate	10	SD1-IN-E	6.1E-05	0.20	0.031%	YES	U	0.0595%
48	Tributyl phosphate	12	SD1-IN-F	6.1E-05	0.20	0.031%	YES	U	0.0595%
48	Tributyl phosphate	14	SD1-IN-G	6.1E-05	0.20	0.030%	YES	U	0.0595%
48	Tributyl phosphate	16	SD1-IN-H	6.5E-05	0.20	0.032%	YES	U	0.0595%
48	Tributyl phosphate	2	SD1-EF-A	6.0E-05	0.20	0.030%	YES	U	0.0595%
48	Tributyl phosphate	4	SD1-EF-B	5.8E-05	0.20	0.029%	YES	U	0.0595%
48	Tributyl phosphate	6	SD1-EF-C	5.9E-05	0.20	0.029%	YES	U	0.0595%
48	Tributyl phosphate	8	SD1-EF-D	5.9E-05	0.20	0.030%	YES	U	0.0595%
48	Tributyl phosphate	10	SD1-EF-E	6.0E-05	0.20	0.030%	YES	QU	0.0595%
48	Tributyl phosphate	12	SD1-EF-F	6.1E-05	0.20	0.030%	YES	U, S*	0.0595%
48	Tributyl phosphate	14	SD1-EF-G	5.9E-05	0.20	0.029%	YES	U	0.0595%
48	Tributyl phosphate	16	SD1-EF-H	6.0E-05	0.20	0.030%	YES	U	0.0595%
48	Tributyl phosphate	2	SC1-IN-A	6.3E-05	0.20	0.031%	YES	U	0.0595%
48	Tributyl phosphate	4	SC1-IN-B	6.4E-05	0.20	0.032%	YES	U	0.0595%
48	Tributyl phosphate	6	SC1-IN-C	6.5E-05	0.20	0.032%	YES	QU	0.0595%
48	Tributyl phosphate	8	SC1-IN-D	6.5E-05	0.20	0.033%	YES	U	0.0595%
48	Tributyl phosphate	10	SC1-IN-E	6.3E-05	0.20	0.031%	YES	U	0.0595%
48	Tributyl phosphate	12	SC1-IN-F	6.1E-05	0.20	0.031%	YES	U	0.0595%
48	Tributyl phosphate	14	SC1-IN-G	6.4E-05	0.20	0.032%	YES	U	0.0595%
48	Tributyl phosphate	16	SC1-IN-H	1.2E-04	0.20	0.059%	YES	U	0.0595%
48	Tributyl phosphate	2	SC1-EF-A	5.8E-05	0.20	0.029%	YES	U	0.0595%
48	Tributyl phosphate	4	SC1-EF-B	6.1E-05	0.20	0.031%	YES	U	0.0595%
48	Tributyl phosphate	6	SC1-EF-C	5.8E-05	0.20	0.029%	YES	U	0.0595%
48	Tributyl phosphate	8	SC1-EF-D	5.8E-05	0.20	0.029%	YES	U	0.0595%
48	Tributyl phosphate	10	SC1-EF-E	5.8E-05	0.20	0.029%	YES	U	0.0595%
48	Tributyl phosphate	12	SC1-EF-F	6.2E-05	0.20	0.031%	YES	U, S*	0.0595%
48	Tributyl phosphate	14	SC1-EF-G	6.1E-05	0.20	0.030%	YES	U	0.0595%
48	Tributyl phosphate	16	SC1-EF-H	6.0E-05	0.20	0.030%	YES	U	0.0595%

Table D.1. APR Cartridge Testing 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	2	SD1-IN-A	2.6E-05	0.007	0.365%	YES	U	0.643%
49	Dibutyl butylphosphonate	4	SD1-IN-B		0.007				0.643%
49	Dibutyl butylphosphonate	6	SD1-IN-C	2.3E-05	0.007	0.331%	YES	U	0.643%
49	Dibutyl butylphosphonate	8	SD1-IN-D	2.3E-05	0.007	0.332%	YES	U	0.643%
49	Dibutyl butylphosphonate	10	SD1-IN-E	2.3E-05	0.007	0.331%	YES	U	0.643%
49	Dibutyl butylphosphonate	12	SD1-IN-F	2.3E-05	0.007	0.330%	YES	U	0.643%
49	Dibutyl butylphosphonate	14	SD1-IN-G	2.3E-05	0.007	0.329%	YES	U	0.643%
49	Dibutyl butylphosphonate	16	SD1-IN-H	2.4E-05	0.007	0.350%	YES	U	0.643%
49	Dibutyl butylphosphonate	2	SD1-EF-A	2.3E-05	0.007	0.323%	YES	U	0.643%
49	Dibutyl butylphosphonate	4	SD1-EF-B	2.2E-05	0.007	0.311%	YES	U	0.643%
49	Dibutyl butylphosphonate	6	SD1-EF-C	2.2E-05	0.007	0.319%	YES	U	0.643%
49	Dibutyl butylphosphonate	8	SD1-EF-D	2.2E-05	0.007	0.321%	YES	U	0.643%
49	Dibutyl butylphosphonate	10	SD1-EF-E	2.3E-05	0.007	0.322%	YES	U	0.643%
49	Dibutyl butylphosphonate	12	SD1-EF-F	2.3E-05	0.007	0.328%	YES	U, S*	0.643%
49	Dibutyl butylphosphonate	14	SD1-EF-G	2.2E-05	0.007	0.319%	YES	U	0.643%
49	Dibutyl butylphosphonate	16	SD1-EF-H	2.3E-05	0.007	0.324%	YES	U	0.643%
49	Dibutyl butylphosphonate	2	SC1-IN-A	2.4E-05	0.007	0.339%	YES	U	0.643%
49	Dibutyl butylphosphonate	4	SC1-IN-B	2.4E-05	0.007	0.348%	YES	U	0.643%
49	Dibutyl butylphosphonate	6	SC1-IN-C	2.5E-05	0.007	0.351%	YES	U	0.643%
49	Dibutyl butylphosphonate	8	SC1-IN-D	2.5E-05	0.007	0.353%	YES	U	0.643%
49	Dibutyl butylphosphonate	10	SC1-IN-E	2.4E-05	0.007	0.338%	YES	U	0.643%
49	Dibutyl butylphosphonate	12	SC1-IN-F	2.3E-05	0.007	0.331%	YES	U	0.643%
49	Dibutyl butylphosphonate	14	SC1-IN-G	2.4E-05	0.007	0.343%	YES	U	0.643%
49	Dibutyl butylphosphonate	16	SC1-IN-H	4.5E-05	0.007	0.643%	YES	U	0.643%
49	Dibutyl butylphosphonate	2	SC1-EF-A	2.2E-05	0.007	0.312%	YES	U	0.643%
49	Dibutyl butylphosphonate	4	SC1-EF-B	2.3E-05	0.007	0.331%	YES	U	0.643%
49	Dibutyl butylphosphonate	6	SC1-EF-C	2.2E-05	0.007	0.315%	YES	U	0.643%
49	Dibutyl butylphosphonate	8	SC1-EF-D	2.2E-05	0.007	0.315%	YES	U	0.643%
49	Dibutyl butylphosphonate	10	SC1-EF-E	2.2E-05	0.007	0.312%	YES	U	0.643%
49	Dibutyl butylphosphonate	12	SC1-EF-F	2.3E-05	0.007	0.332%	YES	U, S*	0.643%
49	Dibutyl butylphosphonate	14	SC1-EF-G	2.3E-05	0.007	0.327%	YES	U	0.643%
49	Dibutyl butylphosphonate	16	SC1-EF-H	2.3E-05	0.007	0.325%	YES	U	0.643%
52	Pyridine	2	SD1-IN-A	1.8E-04	1.0	0.018%	YES		0.0440%
52	Pyridine	4	SD1-IN-B	3.4E-04	1.0	0.034%	YES	U	0.0440%
52	Pyridine	6	SD1-IN-C	3.7E-04	1.0	0.037%	YES	UY	0.0440%
52	Pyridine	8	SD1-IN-D	3.6E-04	1.0	0.036%	YES	U	0.0440%
52	Pyridine	10	SD1-IN-E	3.6E-04	1.0	0.036%	YES	U	0.0440%
52	Pyridine	12	SD1-IN-F	3.6E-04	1.0	0.036%	YES	U	0.0440%
52	Pyridine	14	SD1-IN-G	3.6E-04	1.0	0.036%	YES	U	0.0440%
52	Pyridine	16	SD1-IN-H	1.9E-04	1.0	0.019%	YES		0.0440%
52	Pyridine	2	SD1-EF-A	1.8E-04	1.0	0.018%	YES		0.0440%
52	Pyridine	4	SD1-EF-B	1.8E-04	1.0	0.018%	YES		0.0440%
52	Pyridine	6	SD1-EF-C	1.8E-04	1.0	0.018%	YES		0.0440%
52	Pyridine	8	SD1-EF-D	1.9E-04	1.0	0.019%	YES		0.0440%
52	Pyridine	10	SD1-EF-E	1.9E-04	1.0	0.019%	YES		0.0440%
52	Pyridine	12	SD1-EF-F	2.0E-04	1.0	0.020%	YES		0.0440%
52	Pyridine	14	SD1-EF-G	1.9E-04	1.0	0.019%	YES		0.0440%
52	Pyridine	16	SD1-EF-H	1.8E-04	1.0	0.018%	YES		0.0440%
52	Pyridine	2	SC1-IN-A	3.7E-04	1.0	0.037%	YES		0.0440%
52	Pyridine	4	SC1-IN-B	4.2E-04	1.0	0.042%	YES		0.0440%
52	Pyridine	6	SC1-IN-C	3.9E-04	1.0	0.039%	YES		0.0440%
52	Pyridine	8	SC1-IN-D	4.1E-04	1.0	0.041%	YES		0.0440%
52	Pyridine	10	SC1-IN-E	4.2E-04	1.0	0.042%	YES		0.0440%
52	Pyridine	12	SC1-IN-F	4.1E-04	1.0	0.041%	YES		0.0440%
52	Pyridine	14	SC1-IN-G	4.4E-04	1.0	0.044%	YES		0.0440%
52	Pyridine	16	SC1-IN-H	3.6E-04	1.0	0.036%	YES		0.0440%
52	Pyridine	2	SC1-EF-A	3.7E-04	1.0	0.037%	YES		0.0440%
52	Pyridine	4	SC1-EF-B	3.7E-04	1.0	0.037%	YES		0.0440%
52	Pyridine	6	SC1-EF-C	3.7E-04	1.0	0.037%	YES		0.0440%
52	Pyridine	8	SC1-EF-D	3.8E-04	1.0	0.038%	YES		0.0440%
52	Pyridine	10	SC1-EF-E	3.5E-04	1.0	0.035%	YES		0.0440%
52	Pyridine	12	SC1-EF-F	3.5E-04	1.0	0.035%	YES		0.0440%

Table D.1. APR Cartridge Testing 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	14	SC1-EF-G	3.4E-04	1.0	0.034%	YES		0.0440%
52	Pyridine	16	SC1-EF-H	3.7E-04	1.0	0.037%	YES		0.0440%
53	2,4-Dimethylpyridine	2	SD1-IN-A	1.1E-04	0.50	0.021%	YES		0.0511%
53	2,4-Dimethylpyridine	4	SD1-IN-B	2.3E-04	0.50	0.046%	YES	U	0.0511%
53	2,4-Dimethylpyridine	6	SD1-IN-C	2.5E-04	0.50	0.050%	YES	UY	0.0511%
53	2,4-Dimethylpyridine	8	SD1-IN-D	2.4E-04	0.50	0.048%	YES	U	0.0511%
53	2,4-Dimethylpyridine	10	SD1-IN-E	2.4E-04	0.50	0.048%	YES	U	0.0511%
53	2,4-Dimethylpyridine	12	SD1-IN-F	2.4E-04	0.50	0.048%	YES	U	0.0511%
53	2,4-Dimethylpyridine	14	SD1-IN-G	2.4E-04	0.50	0.048%	YES	U	0.0511%
53	2,4-Dimethylpyridine	16	SD1-IN-H	1.1E-04	0.50	0.022%	YES		0.0511%
53	2,4-Dimethylpyridine	2	SD1-EF-A	1.0E-04	0.50	0.021%	YES		0.0511%
53	2,4-Dimethylpyridine	4	SD1-EF-B	1.0E-04	0.50	0.021%	YES		0.0511%
53	2,4-Dimethylpyridine	6	SD1-EF-C	1.0E-04	0.50	0.021%	YES		0.0511%
53	2,4-Dimethylpyridine	8	SD1-EF-D	1.1E-04	0.50	0.022%	YES		0.0511%
53	2,4-Dimethylpyridine	10	SD1-EF-E	1.1E-04	0.50	0.023%	YES		0.0511%
53	2,4-Dimethylpyridine	12	SD1-EF-F	1.1E-04	0.50	0.023%	YES		0.0511%
53	2,4-Dimethylpyridine	14	SD1-EF-G	1.1E-04	0.50	0.022%	YES		0.0511%
53	2,4-Dimethylpyridine	16	SD1-EF-H	1.0E-04	0.50	0.021%	YES		0.0511%
53	2,4-Dimethylpyridine	2	SC1-IN-A	2.5E-04	0.50	0.049%	YES		0.0511%
53	2,4-Dimethylpyridine	4	SC1-IN-B	2.4E-04	0.50	0.049%	YES		0.0511%
53	2,4-Dimethylpyridine	6	SC1-IN-C	2.3E-04	0.50	0.046%	YES		0.0511%
53	2,4-Dimethylpyridine	8	SC1-IN-D	2.4E-04	0.50	0.047%	YES		0.0511%
53	2,4-Dimethylpyridine	10	SC1-IN-E	2.4E-04	0.50	0.049%	YES		0.0511%
53	2,4-Dimethylpyridine	12	SC1-IN-F	2.4E-04	0.50	0.047%	YES		0.0511%
53	2,4-Dimethylpyridine	14	SC1-IN-G	2.6E-04	0.50	0.051%	YES		0.0511%
53	2,4-Dimethylpyridine	16	SC1-IN-H	2.5E-04	0.50	0.049%	YES		0.0511%
53	2,4-Dimethylpyridine	2	SC1-EF-A	2.5E-04	0.50	0.049%	YES		0.0511%
53	2,4-Dimethylpyridine	4	SC1-EF-B	2.5E-04	0.50	0.050%	YES		0.0511%
53	2,4-Dimethylpyridine	6	SC1-EF-C	2.5E-04	0.50	0.050%	YES		0.0511%
53	2,4-Dimethylpyridine	8	SC1-EF-D	2.6E-04	0.50	0.051%	YES		0.0511%
53	2,4-Dimethylpyridine	10	SC1-EF-E	2.4E-04	0.50	0.047%	YES		0.0511%
53	2,4-Dimethylpyridine	12	SC1-EF-F	2.3E-04	0.50	0.047%	YES		0.0511%
53	2,4-Dimethylpyridine	14	SC1-EF-G	2.3E-04	0.50	0.046%	YES		0.0511%
53	2,4-Dimethylpyridine	16	SC1-EF-H	2.5E-04	0.50	0.050%	YES		0.0511%
Data below is obtained through secondary analysis methods									
16	Butanal/Butyraldehyde	2	SD1-IN-A	3.3E-03	25	0.013%			0.00289%
16	Butanal/Butyraldehyde	4	SD1-IN-B	3.4E-03	25	0.014%			0.00289%
16	Butanal/Butyraldehyde	6	SD1-IN-C	3.4E-03	25	0.013%			0.00289%
16	Butanal/Butyraldehyde	8	SD1-IN-D	3.6E-03	25	0.014%			0.00289%
16	Butanal/Butyraldehyde	10	SD1-IN-E	4.5E-03	25	0.018%			0.00289%
16	Butanal/Butyraldehyde	12	SD1-IN-F	4.1E-03	25	0.016%			0.00289%
16	Butanal/Butyraldehyde	14	SD1-IN-G	4.5E-03	25	0.018%			0.00289%
16	Butanal/Butyraldehyde	16	SD1-IN-H	4.5E-03	25	0.018%			0.00289%
16	Butanal/Butyraldehyde	2	SD1-EF-A	7.1E-04	25	0.003%	YES		0.00289%
16	Butanal/Butyraldehyde	4	SD1-EF-B	6.9E-04	25	0.003%	YES		0.00289%
16	Butanal/Butyraldehyde	6	SD1-EF-C	7.0E-04	25	0.003%	YES		0.00289%
16	Butanal/Butyraldehyde	8	SD1-EF-D	6.8E-04	25	0.003%	YES		0.00289%
16	Butanal/Butyraldehyde	10	SD1-EF-E	6.8E-04	25	0.003%	YES		0.00289%
16	Butanal/Butyraldehyde	12	SD1-EF-F	7.0E-04	25	0.003%	YES		0.00289%
16	Butanal/Butyraldehyde	14	SD1-EF-G	7.0E-04	25	0.003%	YES		0.00289%
16	Butanal/Butyraldehyde	16	SD1-EF-H	7.2E-04	25	0.003%	YES		0.00289%
16	Butanal/Butyraldehyde	2	SC1-IN-A	3.2E-03	25	0.013%			0.00289%
16	Butanal/Butyraldehyde	4	SC1-IN-B	3.7E-03	25	0.015%			0.00289%
16	Butanal/Butyraldehyde	6	SC1-IN-C	3.3E-03	25	0.013%			0.00289%
16	Butanal/Butyraldehyde	8	SC1-IN-D	4.0E-03	25	0.016%			0.00289%
16	Butanal/Butyraldehyde	10	SC1-IN-E	4.0E-03	25	0.016%			0.00289%
16	Butanal/Butyraldehyde	12	SC1-IN-F	3.7E-03	25	0.015%			0.00289%
16	Butanal/Butyraldehyde	14	SC1-IN-G	3.7E-03	25	0.015%			0.00289%
16	Butanal/Butyraldehyde	16	SC1-IN-H	4.7E-03	25	0.019%			0.00289%
16	Butanal/Butyraldehyde	2	SC1-EF-A	1.0E-03	25	0.004%			0.00289%
16	Butanal/Butyraldehyde	4	SC1-EF-B	7.1E-04	25	0.003%	YES		0.00289%

Table D.1. APR Cartridge Testing 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	6	SC1-EF-C	7.2E-04	25	0.003%	YES		0.00289%
16	Butanal/Butyraldehyde	8	SC1-EF-D	7.2E-04	25	0.003%	YES		0.00289%
16	Butanal/Butyraldehyde	10	SC1-EF-E	6.7E-04	25	0.003%	YES		0.00289%
16	Butanal/Butyraldehyde	12	SC1-EF-F	6.8E-04	25	0.003%	YES		0.00289%
16	Butanal/Butyraldehyde	14	SC1-EF-G	7.2E-04	25	0.003%	YES		0.00289%
16	Butanal/Butyraldehyde	16	SC1-EF-H	7.0E-04	25	0.003%	YES		0.00289%
20	Furan	2	SD1-IN-A	2.3E-05	0.001	2.34%	YES		2.54%
20	Furan	4	SD1-IN-B	2.3E-05	0.001	2.28%	YES		2.54%
20	Furan	6	SD1-IN-C	2.3E-05	0.001	2.27%	YES		2.54%
20	Furan	8	SD1-IN-D	2.3E-05	0.001	2.25%	YES		2.54%
20	Furan	10	SD1-IN-E	2.3E-05	0.001	2.28%	YES		2.54%
20	Furan	12	SD1-IN-F	2.3E-05	0.001	2.27%	YES		2.54%
20	Furan	14	SD1-IN-G	2.3E-05	0.001	2.26%	YES		2.54%
20	Furan	16	SD1-IN-H	2.3E-05	0.001	2.27%	YES		2.54%
20	Furan	2	SD1-EF-A	2.5E-05	0.001	2.47%	YES		2.54%
20	Furan	4	SD1-EF-B	2.4E-05	0.001	2.44%	YES		2.54%
20	Furan	6	SD1-EF-C	2.5E-05	0.001	2.45%	YES		2.54%
20	Furan	8	SD1-EF-D	2.3E-05	0.001	2.28%	YES		2.54%
20	Furan	10	SD1-EF-E	2.5E-05	0.001	2.54%	YES		2.54%
20	Furan	12	SD1-EF-F	2.4E-05	0.001	2.39%	YES		2.54%
20	Furan	14	SD1-EF-G	2.4E-05	0.001	2.37%	YES		2.54%
20	Furan	16	SD1-EF-H	2.3E-05	0.001	2.32%	YES		2.54%
20	Furan	2	SC1-IN-A	2.3E-05	0.001	2.34%	YES	U	2.54%
20	Furan	4	SC1-IN-B	2.4E-05	0.001	2.35%	YES	U	2.54%
20	Furan	6	SC1-IN-C	2.3E-05	0.001	2.25%	YES	U	2.54%
20	Furan	8	SC1-IN-D	2.2E-05	0.001	2.25%	YES	U	2.54%
20	Furan	10	SC1-IN-E	2.3E-05	0.001	2.27%	YES	U	2.54%
20	Furan	12	SC1-IN-F	2.3E-05	0.001	2.28%	YES	U	2.54%
20	Furan	14	SC1-IN-G	2.3E-05	0.001	2.28%	YES	U	2.54%
20	Furan	16	SC1-IN-H	2.3E-05	0.001	2.27%	YES	U	2.54%
20	Furan	2	SC1-EF-A	2.5E-05	0.001	2.53%	YES	U	2.54%
20	Furan	4	SC1-EF-B	2.0E-05	0.001	1.99%	YES	U	2.54%
20	Furan	6	SC1-EF-C	2.2E-05	0.001	2.23%	YES	U	2.54%
20	Furan	8	SC1-EF-D	2.2E-05	0.001	2.23%	YES	U	2.54%
20	Furan	10	SC1-EF-E	2.3E-05	0.001	2.26%	YES	U	2.54%
20	Furan	12	SC1-EF-F	2.2E-05	0.001	2.25%	YES	U	2.54%
20	Furan	14	SC1-EF-G	2.3E-05	0.001	2.31%	YES	U	2.54%
20	Furan	16	SC1-EF-H	2.3E-05	0.001	2.28%	YES	U	2.54%
22	2,5-Dihydrofuran	2	SD1-IN-A	1.9E-05	0.001	1.92%	YES		2.08%
22	2,5-Dihydrofuran	4	SD1-IN-B	1.9E-05	0.001	1.87%	YES		2.08%
22	2,5-Dihydrofuran	6	SD1-IN-C	1.9E-05	0.001	1.86%	YES		2.08%
22	2,5-Dihydrofuran	8	SD1-IN-D	1.8E-05	0.001	1.85%	YES		2.08%
22	2,5-Dihydrofuran	10	SD1-IN-E	1.9E-05	0.001	1.87%	YES		2.08%
22	2,5-Dihydrofuran	12	SD1-IN-F	1.9E-05	0.001	1.87%	YES		2.08%
22	2,5-Dihydrofuran	14	SD1-IN-G	1.9E-05	0.001	1.86%	YES		2.08%
22	2,5-Dihydrofuran	16	SD1-IN-H	1.9E-05	0.001	1.86%	YES		2.08%
22	2,5-Dihydrofuran	2	SD1-EF-A	2.0E-05	0.001	2.03%	YES		2.08%
22	2,5-Dihydrofuran	4	SD1-EF-B	2.0E-05	0.001	2.01%	YES		2.08%
22	2,5-Dihydrofuran	6	SD1-EF-C	2.0E-05	0.001	2.02%	YES		2.08%
22	2,5-Dihydrofuran	8	SD1-EF-D	1.9E-05	0.001	1.88%	YES		2.08%
22	2,5-Dihydrofuran	10	SD1-EF-E	2.1E-05	0.001	2.08%	YES		2.08%
22	2,5-Dihydrofuran	12	SD1-EF-F	2.0E-05	0.001	1.97%	YES		2.08%
22	2,5-Dihydrofuran	14	SD1-EF-G	2.0E-05	0.001	1.95%	YES		2.08%
22	2,5-Dihydrofuran	16	SD1-EF-H	1.9E-05	0.001	1.90%	YES		2.08%
22	2,5-Dihydrofuran	2	SC1-IN-A	1.9E-05	0.001	1.92%	YES	U	2.08%
22	2,5-Dihydrofuran	4	SC1-IN-B	1.9E-05	0.001	1.93%	YES	U	2.08%
22	2,5-Dihydrofuran	6	SC1-IN-C	1.8E-05	0.001	1.85%	YES	U	2.08%
22	2,5-Dihydrofuran	8	SC1-IN-D	1.8E-05	0.001	1.85%	YES	U	2.08%
22	2,5-Dihydrofuran	10	SC1-IN-E	1.9E-05	0.001	1.86%	YES	U	2.08%
22	2,5-Dihydrofuran	12	SC1-IN-F	1.9E-05	0.001	1.87%	YES	U	2.08%
22	2,5-Dihydrofuran	14	SC1-IN-G	1.9E-05	0.001	1.88%	YES	U	2.08%
22	2,5-Dihydrofuran	16	SC1-IN-H	1.9E-05	0.001	1.87%	YES	U	2.08%

Table D.1. APR Cartridge Testing 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	2	SC1-EF-A	2.1E-05	0.001	2.08%	YES	U	2.08%
22	2,5-Dihydrofuran	4	SC1-EF-B	1.6E-05	0.001	1.64%	YES	U	2.08%
22	2,5-Dihydrofuran	6	SC1-EF-C	1.8E-05	0.001	1.83%	YES	U	2.08%
22	2,5-Dihydrofuran	8	SC1-EF-D	1.8E-05	0.001	1.84%	YES	U	2.08%
22	2,5-Dihydrofuran	10	SC1-EF-E	1.9E-05	0.001	1.85%	YES	U	2.08%
22	2,5-Dihydrofuran	12	SC1-EF-F	1.8E-05	0.001	1.85%	YES	U	2.08%
22	2,5-Dihydrofuran	14	SC1-EF-G	1.9E-05	0.001	1.90%	YES	U	2.08%
22	2,5-Dihydrofuran	16	SC1-EF-H	1.9E-05	0.001	1.88%	YES	U	2.08%
23	2-Methylfuran	2	SD1-IN-A	2.1E-05	0.001	2.09%	YES		2.26%
23	2-Methylfuran	4	SD1-IN-B	2.0E-05	0.001	2.03%	YES		2.26%
23	2-Methylfuran	6	SD1-IN-C	2.0E-05	0.001	2.03%	YES		2.26%
23	2-Methylfuran	8	SD1-IN-D	2.0E-05	0.001	2.01%	YES		2.26%
23	2-Methylfuran	10	SD1-IN-E	2.0E-05	0.001	2.03%	YES		2.26%
23	2-Methylfuran	12	SD1-IN-F	2.0E-05	0.001	2.03%	YES		2.26%
23	2-Methylfuran	14	SD1-IN-G	2.0E-05	0.001	2.02%	YES		2.26%
23	2-Methylfuran	16	SD1-IN-H	2.0E-05	0.001	2.03%	YES		2.26%
23	2-Methylfuran	2	SD1-EF-A	2.2E-05	0.001	2.21%	YES		2.26%
23	2-Methylfuran	4	SD1-EF-B	2.2E-05	0.001	2.18%	YES		2.26%
23	2-Methylfuran	6	SD1-EF-C	2.2E-05	0.001	2.19%	YES		2.26%
23	2-Methylfuran	8	SD1-EF-D	2.0E-05	0.001	2.04%	YES		2.26%
23	2-Methylfuran	10	SD1-EF-E	2.3E-05	0.001	2.26%	YES		2.26%
23	2-Methylfuran	12	SD1-EF-F	2.1E-05	0.001	2.14%	YES		2.26%
23	2-Methylfuran	14	SD1-EF-G	2.1E-05	0.001	2.12%	YES		2.26%
23	2-Methylfuran	16	SD1-EF-H	2.1E-05	0.001	2.07%	YES		2.26%
23	2-Methylfuran	2	SC1-IN-A	2.8E-05	0.001	2.83%		Y	2.26%
23	2-Methylfuran	4	SC1-IN-B	2.1E-05	0.001	2.10%	YES	U	2.26%
23	2-Methylfuran	6	SC1-IN-C	2.0E-05	0.001	2.01%	YES	U	2.26%
23	2-Methylfuran	8	SC1-IN-D	2.0E-05	0.001	2.01%	YES	U	2.26%
23	2-Methylfuran	10	SC1-IN-E	2.0E-05	0.001	2.03%	YES	U	2.26%
23	2-Methylfuran	12	SC1-IN-F	2.0E-05	0.001	2.03%	YES	U	2.26%
23	2-Methylfuran	14	SC1-IN-G	2.0E-05	0.001	2.04%	YES	U	2.26%
23	2-Methylfuran	16	SC1-IN-H	2.0E-05	0.001	2.03%	YES	U	2.26%
23	2-Methylfuran	2	SC1-EF-A	2.3E-05	0.001	2.26%	YES	U	2.26%
23	2-Methylfuran	4	SC1-EF-B	1.8E-05	0.001	1.78%	YES	U	2.26%
23	2-Methylfuran	6	SC1-EF-C	2.0E-05	0.001	1.99%	YES	U	2.26%
23	2-Methylfuran	8	SC1-EF-D	2.0E-05	0.001	1.99%	YES	U	2.26%
23	2-Methylfuran	10	SC1-EF-E	2.0E-05	0.001	2.01%	YES	U	2.26%
23	2-Methylfuran	12	SC1-EF-F	2.0E-05	0.001	2.01%	YES	U	2.26%
23	2-Methylfuran	14	SC1-EF-G	2.1E-05	0.001	2.06%	YES	U	2.26%
23	2-Methylfuran	16	SC1-EF-H	2.0E-05	0.001	2.04%	YES	U	2.26%
35	Acetonitrile	2	SD1-IN-A	5.0E-01	20	2.50%	YES		2.57%
35	Acetonitrile	4	SD1-IN-B	5.1E-01	20	2.53%	YES		2.57%
35	Acetonitrile	6	SD1-IN-C	5.0E-01	20	2.50%	YES		2.57%
35	Acetonitrile	8	SD1-IN-D	4.9E-01	20	2.43%	YES		2.57%
35	Acetonitrile	10	SD1-IN-E	4.9E-01	20	2.47%	YES		2.57%
35	Acetonitrile	12	SD1-IN-F	5.0E-01	20	2.48%	YES		2.57%
35	Acetonitrile	14	SD1-IN-G	4.9E-01	20	2.45%	YES		2.57%
35	Acetonitrile	16	SD1-IN-H	5.0E-01	20	2.52%	YES		2.57%
35	Acetonitrile	2	SD1-EF-A	4.9E-01	20	2.46%	YES		2.57%
35	Acetonitrile	4	SD1-EF-B	4.6E-01	20	2.32%	YES		2.57%
35	Acetonitrile	6	SD1-EF-C	4.7E-01	20	2.33%	YES		2.57%
35	Acetonitrile	8	SD1-EF-D	4.7E-01	20	2.33%	YES		2.57%
35	Acetonitrile	10	SD1-EF-E	4.7E-01	20	2.35%	YES		2.57%
35	Acetonitrile	12	SD1-EF-F	8.1E-01	20	4.07%			2.57%
35	Acetonitrile	14	SD1-EF-G	4.8E-01	20	2.40%	YES		2.57%
35	Acetonitrile	16	SD1-EF-H	4.8E-01	20	2.40%	YES		2.57%
35	Acetonitrile	2	SC1-IN-A	5.1E-01	20	2.54%	YES		2.57%
35	Acetonitrile	4	SC1-IN-B	5.1E-01	20	2.57%	YES		2.57%
35	Acetonitrile	6	SC1-IN-C	4.9E-01	20	2.43%	YES		2.57%
35	Acetonitrile	8	SC1-IN-D	4.8E-01	20	2.41%	YES		2.57%
35	Acetonitrile	10	SC1-IN-E	4.9E-01	20	2.45%	YES		2.57%
35	Acetonitrile	12	SC1-IN-F	4.9E-01	20	2.43%	YES		2.57%

Table D.1. APR Cartridge Testing 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	14	SC1-IN-G	4.8E-01	20	2.41%	YES		2.57%
35	Acetonitrile	16	SC1-IN-H	4.9E-01	20	2.43%	YES		2.57%
35	Acetonitrile	2	SC1-EF-A	4.5E-01	20	2.23%	YES		2.57%
35	Acetonitrile	4	SC1-EF-B	4.5E-01	20	2.25%	YES	Y	2.57%
35	Acetonitrile	6	SC1-EF-C	4.5E-01	20	2.26%	YES		2.57%
35	Acetonitrile	8	SC1-EF-D	4.6E-01	20	2.31%	YES		2.57%
35	Acetonitrile	10	SC1-EF-E	4.7E-01	20	2.35%	YES		2.57%
35	Acetonitrile	12	SC1-EF-F	4.5E-01	20	2.26%	YES		2.57%
35	Acetonitrile	14	SC1-EF-G	4.8E-01	20	2.40%	YES		2.57%
35	Acetonitrile	16	SC1-EF-H	4.8E-01	20	2.38%	YES		2.57%
52	Pyridine	2	SD1-IN-A	1.1E-03	1.0	0.106%	YES		0.132%
52	Pyridine	4	SD1-IN-B	1.2E-03	1.0	0.124%	YES		0.132%
52	Pyridine	6	SD1-IN-C	1.3E-03	1.0	0.128%	YES		0.132%
52	Pyridine	8	SD1-IN-D	1.3E-03	1.0	0.125%	YES		0.132%
52	Pyridine	10	SD1-IN-E	1.3E-03	1.0	0.127%	YES		0.132%
52	Pyridine	12	SD1-IN-F	1.3E-03	1.0	0.127%	YES		0.132%
52	Pyridine	14	SD1-IN-G	1.3E-03	1.0	0.132%	YES		0.132%
52	Pyridine	16	SD1-IN-H	1.2E-03	1.0	0.125%	YES		0.132%
52	Pyridine	2	SD1-EF-A	1.2E-03	1.0	0.123%	YES		0.132%
52	Pyridine	4	SD1-EF-B	1.3E-03	1.0	0.130%	YES		0.132%
52	Pyridine	6	SD1-EF-C	1.3E-03	1.0	0.131%	YES		0.132%
52	Pyridine	8	SD1-EF-D	1.3E-03	1.0	0.128%	YES		0.132%
52	Pyridine	10	SD1-EF-E	1.3E-03	1.0	0.130%	YES		0.132%
52	Pyridine	12	SD1-EF-F	1.3E-03	1.0	0.128%	YES		0.132%
52	Pyridine	14	SD1-EF-G	1.3E-03	1.0	0.128%	YES		0.132%
52	Pyridine	16	SD1-EF-H	1.3E-03	1.0	0.130%	YES		0.132%
52	Pyridine	2	SC1-IN-A	1.3E-03	1.0	0.127%	YES		0.132%
52	Pyridine	4	SC1-IN-B	1.3E-03	1.0	0.127%	YES		0.132%
52	Pyridine	6	SC1-IN-C	1.3E-03	1.0	0.127%	YES		0.132%
52	Pyridine	8	SC1-IN-D	1.3E-03	1.0	0.125%	YES		0.132%
52	Pyridine	10	SC1-IN-E	1.3E-03	1.0	0.127%	YES		0.132%
52	Pyridine	12	SC1-IN-F	1.3E-03	1.0	0.126%	YES		0.132%
52	Pyridine	14	SC1-IN-G	1.3E-03	1.0	0.127%	YES		0.132%
52	Pyridine	16	SC1-IN-H	1.2E-03	1.0	0.123%	YES		0.132%
52	Pyridine	2	SC1-EF-A	1.2E-03	1.0	0.125%	YES		0.132%
52	Pyridine	4	SC1-EF-B	1.3E-03	1.0	0.127%	YES		0.132%
52	Pyridine	6	SC1-EF-C	1.3E-03	1.0	0.126%	YES		0.132%
52	Pyridine	8	SC1-EF-D	1.2E-03	1.0	0.124%	YES		0.132%
52	Pyridine	10	SC1-EF-E	1.3E-03	1.0	0.125%	YES		0.132%
52	Pyridine	12	SC1-EF-F	1.3E-03	1.0	0.127%	YES		0.132%
52	Pyridine	14	SC1-EF-G	1.3E-03	1.0	0.128%	YES		0.132%
52	Pyridine	16	SC1-EF-H	1.3E-03	1.0	0.128%	YES		0.132%
53	2,4-Dimethylpyridine	2	SD1-IN-A	7.8E-04	0.50	0.156%	YES		0.194%
53	2,4-Dimethylpyridine	4	SD1-IN-B	9.2E-04	0.50	0.183%	YES		0.194%
53	2,4-Dimethylpyridine	6	SD1-IN-C	9.4E-04	0.50	0.189%	YES		0.194%
53	2,4-Dimethylpyridine	8	SD1-IN-D	9.2E-04	0.50	0.185%	YES		0.194%
53	2,4-Dimethylpyridine	10	SD1-IN-E	9.4E-04	0.50	0.188%	YES		0.194%
53	2,4-Dimethylpyridine	12	SD1-IN-F	9.4E-04	0.50	0.188%	YES		0.194%
53	2,4-Dimethylpyridine	14	SD1-IN-G	9.7E-04	0.50	0.194%	YES		0.194%
53	2,4-Dimethylpyridine	16	SD1-IN-H	9.2E-04	0.50	0.184%	YES		0.194%
53	2,4-Dimethylpyridine	2	SD1-EF-A	9.1E-04	0.50	0.181%	YES		0.194%
53	2,4-Dimethylpyridine	4	SD1-EF-B	9.6E-04	0.50	0.192%	YES		0.194%
53	2,4-Dimethylpyridine	6	SD1-EF-C	9.7E-04	0.50	0.194%	YES		0.194%
53	2,4-Dimethylpyridine	8	SD1-EF-D	9.4E-04	0.50	0.189%	YES		0.194%
53	2,4-Dimethylpyridine	10	SD1-EF-E	9.6E-04	0.50	0.192%	YES		0.194%
53	2,4-Dimethylpyridine	12	SD1-EF-F	9.4E-04	0.50	0.189%	YES		0.194%
53	2,4-Dimethylpyridine	14	SD1-EF-G	9.5E-04	0.50	0.190%	YES		0.194%
53	2,4-Dimethylpyridine	16	SD1-EF-H	9.6E-04	0.50	0.192%	YES		0.194%
53	2,4-Dimethylpyridine	2	SC1-IN-A	9.4E-04	0.50	0.188%	YES		0.194%
53	2,4-Dimethylpyridine	4	SC1-IN-B	9.4E-04	0.50	0.187%	YES		0.194%
53	2,4-Dimethylpyridine	6	SC1-IN-C	9.4E-04	0.50	0.187%	YES		0.194%
53	2,4-Dimethylpyridine	8	SC1-IN-D	9.2E-04	0.50	0.185%	YES		0.194%

Table D.1. APR Cartridge Testing 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	SC1-IN-E	9.3E-04	0.50	0.187%	YES		0.194%
53	2,4-Dimethylpyridine	12	SC1-IN-F	9.3E-04	0.50	0.186%	YES		0.194%
53	2,4-Dimethylpyridine	14	SC1-IN-G	9.3E-04	0.50	0.187%	YES		0.194%
53	2,4-Dimethylpyridine	16	SC1-IN-H	9.1E-04	0.50	0.182%	YES		0.194%
53	2,4-Dimethylpyridine	2	SC1-EF-A	9.2E-04	0.50	0.184%	YES		0.194%
53	2,4-Dimethylpyridine	4	SC1-EF-B	9.4E-04	0.50	0.187%	YES		0.194%
53	2,4-Dimethylpyridine	6	SC1-EF-C	9.3E-04	0.50	0.185%	YES		0.194%
53	2,4-Dimethylpyridine	8	SC1-EF-D	9.2E-04	0.50	0.183%	YES		0.194%
53	2,4-Dimethylpyridine	10	SC1-EF-E	9.2E-04	0.50	0.185%	YES		0.194%
53	2,4-Dimethylpyridine	12	SC1-EF-F	9.4E-04	0.50	0.188%	YES		0.194%
53	2,4-Dimethylpyridine	14	SC1-EF-G	9.5E-04	0.50	0.190%	YES		0.194%
53	2,4-Dimethylpyridine	16	SC1-EF-H	9.4E-04	0.50	0.189%	YES		0.194%

Table D.2. PAPR Cartridge Testing 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	2.0E+01	25	80.3%			2.48%
1	Ammonia	4	TL-IN-B	1.7E+01	25	67.4%			2.48%
1	Ammonia	6	TL-IN-C	1.9E+01	25	75.6%			2.48%
1	Ammonia	8	TL-IN-D	2.5E+01	25	102%			2.48%
1	Ammonia	10	TL-IN-E	2.3E+01	25	91.6%			2.48%
1	Ammonia	12	TL-IN-F	2.2E+01	25	89.9%			2.48%
1	Ammonia	14	TL-IN-G	2.4E+01	25	94.1%			2.48%
1	Ammonia	16	TL-IN-H	2.2E+01	25	88.9%			2.48%
1	Ammonia	2	TL-EF-A	5.7E-01	25	2.27%	YES		2.48%
1	Ammonia	4	TL-EF-B	6.2E-01	25	2.48%	YES		2.48%
1	Ammonia	6	TL-EF-C	5.8E-01	25	2.32%	YES		2.48%
1	Ammonia	8	TL-EF-D	5.8E-01	25	2.31%	YES		2.48%
1	Ammonia	10	TL-EF-E	5.7E-01	25	2.30%	YES		2.48%
1	Ammonia	12	TL-EF-F	5.7E-01	25	2.28%	YES		2.48%
1	Ammonia	14	TL-EF-G	5.7E-01	25	2.28%	YES		2.48%
1	Ammonia	16	TL-EF-H	5.7E-01	25	2.28%	YES		2.48%
1	Ammonia	2	FR57-IN-A	2.0E+01	25	79.5%			2.48%
1	Ammonia	4	FR57-IN-B	2.4E+01	25	95.3%			2.48%
1	Ammonia	6	FR57-IN-C	2.4E+01	25	96.0%			2.48%
1	Ammonia	8	FR57-IN-D	2.2E+01	25	88.6%			2.48%
1	Ammonia	10	FR57-IN-E	2.4E+01	25	96.8%			2.48%
1	Ammonia	12	FR57-IN-F	2.2E+01	25	88.2%			2.48%
1	Ammonia	14	FR57-IN-G	2.3E+01	25	91.3%			2.48%
1	Ammonia	16	FR57-IN-H	2.3E+01	25	90.5%			2.48%
1	Ammonia	2	FR57-EF-A	4.9E-01	25	1.98%	YES		2.48%
1	Ammonia	4	FR57-EF-B	8.7E-01	25	3.48%			2.48%
1	Ammonia	6	FR57-EF-C	3.5E+00	25	14.0%			2.48%
1	Ammonia	8	FR57-EF-D	7.6E+00	25	30.3%			2.48%
1	Ammonia	10	FR57-EF-E	9.4E+00	25	37.8%			2.48%
1	Ammonia	12	FR57-EF-F	8.1E+00	25	32.5%			2.48%
1	Ammonia	14	FR57-EF-G	1.2E+01	25	46.6%			2.48%
1	Ammonia	16	FR57-EF-H	1.4E+01	25	57.3%			2.48%
3	Mercury	2	TL-IN-A	2.7E-04	0.003	9.12%			7.02%
3	Mercury	4	TL-IN-B	2.5E-04	0.003	8.24%			7.02%
3	Mercury	6	TL-IN-C	2.9E-04	0.003	9.50%			7.02%
3	Mercury	8	TL-IN-D	3.5E-04	0.003	11.7%			7.02%
3	Mercury	10	TL-IN-E	3.2E-04	0.003	10.7%			7.02%
3	Mercury	12	TL-IN-F	3.3E-04	0.003	10.9%			7.02%
3	Mercury	14	TL-IN-G	3.4E-04	0.003	11.4%			7.02%
3	Mercury	16	TL-IN-H	3.5E-04	0.003	11.5%			7.02%
3	Mercury	2	TL-EF-A	1.9E-04	0.003	6.44%	YES		7.02%
3	Mercury	4	TL-EF-B	2.1E-04	0.003	7.02%	YES		7.02%
3	Mercury	6	TL-EF-C	2.0E-04	0.003	6.52%	YES		7.02%
3	Mercury	8	TL-EF-D	2.0E-04	0.003	6.67%	YES		7.02%
3	Mercury	10	TL-EF-E	2.0E-04	0.003	6.71%	YES		7.02%
3	Mercury	12	TL-EF-F	2.0E-04	0.003	6.72%	YES		7.02%
3	Mercury	14	TL-EF-G	2.0E-04	0.003	6.72%	YES		7.02%
3	Mercury	16	TL-EF-H	2.0E-04	0.003	6.72%	YES		7.02%
3	Mercury	2	FR57-IN-A	3.0E-04	0.003	9.94%			7.02%
3	Mercury	4	FR57-IN-B	3.7E-04	0.003	12.4%			7.02%
3	Mercury	6	FR57-IN-C	3.6E-04	0.003	11.8%			7.02%
3	Mercury	8	FR57-IN-D	3.7E-04	0.003	12.3%			7.02%
3	Mercury	10	FR57-IN-E	3.1E-04	0.003	10.4%			7.02%
3	Mercury	12	FR57-IN-F	3.5E-04	0.003	11.7%			7.02%
3	Mercury	14	FR57-IN-G	3.4E-04	0.003	11.4%			7.02%
3	Mercury	16	FR57-IN-H	3.4E-04	0.003	11.3%			7.02%
3	Mercury	2	FR57-EF-A	1.7E-04	0.003	5.63%	YES		7.02%
3	Mercury	4	FR57-EF-B	2.0E-04	0.003	6.57%	YES		7.02%
3	Mercury	6	FR57-EF-C	2.0E-04	0.003	6.60%	YES		7.02%
3	Mercury	8	FR57-EF-D	2.0E-04	0.003	6.59%	YES		7.02%

Table D.2. PAPR Cartridge Testing 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	10	FR57-EF-E	2.0E-04	0.003	6.63%	YES		7.02%
3	Mercury	12	FR57-EF-F	2.0E-04	0.003	6.57%	YES		7.02%
3	Mercury	14	FR57-EF-G	2.0E-04	0.003	6.51%	YES		7.02%
3	Mercury	16	FR57-EF-H	2.0E-04	0.003	6.54%	YES		7.02%
4	1,3-Butadiene	2	TL-IN-A	1.8E-02	1.0	1.78%	YES		1.98%
4	1,3-Butadiene	4	TL-IN-B	1.8E-02	1.0	1.82%	YES		1.98%
4	1,3-Butadiene	6	TL-IN-C	1.9E-02	1.0	1.87%	YES		1.98%
4	1,3-Butadiene	8	TL-IN-D	1.9E-02	1.0	1.89%	YES		1.98%
4	1,3-Butadiene	10	TL-IN-E	1.9E-02	1.0	1.89%	YES		1.98%
4	1,3-Butadiene	12	TL-IN-F	1.9E-02	1.0	1.87%	YES		1.98%
4	1,3-Butadiene	14	TL-IN-G	3.5E-02	1.0	3.52%			1.98%
4	1,3-Butadiene	16	TL-IN-H	1.9E-02	1.0	1.86%	YES		1.98%
4	1,3-Butadiene	2	TL-EF-A	1.9E-02	1.0	1.94%	YES		1.98%
4	1,3-Butadiene	4	TL-EF-B	2.0E-02	1.0	1.98%	YES		1.98%
4	1,3-Butadiene	6	TL-EF-C	1.8E-02	1.0	1.83%	YES		1.98%
4	1,3-Butadiene	8	TL-EF-D	1.8E-02	1.0	1.78%	YES		1.98%
4	1,3-Butadiene	10	TL-EF-E	1.8E-02	1.0	1.83%	YES		1.98%
4	1,3-Butadiene	12	TL-EF-F	1.8E-02	1.0	1.84%	YES		1.98%
4	1,3-Butadiene	14	TL-EF-G	2.4E-02	1.0	2.42%			1.98%
4	1,3-Butadiene	16	TL-EF-H	1.9E-02	1.0	1.86%	YES		1.98%
4	1,3-Butadiene	2	FR57-IN-A	1.5E-02	1.0	1.53%	YES		1.98%
4	1,3-Butadiene	4	FR57-IN-B	1.8E-02	1.0	1.80%	YES		1.98%
4	1,3-Butadiene	6	FR57-IN-C	1.9E-02	1.0	1.85%	YES		1.98%
4	1,3-Butadiene	8	FR57-IN-D	1.9E-02	1.0	1.86%	YES		1.98%
4	1,3-Butadiene	10	FR57-IN-E	1.8E-02	1.0	1.82%	YES		1.98%
4	1,3-Butadiene	12	FR57-IN-F	1.8E-02	1.0	1.79%	YES		1.98%
4	1,3-Butadiene	14	FR57-IN-G	1.8E-02	1.0	1.79%	YES		1.98%
4	1,3-Butadiene	16	FR57-IN-H	1.8E-02	1.0	1.81%	YES		1.98%
4	1,3-Butadiene	2	FR57-EF-A	1.7E-02	1.0	1.68%	YES		1.98%
4	1,3-Butadiene	4	FR57-EF-B	1.9E-02	1.0	1.89%	YES		1.98%
4	1,3-Butadiene	6	FR57-EF-C	1.9E-02	1.0	1.85%	YES		1.98%
4	1,3-Butadiene	8	FR57-EF-D	1.8E-02	1.0	1.85%	YES		1.98%
4	1,3-Butadiene	10	FR57-EF-E	1.8E-02	1.0	1.85%	YES		1.98%
4	1,3-Butadiene	12	FR57-EF-F	2.1E-02	1.0	2.05%			1.98%
4	1,3-Butadiene	14	FR57-EF-G	1.9E-02	1.0	1.88%	YES		1.98%
4	1,3-Butadiene	16	FR57-EF-H	1.9E-02	1.0	1.87%	YES		1.98%
5	Benzene	2	TL-IN-A	3.1E-04	0.50	0.062%		J	0.0388%
5	Benzene	4	TL-IN-B	1.4E-04	0.50	0.028%		J	0.0388%
5	Benzene	6	TL-IN-C	2.0E-04	0.50	0.041%		J	0.0388%
5	Benzene	8	TL-IN-D	3.4E-04	0.50	0.067%		J	0.0388%
5	Benzene	10	TL-IN-E	5.5E-04	0.50	0.110%		J	0.0388%
5	Benzene	12	TL-IN-F	3.8E-04	0.50	0.076%		J	0.0388%
5	Benzene	14	TL-IN-G	5.7E-04	0.50	0.115%		J	0.0388%
5	Benzene	16	TL-IN-H	4.3E-04	0.50	0.086%		J	0.0388%
5	Benzene	2	TL-EF-A	3.2E-04	0.50	0.063%		J	0.0388%
5	Benzene	4	TL-EF-B	2.1E-04	0.50	0.042%		J	0.0388%
5	Benzene	6	TL-EF-C	2.7E-04	0.50	0.054%		J	0.0388%
5	Benzene	8	TL-EF-D	4.6E-04	0.50	0.093%		J	0.0388%
5	Benzene	10	TL-EF-E	6.9E-04	0.50	0.138%		J	0.0388%
5	Benzene	12	TL-EF-F	4.7E-04	0.50	0.094%		J	0.0388%
5	Benzene	14	TL-EF-G	6.5E-04	0.50	0.131%		J	0.0388%
5	Benzene	16	TL-EF-H	4.1E-04	0.50	0.083%		J	0.0388%
5	Benzene	2	FR57-IN-A	2.5E-04	0.50	0.051%		J	0.0388%
5	Benzene	4	FR57-IN-B	3.5E-04	0.50	0.071%		J	0.0388%
5	Benzene	6	FR57-IN-C	3.5E-04	0.50	0.070%		J	0.0388%
5	Benzene	8	FR57-IN-D	4.0E-04	0.50	0.080%		J	0.0388%
5	Benzene	10	FR57-IN-E	6.4E-04	0.50	0.129%		J	0.0388%
5	Benzene	12	FR57-IN-F	5.7E-04	0.50	0.114%		J	0.0388%
5	Benzene	14	FR57-IN-G		0.50				0.0388%
5	Benzene	16	FR57-IN-H	4.7E-04	0.50	0.094%		J	0.0388%

Table D.2. PAPR Cartridge Testing 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	FR57-EF-A	2.4E-04	0.50	0.047%		J	0.0388%
5	Benzene	4	FR57-EF-B	3.2E-04	0.50	0.063%		J	0.0388%
5	Benzene	6	FR57-EF-C	3.1E-04	0.50	0.062%		J	0.0388%
5	Benzene	8	FR57-EF-D	3.2E-04	0.50	0.065%		J	0.0388%
5	Benzene	10	FR57-EF-E	5.1E-04	0.50	0.101%		J	0.0388%
5	Benzene	12	FR57-EF-F	5.0E-04	0.50	0.099%		J	0.0388%
5	Benzene	14	FR57-EF-G	4.5E-04	0.50	0.089%		J	0.0388%
5	Benzene	16	FR57-EF-H	4.7E-04	0.50	0.093%		J	0.0388%
6	Biphenyl	2	TL-IN-A	4.6E-05	0.20	0.023%	YES	U	0.0273%
6	Biphenyl	4	TL-IN-B	4.5E-05	0.20	0.022%	YES	U	0.0273%
6	Biphenyl	6	TL-IN-C	4.7E-05	0.20	0.023%	YES	U	0.0273%
6	Biphenyl	8	TL-IN-D	4.6E-05	0.20	0.023%	YES	U	0.0273%
6	Biphenyl	10	TL-IN-E	4.7E-05	0.20	0.023%	YES	U	0.0273%
6	Biphenyl	12	TL-IN-F	4.6E-05	0.20	0.023%	YES	U	0.0273%
6	Biphenyl	14	TL-IN-G	4.6E-05	0.20	0.023%	YES	U	0.0273%
6	Biphenyl	16	TL-IN-H	4.5E-05	0.20	0.023%	YES	U	0.0273%
6	Biphenyl	2	TL-EF-A	4.6E-05	0.20	0.023%	YES	U	0.0273%
6	Biphenyl	4	TL-EF-B	5.5E-05	0.20	0.027%	YES	U	0.0273%
6	Biphenyl	6	TL-EF-C	4.6E-05	0.20	0.023%	YES	U	0.0273%
6	Biphenyl	8	TL-EF-D	4.9E-05	0.20	0.024%	YES	U	0.0273%
6	Biphenyl	10	TL-EF-E	4.5E-05	0.20	0.022%	YES	U	0.0273%
6	Biphenyl	12	TL-EF-F	4.7E-05	0.20	0.024%	YES	U	0.0273%
6	Biphenyl	14	TL-EF-G	4.5E-05	0.20	0.022%	YES	U	0.0273%
6	Biphenyl	16	TL-EF-H	4.6E-05	0.20	0.023%	YES	U	0.0273%
6	Biphenyl	2	FR57-IN-A	3.6E-05	0.20	0.018%	YES	U	0.0273%
6	Biphenyl	4	FR57-IN-B	4.5E-05	0.20	0.022%	YES	U	0.0273%
6	Biphenyl	6	FR57-IN-C	4.9E-05	0.20	0.025%	YES	U	0.0273%
6	Biphenyl	8	FR57-IN-D	5.1E-05	0.20	0.025%	YES	U	0.0273%
6	Biphenyl	10	FR57-IN-E	4.9E-05	0.20	0.025%	YES	U	0.0273%
6	Biphenyl	12	FR57-IN-F	4.8E-05	0.20	0.024%	YES	U	0.0273%
6	Biphenyl	14	FR57-IN-G	4.8E-05	0.20	0.024%	YES	U	0.0273%
6	Biphenyl	16	FR57-IN-H	4.8E-05	0.20	0.024%	YES	U	0.0273%
6	Biphenyl	2	FR57-EF-A	3.8E-05	0.20	0.019%	YES	U	0.0273%
6	Biphenyl	4	FR57-EF-B	4.3E-05	0.20	0.022%	YES	U	0.0273%
6	Biphenyl	6	FR57-EF-C	4.7E-05	0.20	0.024%	YES	U	0.0273%
6	Biphenyl	8	FR57-EF-D	4.7E-05	0.20	0.024%	YES	U	0.0273%
6	Biphenyl	10	FR57-EF-E	4.7E-05	0.20	0.024%	YES	U	0.0273%
6	Biphenyl	12	FR57-EF-F	4.4E-05	0.20	0.022%	YES	U	0.0273%
6	Biphenyl	14	FR57-EF-G	4.6E-05	0.20	0.023%	YES	U	0.0273%
6	Biphenyl	16	FR57-EF-H	4.5E-05	0.20	0.023%	YES	U	0.0273%
7	1-Butanol	2	TL-IN-A	6.6E-04	20	0.003%		J	0.0228%
7	1-Butanol	4	TL-IN-B	2.8E-04	20	0.001%	YES	L	0.0228%
7	1-Butanol	6	TL-IN-C	3.5E-04	20	0.002%		JL	0.0228%
7	1-Butanol	8	TL-IN-D	2.7E-03	20	0.014%		L	0.0228%
7	1-Butanol	10	TL-IN-E	1.1E-03	20	0.005%		JL	0.0228%
7	1-Butanol	12	TL-IN-F	2.9E-04	20	0.001%	YES	L	0.0228%
7	1-Butanol	14	TL-IN-G	1.6E-03	20	0.008%		JL	0.0228%
7	1-Butanol	16	TL-IN-H	4.0E-03	20	0.020%	YES		0.0228%
7	1-Butanol	2	TL-EF-A	4.2E-03	20	0.021%	YES		0.0228%
7	1-Butanol	4	TL-EF-B	4.6E-03	20	0.023%	YES		0.0228%
7	1-Butanol	6	TL-EF-C	4.0E-03	20	0.020%	YES		0.0228%
7	1-Butanol	8	TL-EF-D	3.9E-03	20	0.019%	YES		0.0228%
7	1-Butanol	10	TL-EF-E	3.6E-03	20	0.018%	YES		0.0228%
7	1-Butanol	12	TL-EF-F	3.7E-03	20	0.018%	YES		0.0228%
7	1-Butanol	14	TL-EF-G	4.2E-03	20	0.021%	YES		0.0228%
7	1-Butanol	16	TL-EF-H	4.3E-03	20	0.021%	YES		0.0228%
7	1-Butanol	2	FR57-IN-A	9.6E-04	20	0.005%		J	0.0228%
7	1-Butanol	4	FR57-IN-B	3.8E-03	20	0.019%	YES	U	0.0228%
7	1-Butanol	6	FR57-IN-C	3.8E-03	20	0.019%	YES	U	0.0228%
7	1-Butanol	8	FR57-IN-D	3.8E-03	20	0.019%	YES	U	0.0228%

Table D.2. PAPR Cartridge Testing 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	10	FR57-IN-E	3.8E-03	20	0.019%	YES	U	0.0228%
7	1-Butanol	12	FR57-IN-F	3.8E-03	20	0.019%	YES	U	0.0228%
7	1-Butanol	14	FR57-IN-G		20				0.0228%
7	1-Butanol	16	FR57-IN-H	1.0E-03	20	0.005%		J	0.0228%
7	1-Butanol	2	FR57-EF-A	3.2E-04	20	0.002%	YES		0.0228%
7	1-Butanol	4	FR57-EF-B	3.9E-04	20	0.002%	YES		0.0228%
7	1-Butanol	6	FR57-EF-C	7.2E-04	20	0.004%		J	0.0228%
7	1-Butanol	8	FR57-EF-D	3.8E-04	20	0.002%	YES		0.0228%
7	1-Butanol	10	FR57-EF-E	4.0E-04	20	0.002%	YES		0.0228%
7	1-Butanol	12	FR57-EF-F	3.7E-04	20	0.002%	YES		0.0228%
7	1-Butanol	14	FR57-EF-G	4.2E-04	20	0.002%	YES		0.0228%
7	1-Butanol	16	FR57-EF-H	4.2E-04	20	0.002%	YES		0.0228%
8	Methanol	2	TL-IN-A	3.7E-01	200	0.184%	YES		0.206%
8	Methanol	4	TL-IN-B	1.2E+00	200	0.596%			0.206%
8	Methanol	6	TL-IN-C	3.9E-01	200	0.193%	YES		0.206%
8	Methanol	8	TL-IN-D	3.5E-01	200	0.174%	YES		0.206%
8	Methanol	10	TL-IN-E	3.6E-01	200	0.182%	YES		0.206%
8	Methanol	12	TL-IN-F	3.6E-01	200	0.182%	YES		0.206%
8	Methanol	14	TL-IN-G	3.8E-01	200	0.189%	YES		0.206%
8	Methanol	16	TL-IN-H	3.8E-01	200	0.189%	YES		0.206%
8	Methanol	2	TL-EF-A	3.6E-01	200	0.178%	YES		0.206%
8	Methanol	4	TL-EF-B	4.1E-01	200	0.206%	YES		0.206%
8	Methanol	6	TL-EF-C	3.7E-01	200	0.187%	YES		0.206%
8	Methanol	8	TL-EF-D	3.6E-01	200	0.181%	YES		0.206%
8	Methanol	10	TL-EF-E	3.7E-01	200	0.183%	YES		0.206%
8	Methanol	12	TL-EF-F	3.6E-01	200	0.181%	YES		0.206%
8	Methanol	14	TL-EF-G	3.6E-01	200	0.182%	YES		0.206%
8	Methanol	16	TL-EF-H	3.7E-01	200	0.185%	YES		0.206%
8	Methanol	2	FR57-IN-A	2.9E-01	200	0.145%	YES		0.206%
8	Methanol	4	FR57-IN-B	3.5E-01	200	0.176%	YES		0.206%
8	Methanol	6	FR57-IN-C	3.6E-01	200	0.181%	YES		0.206%
8	Methanol	8	FR57-IN-D	3.8E-01	200	0.189%	YES		0.206%
8	Methanol	10	FR57-IN-E	3.6E-01	200	0.180%	YES		0.206%
8	Methanol	12	FR57-IN-F	3.6E-01	200	0.179%	YES		0.206%
8	Methanol	14	FR57-IN-G	3.8E-01	200	0.190%	YES		0.206%
8	Methanol	16	FR57-IN-H	3.9E-01	200	0.193%	YES		0.206%
8	Methanol	2	FR57-EF-A	2.9E-01	200	0.143%	YES		0.206%
8	Methanol	4	FR57-EF-B	3.7E-01	200	0.183%	YES		0.206%
8	Methanol	6	FR57-EF-C	3.9E-01	200	0.196%	YES		0.206%
8	Methanol	8	FR57-EF-D	3.8E-01	200	0.191%	YES		0.206%
8	Methanol	10	FR57-EF-E	3.7E-01	200	0.186%	YES		0.206%
8	Methanol	12	FR57-EF-F	3.7E-01	200	0.184%	YES		0.206%
8	Methanol	14	FR57-EF-G	4.0E-01	200	0.201%	YES		0.206%
8	Methanol	16	FR57-EF-H	3.9E-01	200	0.196%	YES		0.206%
9	2-Hexanone	2	TL-IN-A	9.1E-05	5.0	0.002%	YES		0.00193%
9	2-Hexanone	4	TL-IN-B	6.2E-05	5.0	0.001%	YES		0.00193%
9	2-Hexanone	6	TL-IN-C	5.9E-05	5.0	0.001%	YES		0.00193%
9	2-Hexanone	8	TL-IN-D	5.3E-05	5.0	0.001%	YES		0.00193%
9	2-Hexanone	10	TL-IN-E	5.8E-05	5.0	0.001%	YES		0.00193%
9	2-Hexanone	12	TL-IN-F	6.3E-05	5.0	0.001%	YES		0.00193%
9	2-Hexanone	14	TL-IN-G	5.6E-05	5.0	0.001%	YES		0.00193%
9	2-Hexanone	16	TL-IN-H	8.4E-05	5.0	0.002%	YES		0.00193%
9	2-Hexanone	2	TL-EF-A	8.9E-05	5.0	0.002%	YES		0.00193%
9	2-Hexanone	4	TL-EF-B	9.6E-05	5.0	0.002%	YES		0.00193%
9	2-Hexanone	6	TL-EF-C	8.4E-05	5.0	0.002%	YES		0.00193%
9	2-Hexanone	8	TL-EF-D	8.2E-05	5.0	0.002%	YES		0.00193%
9	2-Hexanone	10	TL-EF-E	7.7E-05	5.0	0.002%	YES		0.00193%
9	2-Hexanone	12	TL-EF-F	7.8E-05	5.0	0.002%	YES		0.00193%
9	2-Hexanone	14	TL-EF-G	8.9E-05	5.0	0.002%	YES		0.00193%
9	2-Hexanone	16	TL-EF-H	9.0E-05	5.0	0.002%	YES		0.00193%

Table D.2. PAPR Cartridge Testing 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	2	FR57-IN-A	7.1E-05	5.0	0.001%	YES		0.00193%
9	2-Hexanone	4	FR57-IN-B	8.1E-05	5.0	0.002%	YES	U	0.00193%
9	2-Hexanone	6	FR57-IN-C	1.3E-04	5.0	0.003%		J	0.00193%
9	2-Hexanone	8	FR57-IN-D	8.1E-05	5.0	0.002%	YES	U	0.00193%
9	2-Hexanone	10	FR57-IN-E	8.0E-05	5.0	0.002%	YES	U	0.00193%
9	2-Hexanone	12	FR57-IN-F	8.1E-05	5.0	0.002%	YES	U	0.00193%
9	2-Hexanone	14	FR57-IN-G		5.0				0.00193%
9	2-Hexanone	16	FR57-IN-H	9.4E-05	5.0	0.002%	YES		0.00193%
9	2-Hexanone	2	FR57-EF-A	7.3E-05	5.0	0.001%	YES		0.00193%
9	2-Hexanone	4	FR57-EF-B	8.8E-05	5.0	0.002%	YES		0.00193%
9	2-Hexanone	6	FR57-EF-C	8.7E-05	5.0	0.002%	YES		0.00193%
9	2-Hexanone	8	FR57-EF-D	8.6E-05	5.0	0.002%	YES		0.00193%
9	2-Hexanone	10	FR57-EF-E	9.0E-05	5.0	0.002%	YES		0.00193%
9	2-Hexanone	12	FR57-EF-F	8.3E-05	5.0	0.002%	YES		0.00193%
9	2-Hexanone	14	FR57-EF-G	9.5E-05	5.0	0.002%	YES		0.00193%
9	2-Hexanone	16	FR57-EF-H	9.6E-05	5.0	0.002%	YES		0.00193%
11	4-Methyl-2-hexanone	2	TL-IN-A	6.9E-05	0.50	0.014%	YES		0.0217%
11	4-Methyl-2-hexanone	4	TL-IN-B	4.8E-05	0.50	0.010%	YES		0.0217%
11	4-Methyl-2-hexanone	6	TL-IN-C	4.5E-05	0.50	0.009%	YES		0.0217%
11	4-Methyl-2-hexanone	8	TL-IN-D	4.1E-05	0.50	0.008%	YES		0.0217%
11	4-Methyl-2-hexanone	10	TL-IN-E	4.5E-05	0.50	0.009%	YES		0.0217%
11	4-Methyl-2-hexanone	12	TL-IN-F	4.9E-05	0.50	0.010%	YES		0.0217%
11	4-Methyl-2-hexanone	14	TL-IN-G	4.3E-05	0.50	0.009%	YES		0.0217%
11	4-Methyl-2-hexanone	16	TL-IN-H	9.5E-05	0.50	0.019%	YES		0.0217%
11	4-Methyl-2-hexanone	2	TL-EF-A	1.0E-04	0.50	0.020%	YES		0.0217%
11	4-Methyl-2-hexanone	4	TL-EF-B	1.1E-04	0.50	0.022%	YES		0.0217%
11	4-Methyl-2-hexanone	6	TL-EF-C	9.5E-05	0.50	0.019%	YES		0.0217%
11	4-Methyl-2-hexanone	8	TL-EF-D	9.2E-05	0.50	0.018%	YES		0.0217%
11	4-Methyl-2-hexanone	10	TL-EF-E	8.6E-05	0.50	0.017%	YES		0.0217%
11	4-Methyl-2-hexanone	12	TL-EF-F	8.8E-05	0.50	0.018%	YES		0.0217%
11	4-Methyl-2-hexanone	14	TL-EF-G	1.0E-04	0.50	0.020%	YES		0.0217%
11	4-Methyl-2-hexanone	16	TL-EF-H	1.0E-04	0.50	0.020%	YES		0.0217%
11	4-Methyl-2-hexanone	2	FR57-IN-A	5.4E-05	0.50	0.011%	YES		0.0217%
11	4-Methyl-2-hexanone	4	FR57-IN-B	9.1E-05	0.50	0.018%	YES	U	0.0217%
11	4-Methyl-2-hexanone	6	FR57-IN-C	9.0E-05	0.50	0.018%	YES	U	0.0217%
11	4-Methyl-2-hexanone	8	FR57-IN-D	9.2E-05	0.50	0.018%	YES	U	0.0217%
11	4-Methyl-2-hexanone	10	FR57-IN-E	9.0E-05	0.50	0.018%	YES	U	0.0217%
11	4-Methyl-2-hexanone	12	FR57-IN-F	9.1E-05	0.50	0.018%	YES	U	0.0217%
11	4-Methyl-2-hexanone	14	FR57-IN-G		0.50				0.0217%
11	4-Methyl-2-hexanone	16	FR57-IN-H	7.2E-05	0.50	0.014%	YES		0.0217%
11	4-Methyl-2-hexanone	2	FR57-EF-A	5.5E-05	0.50	0.011%	YES		0.0217%
11	4-Methyl-2-hexanone	4	FR57-EF-B	6.7E-05	0.50	0.013%	YES		0.0217%
11	4-Methyl-2-hexanone	6	FR57-EF-C	6.6E-05	0.50	0.013%	YES		0.0217%
11	4-Methyl-2-hexanone	8	FR57-EF-D	6.6E-05	0.50	0.013%	YES		0.0217%
11	4-Methyl-2-hexanone	10	FR57-EF-E	6.8E-05	0.50	0.014%	YES		0.0217%
11	4-Methyl-2-hexanone	12	FR57-EF-F	6.3E-05	0.50	0.013%	YES		0.0217%
11	4-Methyl-2-hexanone	14	FR57-EF-G	7.2E-05	0.50	0.014%	YES		0.0217%
11	4-Methyl-2-hexanone	16	FR57-EF-H	7.3E-05	0.50	0.015%	YES		0.0217%
13	3-Buten-2-one	2	TL-IN-A	2.4E-04	0.20	0.122%		J	0.177%
13	3-Buten-2-one	4	TL-IN-B	1.0E-04	0.20	0.051%		J	0.177%
13	3-Buten-2-one	6	TL-IN-C	1.8E-04	0.20	0.092%		J	0.177%
13	3-Buten-2-one	8	TL-IN-D	2.4E-04	0.20	0.119%		J	0.177%
13	3-Buten-2-one	10	TL-IN-E	2.0E-04	0.20	0.100%		J	0.177%
13	3-Buten-2-one	12	TL-IN-F	1.4E-04	0.20	0.071%		J	0.177%
13	3-Buten-2-one	14	TL-IN-G	2.3E-04	0.20	0.113%		J	0.177%
13	3-Buten-2-one	16	TL-IN-H	3.1E-04	0.20	0.155%	YES		0.177%
13	3-Buten-2-one	2	TL-EF-A	3.3E-04	0.20	0.163%	YES		0.177%
13	3-Buten-2-one	4	TL-EF-B	3.5E-04	0.20	0.177%	YES		0.177%
13	3-Buten-2-one	6	TL-EF-C	3.1E-04	0.20	0.155%	YES		0.177%
13	3-Buten-2-one	8	TL-EF-D	3.0E-04	0.20	0.150%	YES		0.177%

Table D.2. PAPR Cartridge Testing 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	10	TL-EF-E	2.8E-04	0.20	0.141%	YES		0.177%
13	3-Buten-2-one	12	TL-EF-F	2.9E-04	0.20	0.143%	YES		0.177%
13	3-Buten-2-one	14	TL-EF-G	3.3E-04	0.20	0.164%	YES		0.177%
13	3-Buten-2-one	16	TL-EF-H	3.3E-04	0.20	0.166%	YES		0.177%
13	3-Buten-2-one	2	FR57-IN-A	2.4E-04	0.20	0.118%		J	0.177%
13	3-Buten-2-one	4	FR57-IN-B	3.0E-04	0.20	0.148%	YES	U	0.177%
13	3-Buten-2-one	6	FR57-IN-C	2.9E-04	0.20	0.147%	YES	U	0.177%
13	3-Buten-2-one	8	FR57-IN-D	3.0E-04	0.20	0.149%	YES	U	0.177%
13	3-Buten-2-one	10	FR57-IN-E	2.9E-04	0.20	0.147%	YES	U	0.177%
13	3-Buten-2-one	12	FR57-IN-F	3.0E-04	0.20	0.148%	YES	U	0.177%
13	3-Buten-2-one	14	FR57-IN-G		0.20				0.177%
13	3-Buten-2-one	16	FR57-IN-H	2.0E-04	0.20	0.099%		J	0.177%
13	3-Buten-2-one	2	FR57-EF-A	1.0E-04	0.20	0.052%	YES		0.177%
13	3-Buten-2-one	4	FR57-EF-B	1.3E-04	0.20	0.063%	YES		0.177%
13	3-Buten-2-one	6	FR57-EF-C	1.6E-04	0.20	0.082%		J	0.177%
13	3-Buten-2-one	8	FR57-EF-D	1.2E-04	0.20	0.062%	YES		0.177%
13	3-Buten-2-one	10	FR57-EF-E	1.3E-04	0.20	0.064%	YES		0.177%
13	3-Buten-2-one	12	FR57-EF-F	1.2E-04	0.20	0.059%	YES		0.177%
13	3-Buten-2-one	14	FR57-EF-G	1.4E-04	0.20	0.072%		J	0.177%
13	3-Buten-2-one	16	FR57-EF-H	1.4E-04	0.20	0.068%	YES		0.177%
14	Formaldehyde	2	TL-IN-A	1.7E-03	0.30	0.558%	YES		0.595%
14	Formaldehyde	4	TL-IN-B	1.7E-03	0.30	0.558%	YES		0.595%
14	Formaldehyde	6	TL-IN-C	1.7E-03	0.30	0.553%	YES		0.595%
14	Formaldehyde	8	TL-IN-D	1.7E-03	0.30	0.572%	YES		0.595%
14	Formaldehyde	10	TL-IN-E	3.8E-03	0.30	1.27%			0.595%
14	Formaldehyde	12	TL-IN-F	3.1E-03	0.30	1.05%			0.595%
14	Formaldehyde	14	TL-IN-G	6.1E-03	0.30	2.04%			0.595%
14	Formaldehyde	16	TL-IN-H	5.1E-03	0.30	1.70%			0.595%
14	Formaldehyde	2	TL-EF-A	1.7E-03	0.30	0.564%	YES		0.595%
14	Formaldehyde	4	TL-EF-B	1.8E-03	0.30	0.595%	YES		0.595%
14	Formaldehyde	6	TL-EF-C	1.7E-03	0.30	0.557%	YES		0.595%
14	Formaldehyde	8	TL-EF-D	1.6E-03	0.30	0.532%	YES		0.595%
14	Formaldehyde	10	TL-EF-E	2.6E-03	0.30	0.868%			0.595%
14	Formaldehyde	12	TL-EF-F	3.7E-03	0.30	1.23%			0.595%
14	Formaldehyde	14	TL-EF-G	8.0E-03	0.30	2.67%			0.595%
14	Formaldehyde	16	TL-EF-H	5.7E-03	0.30	1.91%			0.595%
14	Formaldehyde	2	FR57-IN-A	2.2E-03	0.30	0.734%			0.595%
14	Formaldehyde	4	FR57-IN-B	1.7E-03	0.30	0.551%	YES		0.595%
14	Formaldehyde	6	FR57-IN-C	1.7E-03	0.30	0.566%			0.595%
14	Formaldehyde	8	FR57-IN-D	1.7E-03	0.30	0.559%	YES		0.595%
14	Formaldehyde	10	FR57-IN-E	4.0E-03	0.30	1.32%			0.595%
14	Formaldehyde	12	FR57-IN-F	3.6E-03	0.30	1.21%			0.595%
14	Formaldehyde	14	FR57-IN-G	6.1E-03	0.30	2.03%			0.595%
14	Formaldehyde	16	FR57-IN-H	5.2E-03	0.30	1.75%			0.595%
14	Formaldehyde	2	FR57-EF-A	1.4E-03	0.30	0.460%	YES		0.595%
14	Formaldehyde	4	FR57-EF-B	1.7E-03	0.30	0.552%	YES		0.595%
14	Formaldehyde	6	FR57-EF-C	1.7E-03	0.30	0.557%	YES		0.595%
14	Formaldehyde	8	FR57-EF-D	1.7E-03	0.30	0.557%	YES		0.595%
14	Formaldehyde	10	FR57-EF-E	5.0E-03	0.30	1.67%			0.595%
14	Formaldehyde	12	FR57-EF-F	1.1E-02	0.30	3.66%			0.595%
14	Formaldehyde	14	FR57-EF-G	2.6E-03	0.30	0.882%			0.595%
14	Formaldehyde	16	FR57-EF-H	4.9E-03	0.30	1.63%			0.595%
15	Acetaldehyde	2	TL-IN-A	9.4E-03	25	0.037%			0.00487%
15	Acetaldehyde	4	TL-IN-B	7.3E-03	25	0.029%			0.00487%
15	Acetaldehyde	6	TL-IN-C	9.0E-03	25	0.036%			0.00487%
15	Acetaldehyde	8	TL-IN-D	1.2E-02	25	0.050%			0.00487%
15	Acetaldehyde	10	TL-IN-E	1.2E-02	25	0.047%			0.00487%
15	Acetaldehyde	12	TL-IN-F	1.2E-02	25	0.048%			0.00487%
15	Acetaldehyde	14	TL-IN-G	1.2E-02	25	0.048%			0.00487%
15	Acetaldehyde	16	TL-IN-H	1.2E-02	25	0.047%			0.00487%

Table D.2. PAPR Cartridge Testing 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	2	TL-EF-A	3.2E-03	25	0.013%			0.00487%
15	Acetaldehyde	4	TL-EF-B	6.1E-03	25	0.024%			0.00487%
15	Acetaldehyde	6	TL-EF-C	6.4E-03	25	0.025%			0.00487%
15	Acetaldehyde	8	TL-EF-D	7.0E-03	25	0.028%			0.00487%
15	Acetaldehyde	10	TL-EF-E	7.1E-03	25	0.028%			0.00487%
15	Acetaldehyde	12	TL-EF-F	8.2E-03	25	0.033%			0.00487%
15	Acetaldehyde	14	TL-EF-G	8.2E-03	25	0.033%			0.00487%
15	Acetaldehyde	16	TL-EF-H	7.6E-03	25	0.030%			0.00487%
15	Acetaldehyde	2	FR57-IN-A	8.7E-03	25	0.035%			0.00487%
15	Acetaldehyde	4	FR57-IN-B	1.0E-02	25	0.041%			0.00487%
15	Acetaldehyde	6	FR57-IN-C	1.0E-02	25	0.042%			0.00487%
15	Acetaldehyde	8	FR57-IN-D	9.8E-03	25	0.039%			0.00487%
15	Acetaldehyde	10	FR57-IN-E	1.2E-02	25	0.048%			0.00487%
15	Acetaldehyde	12	FR57-IN-F	1.2E-02	25	0.048%			0.00487%
15	Acetaldehyde	14	FR57-IN-G	1.2E-02	25	0.046%			0.00487%
15	Acetaldehyde	16	FR57-IN-H	1.2E-02	25	0.048%			0.00487%
15	Acetaldehyde	2	FR57-EF-A	3.4E-03	25	0.014%			0.00487%
15	Acetaldehyde	4	FR57-EF-B	6.3E-03	25	0.025%			0.00487%
15	Acetaldehyde	6	FR57-EF-C	5.7E-03	25	0.023%			0.00487%
15	Acetaldehyde	8	FR57-EF-D	4.8E-03	25	0.019%			0.00487%
15	Acetaldehyde	10	FR57-EF-E	4.8E-03	25	0.019%			0.00487%
15	Acetaldehyde	12	FR57-EF-F	5.1E-03	25	0.020%			0.00487%
15	Acetaldehyde	14	FR57-EF-G	3.6E-03	25	0.014%			0.00487%
15	Acetaldehyde	16	FR57-EF-H	4.7E-03	25	0.019%			0.00487%
16	Butanal/Butyraldehyde	2	TL-IN-A	4.3E-04	25	0.002%	YES		0.00181%
16	Butanal/Butyraldehyde	4	TL-IN-B	1.9E-04	25	0.001%		J	0.00181%
16	Butanal/Butyraldehyde	6	TL-IN-C	5.6E-04	25	0.002%		J	0.00181%
16	Butanal/Butyraldehyde	8	TL-IN-D	3.2E-04	25	0.001%		J	0.00181%
16	Butanal/Butyraldehyde	10	TL-IN-E	1.9E-04	25	0.001%		J	0.00181%
16	Butanal/Butyraldehyde	12	TL-IN-F	1.7E-04	25	0.001%		J	0.00181%
16	Butanal/Butyraldehyde	14	TL-IN-G	2.3E-04	25	0.001%		J	0.00181%
16	Butanal/Butyraldehyde	16	TL-IN-H	3.2E-04	25	0.001%	YES		0.00181%
16	Butanal/Butyraldehyde	2	TL-EF-A	3.3E-04	25	0.001%	YES		0.00181%
16	Butanal/Butyraldehyde	4	TL-EF-B	3.6E-04	25	0.001%	YES		0.00181%
16	Butanal/Butyraldehyde	6	TL-EF-C	3.2E-04	25	0.001%	YES		0.00181%
16	Butanal/Butyraldehyde	8	TL-EF-D	3.1E-04	25	0.001%	YES		0.00181%
16	Butanal/Butyraldehyde	10	TL-EF-E	2.9E-04	25	0.001%	YES		0.00181%
16	Butanal/Butyraldehyde	12	TL-EF-F	3.0E-04	25	0.001%		JQY	0.00181%
16	Butanal/Butyraldehyde	14	TL-EF-G	3.4E-04	25	0.001%	YES		0.00181%
16	Butanal/Butyraldehyde	16	TL-EF-H	3.4E-04	25	0.001%	YES		0.00181%
16	Butanal/Butyraldehyde	2	FR57-IN-A	3.4E-04	25	0.001%	YES		0.00181%
16	Butanal/Butyraldehyde	4	FR57-IN-B	3.0E-04	25	0.001%	YES	QUY	0.00181%
16	Butanal/Butyraldehyde	6	FR57-IN-C	3.5E-04	25	0.001%		JQY	0.00181%
16	Butanal/Butyraldehyde	8	FR57-IN-D	3.1E-04	25	0.001%	YES	QUY	0.00181%
16	Butanal/Butyraldehyde	10	FR57-IN-E	3.0E-04	25	0.001%	YES	QUY	0.00181%
16	Butanal/Butyraldehyde	12	FR57-IN-F	3.1E-04	25	0.001%		JQY	0.00181%
16	Butanal/Butyraldehyde	14	FR57-IN-G		25				0.00181%
16	Butanal/Butyraldehyde	16	FR57-IN-H	4.5E-04	25	0.002%	YES		0.00181%
16	Butanal/Butyraldehyde	2	FR57-EF-A	3.4E-04	25	0.001%	YES		0.00181%
16	Butanal/Butyraldehyde	4	FR57-EF-B	4.2E-04	25	0.002%	YES		0.00181%
16	Butanal/Butyraldehyde	6	FR57-EF-C	4.1E-04	25	0.002%	YES		0.00181%
16	Butanal/Butyraldehyde	8	FR57-EF-D	4.1E-04	25	0.002%	YES		0.00181%
16	Butanal/Butyraldehyde	10	FR57-EF-E	4.2E-04	25	0.002%	YES		0.00181%
16	Butanal/Butyraldehyde	12	FR57-EF-F	3.9E-04	25	0.002%	YES		0.00181%
16	Butanal/Butyraldehyde	14	FR57-EF-G	4.5E-04	25	0.002%	YES		0.00181%
16	Butanal/Butyraldehyde	16	FR57-EF-H	4.5E-04	25	0.002%	YES		0.00181%
19	2-Propenal/Acrolein	2	TL-IN-A	9.0E-04	0.100	0.897%	YES		0.956%
19	2-Propenal/Acrolein	4	TL-IN-B	9.0E-04	0.100	0.897%	YES		0.956%
19	2-Propenal/Acrolein	6	TL-IN-C	8.9E-04	0.100	0.889%	YES		0.956%
19	2-Propenal/Acrolein	8	TL-IN-D	9.2E-04	0.100	0.920%	YES		0.956%

Table D.2. PAPR Cartridge Testing 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	10	TL-IN-E	9.3E-04	0.100	0.927%	YES		0.956%
19	2-Propenal/Acrolein	12	TL-IN-F	9.1E-04	0.100	0.913%	YES		0.956%
19	2-Propenal/Acrolein	14	TL-IN-G	9.1E-04	0.100	0.909%	YES		0.956%
19	2-Propenal/Acrolein	16	TL-IN-H	9.1E-04	0.100	0.912%	YES		0.956%
19	2-Propenal/Acrolein	2	TL-EF-A	9.1E-04	0.100	0.905%	YES		0.956%
19	2-Propenal/Acrolein	4	TL-EF-B	9.6E-04	0.100	0.956%	YES		0.956%
19	2-Propenal/Acrolein	6	TL-EF-C	8.9E-04	0.100	0.894%	YES		0.956%
19	2-Propenal/Acrolein	8	TL-EF-D	8.6E-04	0.100	0.855%	YES		0.956%
19	2-Propenal/Acrolein	10	TL-EF-E	8.9E-04	0.100	0.894%	YES		0.956%
19	2-Propenal/Acrolein	12	TL-EF-F	9.0E-04	0.100	0.899%	YES		0.956%
19	2-Propenal/Acrolein	14	TL-EF-G	8.9E-04	0.100	0.894%	YES		0.956%
19	2-Propenal/Acrolein	16	TL-EF-H	9.0E-04	0.100	0.903%	YES		0.956%
19	2-Propenal/Acrolein	2	FR57-IN-A	7.1E-04	0.100	0.711%	YES		0.956%
19	2-Propenal/Acrolein	4	FR57-IN-B	8.8E-04	0.100	0.885%	YES		0.956%
19	2-Propenal/Acrolein	6	FR57-IN-C	8.9E-04	0.100	0.891%	YES		0.956%
19	2-Propenal/Acrolein	8	FR57-IN-D	9.0E-04	0.100	0.898%	YES		0.956%
19	2-Propenal/Acrolein	10	FR57-IN-E	8.8E-04	0.100	0.882%	YES		0.956%
19	2-Propenal/Acrolein	12	FR57-IN-F	8.8E-04	0.100	0.881%	YES		0.956%
19	2-Propenal/Acrolein	14	FR57-IN-G	8.6E-04	0.100	0.858%	YES		0.956%
19	2-Propenal/Acrolein	16	FR57-IN-H	8.8E-04	0.100	0.877%	YES		0.956%
19	2-Propenal/Acrolein	2	FR57-EF-A	7.4E-04	0.100	0.739%	YES		0.956%
19	2-Propenal/Acrolein	4	FR57-EF-B	8.9E-04	0.100	0.886%	YES		0.956%
19	2-Propenal/Acrolein	6	FR57-EF-C	9.0E-04	0.100	0.896%	YES		0.956%
19	2-Propenal/Acrolein	8	FR57-EF-D	9.0E-04	0.100	0.895%	YES		0.956%
19	2-Propenal/Acrolein	10	FR57-EF-E	8.9E-04	0.100	0.894%	YES		0.956%
19	2-Propenal/Acrolein	12	FR57-EF-F	8.6E-04	0.100	0.864%	YES		0.956%
19	2-Propenal/Acrolein	14	FR57-EF-G	8.9E-04	0.100	0.885%	YES		0.956%
19	2-Propenal/Acrolein	16	FR57-EF-H	8.8E-04	0.100	0.875%	YES		0.956%
20	Furan	2	TL-IN-A	9.0E-05	0.001	8.96%	YES		24.3%
20	Furan	4	TL-IN-B	9.5E-05	0.001	9.50%	YES		24.3%
20	Furan	6	TL-IN-C	9.0E-05	0.001	8.99%	YES		24.3%
20	Furan	8	TL-IN-D	5.7E-04	0.001	57.3%		J	24.3%
20	Furan	10	TL-IN-E	2.8E-04	0.001	27.7%		J	24.3%
20	Furan	12	TL-IN-F	9.7E-05	0.001	9.72%	YES		24.3%
20	Furan	14	TL-IN-G	3.5E-04	0.001	34.6%		J	24.3%
20	Furan	16	TL-IN-H	2.1E-04	0.001	21.2%	YES		24.3%
20	Furan	2	TL-EF-A	2.2E-04	0.001	22.3%	YES		24.3%
20	Furan	4	TL-EF-B	2.4E-04	0.001	24.3%	YES		24.3%
20	Furan	6	TL-EF-C	2.1E-04	0.001	21.3%	YES		24.3%
20	Furan	8	TL-EF-D	2.1E-04	0.001	20.6%	YES		24.3%
20	Furan	10	TL-EF-E	1.9E-04	0.001	19.3%	YES		24.3%
20	Furan	12	TL-EF-F	2.0E-04	0.001	19.6%	YES		24.3%
20	Furan	14	TL-EF-G	2.3E-04	0.001	22.5%	YES		24.3%
20	Furan	16	TL-EF-H	2.3E-04	0.001	22.8%	YES		24.3%
20	Furan	2	FR57-IN-A	1.9E-04	0.001	18.8%		J	24.3%
20	Furan	4	FR57-IN-B	2.0E-04	0.001	20.3%	YES	U	24.3%
20	Furan	6	FR57-IN-C	2.0E-04	0.001	20.2%	YES	U	24.3%
20	Furan	8	FR57-IN-D	2.1E-04	0.001	20.5%	YES	U	24.3%
20	Furan	10	FR57-IN-E	2.0E-04	0.001	20.2%	YES	U	24.3%
20	Furan	12	FR57-IN-F	2.0E-04	0.001	20.4%	YES	U	24.3%
20	Furan	14	FR57-IN-G		0.001				24.3%
20	Furan	16	FR57-IN-H	9.3E-05	0.001	9.26%	YES		24.3%
20	Furan	2	FR57-EF-A	7.1E-05	0.001	7.12%	YES		24.3%
20	Furan	4	FR57-EF-B	8.6E-05	0.001	8.64%	YES		24.3%
20	Furan	6	FR57-EF-C	8.5E-05	0.001	8.49%	YES		24.3%
20	Furan	8	FR57-EF-D	8.5E-05	0.001	8.46%	YES		24.3%
20	Furan	10	FR57-EF-E	8.8E-05	0.001	8.82%	YES		24.3%
20	Furan	12	FR57-EF-F	8.1E-05	0.001	8.15%	YES		24.3%
20	Furan	14	FR57-EF-G	9.3E-05	0.001	9.29%	YES		24.3%
20	Furan	16	FR57-EF-H	9.4E-05	0.001	9.38%	YES		24.3%

Table D.2. PAPR Cartridge Testing 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	2	TL-IN-A	2.9E-05	0.001	2.90%	YES	U	8.19%
21	2,3-Dihydrofuran	4	TL-IN-B	2.8E-05	0.001	2.85%	YES	U	8.19%
21	2,3-Dihydrofuran	6	TL-IN-C	2.9E-05	0.001	2.93%	YES	U	8.19%
21	2,3-Dihydrofuran	8	TL-IN-D	3.0E-05	0.001	3.01%	YES	U	8.19%
21	2,3-Dihydrofuran	10	TL-IN-E	3.1E-05	0.001	3.06%	YES	U	8.19%
21	2,3-Dihydrofuran	12	TL-IN-F	3.1E-05	0.001	3.09%	YES	U	8.19%
21	2,3-Dihydrofuran	14	TL-IN-G	3.0E-05	0.001	3.05%	YES	U	8.19%
21	2,3-Dihydrofuran	16	TL-IN-H	3.1E-05	0.001	3.12%	YES	U	8.19%
21	2,3-Dihydrofuran	2	TL-EF-A	2.9E-05	0.001	2.90%	YES	U	8.19%
21	2,3-Dihydrofuran	4	TL-EF-B	3.3E-05	0.001	3.26%	YES	U	8.19%
21	2,3-Dihydrofuran	6	TL-EF-C	3.0E-05	0.001	2.95%	YES	U	8.19%
21	2,3-Dihydrofuran	8	TL-EF-D	3.1E-05	0.001	3.07%	YES	U	8.19%
21	2,3-Dihydrofuran	10	TL-EF-E	3.0E-05	0.001	2.96%	YES	U	8.19%
21	2,3-Dihydrofuran	12	TL-EF-F	2.9E-05	0.001	2.90%	YES	U	8.19%
21	2,3-Dihydrofuran	14	TL-EF-G	2.9E-05	0.001	2.85%	YES	U	8.19%
21	2,3-Dihydrofuran	16	TL-EF-H	2.8E-05	0.001	2.84%	YES	U	8.19%
21	2,3-Dihydrofuran	2	FR57-IN-A	6.3E-05	0.001	6.29%	YES	U	8.19%
21	2,3-Dihydrofuran	4	FR57-IN-B	7.7E-05	0.001	7.68%	YES	U	8.19%
21	2,3-Dihydrofuran	6	FR57-IN-C	8.1E-05	0.001	8.09%	YES	U	8.19%
21	2,3-Dihydrofuran	8	FR57-IN-D	8.2E-05	0.001	8.19%	YES	U	8.19%
21	2,3-Dihydrofuran	10	FR57-IN-E	7.9E-05	0.001	7.95%	YES	U	8.19%
21	2,3-Dihydrofuran	12	FR57-IN-F	7.6E-05	0.001	7.60%	YES	U	8.19%
21	2,3-Dihydrofuran	14	FR57-IN-G	7.5E-05	0.001	7.55%	YES	U	8.19%
21	2,3-Dihydrofuran	16	FR57-IN-H	7.7E-05	0.001	7.67%	YES	U	8.19%
21	2,3-Dihydrofuran	2	FR57-EF-A	6.1E-05	0.001	6.13%	YES	U	8.19%
21	2,3-Dihydrofuran	4	FR57-EF-B	7.5E-05	0.001	7.52%	YES	U	8.19%
21	2,3-Dihydrofuran	6	FR57-EF-C	7.9E-05	0.001	7.91%	YES	U	8.19%
21	2,3-Dihydrofuran	8	FR57-EF-D	8.0E-05	0.001	7.97%	YES	U	8.19%
21	2,3-Dihydrofuran	10	FR57-EF-E	7.9E-05	0.001	7.89%	YES	U	8.19%
21	2,3-Dihydrofuran	12	FR57-EF-F	7.7E-05	0.001	7.67%	YES	U	8.19%
21	2,3-Dihydrofuran	14	FR57-EF-G	7.6E-05	0.001	7.65%	YES	U	8.19%
21	2,3-Dihydrofuran	16	FR57-EF-H	7.7E-05	0.001	7.70%	YES	U	8.19%
22	2,5-Dihydrofuran	2	TL-IN-A	2.4E-04	0.001	24.4%	YES		25.5%
22	2,5-Dihydrofuran	4	TL-IN-B	5.4E-05	0.001	5.44%	YES		25.5%
22	2,5-Dihydrofuran	6	TL-IN-C	5.1E-05	0.001	5.15%	YES		25.5%
22	2,5-Dihydrofuran	8	TL-IN-D	4.7E-05	0.001	4.69%	YES		25.5%
22	2,5-Dihydrofuran	10	TL-IN-E	5.1E-05	0.001	5.11%	YES		25.5%
22	2,5-Dihydrofuran	12	TL-IN-F	5.6E-05	0.001	5.57%	YES		25.5%
22	2,5-Dihydrofuran	14	TL-IN-G	5.0E-05	0.001	4.96%	YES		25.5%
22	2,5-Dihydrofuran	16	TL-IN-H	1.2E-04	0.001	12.0%	YES		25.5%
22	2,5-Dihydrofuran	2	TL-EF-A	1.3E-04	0.001	12.6%	YES		25.5%
22	2,5-Dihydrofuran	4	TL-EF-B	1.4E-04	0.001	13.8%	YES		25.5%
22	2,5-Dihydrofuran	6	TL-EF-C	1.2E-04	0.001	12.0%	YES		25.5%
22	2,5-Dihydrofuran	8	TL-EF-D	1.2E-04	0.001	11.6%	YES		25.5%
22	2,5-Dihydrofuran	10	TL-EF-E	1.1E-04	0.001	11.0%	YES		25.5%
22	2,5-Dihydrofuran	12	TL-EF-F	1.1E-04	0.001	11.1%	YES		25.5%
22	2,5-Dihydrofuran	14	TL-EF-G	1.3E-04	0.001	12.8%	YES		25.5%
22	2,5-Dihydrofuran	16	TL-EF-H	1.3E-04	0.001	12.9%	YES		25.5%
22	2,5-Dihydrofuran	2	FR57-IN-A	1.9E-04	0.001	18.9%	YES		25.5%
22	2,5-Dihydrofuran	4	FR57-IN-B	1.2E-04	0.001	11.5%	YES	U	25.5%
22	2,5-Dihydrofuran	6	FR57-IN-C	1.1E-04	0.001	11.4%	YES	U	25.5%
22	2,5-Dihydrofuran	8	FR57-IN-D	1.2E-04	0.001	11.6%	YES	U	25.5%
22	2,5-Dihydrofuran	10	FR57-IN-E	1.1E-04	0.001	11.4%	YES	U	25.5%
22	2,5-Dihydrofuran	12	FR57-IN-F	1.2E-04	0.001	11.5%	YES	U	25.5%
22	2,5-Dihydrofuran	14	FR57-IN-G		0.001				25.5%
22	2,5-Dihydrofuran	16	FR57-IN-H	2.5E-04	0.001	25.2%	YES		25.5%
22	2,5-Dihydrofuran	2	FR57-EF-A	1.9E-04	0.001	19.3%	YES		25.5%
22	2,5-Dihydrofuran	4	FR57-EF-B	2.3E-04	0.001	23.5%	YES		25.5%
22	2,5-Dihydrofuran	6	FR57-EF-C	2.3E-04	0.001	23.1%	YES		25.5%
22	2,5-Dihydrofuran	8	FR57-EF-D	2.3E-04	0.001	23.0%	YES		25.5%
22	2,5-Dihydrofuran	10	FR57-EF-E	2.4E-04	0.001	24.0%	YES		25.5%

Table D.2. PAPR Cartridge Testing 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	12	FR57-EF-F	2.2E-04	0.001	22.2%	YES		25.5%
22	2,5-Dihydrofuran	14	FR57-EF-G	2.5E-04	0.001	25.3%	YES		25.5%
22	2,5-Dihydrofuran	16	FR57-EF-H	2.6E-04	0.001	25.5%	YES		25.5%
23	2-Methylfuran	2	TL-IN-A	8.2E-05	0.001	8.18%	YES		10.9%
23	2-Methylfuran	4	TL-IN-B	6.2E-05	0.001	6.22%	YES		10.9%
23	2-Methylfuran	6	TL-IN-C	5.9E-05	0.001	5.89%	YES		10.9%
23	2-Methylfuran	8	TL-IN-D	5.4E-05	0.001	5.36%	YES		10.9%
23	2-Methylfuran	10	TL-IN-E	5.8E-05	0.001	5.84%	YES		10.9%
23	2-Methylfuran	12	TL-IN-F	6.4E-05	0.001	6.37%	YES		10.9%
23	2-Methylfuran	14	TL-IN-G	5.7E-05	0.001	5.67%	YES		10.9%
23	2-Methylfuran	16	TL-IN-H	9.5E-05	0.001	9.54%	YES		10.9%
23	2-Methylfuran	2	TL-EF-A	1.0E-04	0.001	10.0%	YES		10.9%
23	2-Methylfuran	4	TL-EF-B	1.1E-04	0.001	10.9%	YES		10.9%
23	2-Methylfuran	6	TL-EF-C	9.6E-05	0.001	9.55%	YES		10.9%
23	2-Methylfuran	8	TL-EF-D	9.2E-05	0.001	9.23%	YES		10.9%
23	2-Methylfuran	10	TL-EF-E	8.7E-05	0.001	8.68%	YES		10.9%
23	2-Methylfuran	12	TL-EF-F	8.8E-05	0.001	8.81%	YES		10.9%
23	2-Methylfuran	14	TL-EF-G	1.0E-04	0.001	10.1%	YES		10.9%
23	2-Methylfuran	16	TL-EF-H	1.0E-04	0.001	10.2%	YES		10.9%
23	2-Methylfuran	2	FR57-IN-A	6.9E-05	0.001	6.93%		J	10.9%
23	2-Methylfuran	4	FR57-IN-B	9.1E-05	0.001	9.13%	YES	U	10.9%
23	2-Methylfuran	6	FR57-IN-C	9.1E-05	0.001	9.06%	YES	U	10.9%
23	2-Methylfuran	8	FR57-IN-D	9.2E-05	0.001	9.21%	YES	U	10.9%
23	2-Methylfuran	10	FR57-IN-E	9.1E-05	0.001	9.06%	YES	U	10.9%
23	2-Methylfuran	12	FR57-IN-F	9.1E-05	0.001	9.15%	YES	U	10.9%
23	2-Methylfuran	14	FR57-IN-G		0.001				10.9%
23	2-Methylfuran	16	FR57-IN-H	8.4E-05	0.001	8.44%	YES		10.9%
23	2-Methylfuran	2	FR57-EF-A	6.5E-05	0.001	6.49%	YES		10.9%
23	2-Methylfuran	4	FR57-EF-B	7.9E-05	0.001	7.88%	YES		10.9%
23	2-Methylfuran	6	FR57-EF-C	7.7E-05	0.001	7.74%	YES		10.9%
23	2-Methylfuran	8	FR57-EF-D	7.7E-05	0.001	7.72%	YES		10.9%
23	2-Methylfuran	10	FR57-EF-E	8.0E-05	0.001	8.05%	YES		10.9%
23	2-Methylfuran	12	FR57-EF-F	7.4E-05	0.001	7.43%	YES		10.9%
23	2-Methylfuran	14	FR57-EF-G	8.5E-05	0.001	8.47%	YES		10.9%
23	2-Methylfuran	16	FR57-EF-H	8.6E-05	0.001	8.55%	YES		10.9%
24	2,5-Dimethylfuran	2	TL-IN-A	2.7E-05	0.001	2.73%	YES	U	4.09%
24	2,5-Dimethylfuran	4	TL-IN-B	2.7E-05	0.001	2.68%	YES	U	4.09%
24	2,5-Dimethylfuran	6	TL-IN-C	2.8E-05	0.001	2.75%	YES	U	4.09%
24	2,5-Dimethylfuran	8	TL-IN-D	2.8E-05	0.001	2.83%	YES	U	4.09%
24	2,5-Dimethylfuran	10	TL-IN-E	2.9E-05	0.001	2.88%	YES	U	4.09%
24	2,5-Dimethylfuran	12	TL-IN-F	2.9E-05	0.001	2.90%	YES	U	4.09%
24	2,5-Dimethylfuran	14	TL-IN-G	2.9E-05	0.001	2.86%	YES	U	4.09%
24	2,5-Dimethylfuran	16	TL-IN-H	2.9E-05	0.001	2.93%	YES	U	4.09%
24	2,5-Dimethylfuran	2	TL-EF-A	2.7E-05	0.001	2.73%	YES	U	4.09%
24	2,5-Dimethylfuran	4	TL-EF-B	3.1E-05	0.001	3.06%	YES	U	4.09%
24	2,5-Dimethylfuran	6	TL-EF-C	2.8E-05	0.001	2.78%	YES	U	4.09%
24	2,5-Dimethylfuran	8	TL-EF-D	2.9E-05	0.001	2.89%	YES	U	4.09%
24	2,5-Dimethylfuran	10	TL-EF-E	2.8E-05	0.001	2.78%	YES	U	4.09%
24	2,5-Dimethylfuran	12	TL-EF-F	2.7E-05	0.001	2.72%	YES	U	4.09%
24	2,5-Dimethylfuran	14	TL-EF-G	2.7E-05	0.001	2.68%	YES	U	4.09%
24	2,5-Dimethylfuran	16	TL-EF-H	2.7E-05	0.001	2.67%	YES	U	4.09%
24	2,5-Dimethylfuran	2	FR57-IN-A	3.1E-05	0.001	3.14%	YES	U	4.09%
24	2,5-Dimethylfuran	4	FR57-IN-B	3.8E-05	0.001	3.84%	YES	U	4.09%
24	2,5-Dimethylfuran	6	FR57-IN-C	4.0E-05	0.001	4.04%	YES	U	4.09%
24	2,5-Dimethylfuran	8	FR57-IN-D	4.1E-05	0.001	4.09%	YES	U	4.09%
24	2,5-Dimethylfuran	10	FR57-IN-E	4.0E-05	0.001	3.97%	YES	U	4.09%
24	2,5-Dimethylfuran	12	FR57-IN-F	3.8E-05	0.001	3.80%	YES	U	4.09%
24	2,5-Dimethylfuran	14	FR57-IN-G	3.8E-05	0.001	3.77%	YES	U	4.09%
24	2,5-Dimethylfuran	16	FR57-IN-H	3.8E-05	0.001	3.83%	YES	U	4.09%
24	2,5-Dimethylfuran	2	FR57-EF-A	3.1E-05	0.001	3.06%	YES	U	4.09%

Table D.2. PAPR Cartridge Testing 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	4	FR57-EF-B	3.8E-05	0.001	3.76%	YES	U	4.09%
24	2,5-Dimethylfuran	6	FR57-EF-C	4.0E-05	0.001	3.96%	YES	U	4.09%
24	2,5-Dimethylfuran	8	FR57-EF-D	4.0E-05	0.001	3.99%	YES	U	4.09%
24	2,5-Dimethylfuran	10	FR57-EF-E	3.9E-05	0.001	3.94%	YES	U	4.09%
24	2,5-Dimethylfuran	12	FR57-EF-F	3.8E-05	0.001	3.84%	YES	U	4.09%
24	2,5-Dimethylfuran	14	FR57-EF-G	3.8E-05	0.001	3.82%	YES	U	4.09%
24	2,5-Dimethylfuran	16	FR57-EF-H	3.8E-05	0.001	3.85%	YES	U	4.09%
28	2-Pentylfuran	2	TL-IN-A	2.7E-05	0.001	2.74%	YES	U	3.09%
28	2-Pentylfuran	4	TL-IN-B	2.7E-05	0.001	2.69%	YES	U	3.09%
28	2-Pentylfuran	6	TL-IN-C	2.8E-05	0.001	2.77%	YES	U	3.09%
28	2-Pentylfuran	8	TL-IN-D	2.8E-05	0.001	2.85%	YES	U	3.09%
28	2-Pentylfuran	10	TL-IN-E	2.9E-05	0.001	2.90%	YES	U	3.09%
28	2-Pentylfuran	12	TL-IN-F	2.9E-05	0.001	2.92%	YES	U	3.09%
28	2-Pentylfuran	14	TL-IN-G	2.9E-05	0.001	2.88%	YES	U	3.09%
28	2-Pentylfuran	16	TL-IN-H	2.9E-05	0.001	2.95%	YES	U	3.09%
28	2-Pentylfuran	2	TL-EF-A	2.7E-05	0.001	2.75%	YES	U	3.09%
28	2-Pentylfuran	4	TL-EF-B	3.1E-05	0.001	3.09%	YES	U	3.09%
28	2-Pentylfuran	6	TL-EF-C	2.8E-05	0.001	2.79%	YES	U	3.09%
28	2-Pentylfuran	8	TL-EF-D	2.9E-05	0.001	2.91%	YES	U	3.09%
28	2-Pentylfuran	10	TL-EF-E	2.8E-05	0.001	2.80%	YES	U	3.09%
28	2-Pentylfuran	12	TL-EF-F	2.7E-05	0.001	2.74%	YES	U	3.09%
28	2-Pentylfuran	14	TL-EF-G	2.7E-05	0.001	2.70%	YES	U	3.09%
28	2-Pentylfuran	16	TL-EF-H	2.7E-05	0.001	2.68%	YES	U	3.09%
28	2-Pentylfuran	2	FR57-IN-A	1.8E-05	0.001	1.75%	YES	U	3.09%
28	2-Pentylfuran	4	FR57-IN-B	2.1E-05	0.001	2.14%	YES	U	3.09%
28	2-Pentylfuran	6	FR57-IN-C	2.3E-05	0.001	2.26%	YES	U	3.09%
28	2-Pentylfuran	8	FR57-IN-D	2.3E-05	0.001	2.28%	YES	U	3.09%
28	2-Pentylfuran	10	FR57-IN-E	2.2E-05	0.001	2.22%	YES	U	3.09%
28	2-Pentylfuran	12	FR57-IN-F	2.1E-05	0.001	2.12%	YES	U	3.09%
28	2-Pentylfuran	14	FR57-IN-G	2.1E-05	0.001	2.11%	YES	U	3.09%
28	2-Pentylfuran	16	FR57-IN-H	2.1E-05	0.001	2.14%	YES	U	3.09%
28	2-Pentylfuran	2	FR57-EF-A	1.7E-05	0.001	1.71%	YES	U	3.09%
28	2-Pentylfuran	4	FR57-EF-B	2.1E-05	0.001	2.10%	YES	U	3.09%
28	2-Pentylfuran	6	FR57-EF-C	2.2E-05	0.001	2.21%	YES	U	3.09%
28	2-Pentylfuran	8	FR57-EF-D	2.2E-05	0.001	2.22%	YES	U	3.09%
28	2-Pentylfuran	10	FR57-EF-E	2.2E-05	0.001	2.20%	YES	U	3.09%
28	2-Pentylfuran	12	FR57-EF-F	2.1E-05	0.001	2.14%	YES	U	3.09%
28	2-Pentylfuran	14	FR57-EF-G	2.1E-05	0.001	2.13%	YES	U	3.09%
28	2-Pentylfuran	16	FR57-EF-H	2.1E-05	0.001	2.15%	YES	U	3.09%
29	2-Heptylfuran	2	TL-IN-A	2.6E-05	0.001	2.59%	YES	U	2.91%
29	2-Heptylfuran	4	TL-IN-B	2.5E-05	0.001	2.54%	YES	U	2.91%
29	2-Heptylfuran	6	TL-IN-C	2.6E-05	0.001	2.61%	YES	U	2.91%
29	2-Heptylfuran	8	TL-IN-D	2.7E-05	0.001	2.68%	YES	U	2.91%
29	2-Heptylfuran	10	TL-IN-E	2.7E-05	0.001	2.73%	YES	U	2.91%
29	2-Heptylfuran	12	TL-IN-F	2.8E-05	0.001	2.75%	YES	U	2.91%
29	2-Heptylfuran	14	TL-IN-G	2.7E-05	0.001	2.72%	YES	U	2.91%
29	2-Heptylfuran	16	TL-IN-H	2.8E-05	0.001	2.78%	YES	U	2.91%
29	2-Heptylfuran	2	TL-EF-A	2.6E-05	0.001	2.59%	YES	U	2.91%
29	2-Heptylfuran	4	TL-EF-B	2.9E-05	0.001	2.91%	YES	U	2.91%
29	2-Heptylfuran	6	TL-EF-C	2.6E-05	0.001	2.63%	YES	U	2.91%
29	2-Heptylfuran	8	TL-EF-D	2.7E-05	0.001	2.74%	YES	U	2.91%
29	2-Heptylfuran	10	TL-EF-E	2.6E-05	0.001	2.64%	YES	U	2.91%
29	2-Heptylfuran	12	TL-EF-F	2.6E-05	0.001	2.58%	YES	U	2.91%
29	2-Heptylfuran	14	TL-EF-G	2.5E-05	0.001	2.54%	YES	U	2.91%
29	2-Heptylfuran	16	TL-EF-H	2.5E-05	0.001	2.53%	YES	U	2.91%
29	2-Heptylfuran	2	FR57-IN-A	1.9E-05	0.001	1.85%	YES	U	2.91%
29	2-Heptylfuran	4	FR57-IN-B	2.3E-05	0.001	2.27%	YES	U	2.91%
29	2-Heptylfuran	6	FR57-IN-C	2.4E-05	0.001	2.39%	YES	U	2.91%
29	2-Heptylfuran	8	FR57-IN-D	2.4E-05	0.001	2.42%	YES	U	2.91%
29	2-Heptylfuran	10	FR57-IN-E	2.3E-05	0.001	2.35%	YES	U	2.91%

Table D.2. PAPR Cartridge Testing 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	12	FR57-IN-F	2.2E-05	0.001	2.24%	YES	U	2.91%
29	2-Heptylfuran	14	FR57-IN-G	2.2E-05	0.001	2.23%	YES	U	2.91%
29	2-Heptylfuran	16	FR57-IN-H	2.3E-05	0.001	2.26%	YES	U	2.91%
29	2-Heptylfuran	2	FR57-EF-A	1.8E-05	0.001	1.81%	YES	U	2.91%
29	2-Heptylfuran	4	FR57-EF-B	2.2E-05	0.001	2.22%	YES	U	2.91%
29	2-Heptylfuran	6	FR57-EF-C	2.3E-05	0.001	2.33%	YES	U	2.91%
29	2-Heptylfuran	8	FR57-EF-D	3.4E-05	0.001	3.36%		J	2.91%
29	2-Heptylfuran	10	FR57-EF-E	2.3E-05	0.001	2.33%	YES	U	2.91%
29	2-Heptylfuran	12	FR57-EF-F	2.3E-05	0.001	2.26%	YES	U	2.91%
29	2-Heptylfuran	14	FR57-EF-G	2.3E-05	0.001	2.26%		J	2.91%
29	2-Heptylfuran	16	FR57-EF-H	2.3E-05	0.001	2.27%	YES	U	2.91%
30	2-Propylfuran	2	TL-IN-A	1.6E-05	0.001	1.63%	YES	U	2.98%
30	2-Propylfuran	4	TL-IN-B	1.6E-05	0.001	1.60%	YES	U	2.98%
30	2-Propylfuran	6	TL-IN-C	1.6E-05	0.001	1.65%	YES	U	2.98%
30	2-Propylfuran	8	TL-IN-D	1.7E-05	0.001	1.69%	YES	U	2.98%
30	2-Propylfuran	10	TL-IN-E	1.7E-05	0.001	1.72%	YES	U	2.98%
30	2-Propylfuran	12	TL-IN-F	1.7E-05	0.001	1.74%	YES	U	2.98%
30	2-Propylfuran	14	TL-IN-G	1.7E-05	0.001	1.72%	YES	U	2.98%
30	2-Propylfuran	16	TL-IN-H	1.8E-05	0.001	1.76%	YES	U	2.98%
30	2-Propylfuran	2	TL-EF-A	1.6E-05	0.001	1.63%	YES	U	2.98%
30	2-Propylfuran	4	TL-EF-B	1.8E-05	0.001	1.84%	YES	U	2.98%
30	2-Propylfuran	6	TL-EF-C	1.7E-05	0.001	1.66%	YES	U	2.98%
30	2-Propylfuran	8	TL-EF-D	1.7E-05	0.001	1.73%	YES	U	2.98%
30	2-Propylfuran	10	TL-EF-E	1.7E-05	0.001	1.66%	YES	U	2.98%
30	2-Propylfuran	12	TL-EF-F	1.6E-05	0.001	1.63%	YES	U	2.98%
30	2-Propylfuran	14	TL-EF-G	1.6E-05	0.001	1.60%	YES	U	2.98%
30	2-Propylfuran	16	TL-EF-H	1.6E-05	0.001	1.60%	YES	U	2.98%
30	2-Propylfuran	2	FR57-IN-A	2.3E-05	0.001	2.29%	YES	U	2.98%
30	2-Propylfuran	4	FR57-IN-B	2.8E-05	0.001	2.79%	YES	U	2.98%
30	2-Propylfuran	6	FR57-IN-C	2.9E-05	0.001	2.94%	YES	U	2.98%
30	2-Propylfuran	8	FR57-IN-D	3.0E-05	0.001	2.98%	YES	U	2.98%
30	2-Propylfuran	10	FR57-IN-E	2.9E-05	0.001	2.89%	YES	U	2.98%
30	2-Propylfuran	12	FR57-IN-F	2.8E-05	0.001	2.76%	YES	U	2.98%
30	2-Propylfuran	14	FR57-IN-G	2.7E-05	0.001	2.75%	YES	U	2.98%
30	2-Propylfuran	16	FR57-IN-H	2.8E-05	0.001	2.79%	YES	U	2.98%
30	2-Propylfuran	2	FR57-EF-A	2.2E-05	0.001	2.23%	YES	U	2.98%
30	2-Propylfuran	4	FR57-EF-B	2.7E-05	0.001	2.73%	YES	U	2.98%
30	2-Propylfuran	6	FR57-EF-C	2.9E-05	0.001	2.88%	YES	U	2.98%
30	2-Propylfuran	8	FR57-EF-D	2.9E-05	0.001	2.90%	YES	U	2.98%
30	2-Propylfuran	10	FR57-EF-E	2.9E-05	0.001	2.87%	YES	U	2.98%
30	2-Propylfuran	12	FR57-EF-F	2.8E-05	0.001	2.79%	YES	U	2.98%
30	2-Propylfuran	14	FR57-EF-G	2.8E-05	0.001	2.78%	YES	U	2.98%
30	2-Propylfuran	16	FR57-EF-H	2.8E-05	0.001	2.80%	YES	U	2.98%
34	Diethylphthalate	2	TL-IN-A	5.3E-05	0.54	0.010%	YES	U	0.0116%
34	Diethylphthalate	4	TL-IN-B	5.1E-05	0.54	0.009%	YES	U	0.0116%
34	Diethylphthalate	6	TL-IN-C	5.4E-05	0.54	0.010%	YES	U	0.0116%
34	Diethylphthalate	8	TL-IN-D	5.3E-05	0.54	0.010%	YES	U	0.0116%
34	Diethylphthalate	10	TL-IN-E	5.4E-05	0.54	0.010%	YES	U	0.0116%
34	Diethylphthalate	12	TL-IN-F	5.3E-05	0.54	0.010%	YES	U	0.0116%
34	Diethylphthalate	14	TL-IN-G	5.3E-05	0.54	0.010%	YES	U	0.0116%
34	Diethylphthalate	16	TL-IN-H	5.3E-05	0.54	0.010%	YES	U	0.0116%
34	Diethylphthalate	2	TL-EF-A	5.3E-05	0.54	0.010%	YES	U	0.0116%
34	Diethylphthalate	4	TL-EF-B	6.3E-05	0.54	0.012%	YES	U	0.0116%
34	Diethylphthalate	6	TL-EF-C	5.3E-05	0.54	0.010%	YES	U	0.0116%
34	Diethylphthalate	8	TL-EF-D	5.6E-05	0.54	0.010%	YES	U	0.0116%
34	Diethylphthalate	10	TL-EF-E	5.2E-05	0.54	0.010%	YES	U	0.0116%
34	Diethylphthalate	12	TL-EF-F	5.5E-05	0.54	0.010%	YES	U	0.0116%
34	Diethylphthalate	14	TL-EF-G	5.2E-05	0.54	0.010%	YES	U	0.0116%
34	Diethylphthalate	16	TL-EF-H	5.3E-05	0.54	0.010%	YES	U	0.0116%
34	Diethylphthalate	2	FR57-IN-A	4.2E-05	0.54	0.008%	YES	U	0.0116%

Table D.2. PAPR Cartridge Testing 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	4	FR57-IN-B	1.0E-04	0.54	0.019%		J	0.0116%
34	Diethylphthalate	6	FR57-IN-C	9.4E-05	0.54	0.017%		J	0.0116%
34	Diethylphthalate	8	FR57-IN-D	5.9E-05	0.54	0.011%	YES	U	0.0116%
34	Diethylphthalate	10	FR57-IN-E	1.2E-04	0.54	0.022%		J	0.0116%
34	Diethylphthalate	12	FR57-IN-F	5.5E-05	0.54	0.010%	YES	U	0.0116%
34	Diethylphthalate	14	FR57-IN-G	8.9E-05	0.54	0.016%		J	0.0116%
34	Diethylphthalate	16	FR57-IN-H	5.5E-05	0.54	0.010%	YES	U	0.0116%
34	Diethylphthalate	2	FR57-EF-A	4.4E-05	0.54	0.008%	YES	U	0.0116%
34	Diethylphthalate	4	FR57-EF-B	5.0E-05	0.54	0.009%	YES	U	0.0116%
34	Diethylphthalate	6	FR57-EF-C	5.4E-05	0.54	0.010%	YES	U	0.0116%
34	Diethylphthalate	8	FR57-EF-D	5.5E-05	0.54	0.010%	YES	U	0.0116%
34	Diethylphthalate	10	FR57-EF-E	5.4E-05	0.54	0.010%	YES	U	0.0116%
34	Diethylphthalate	12	FR57-EF-F	5.1E-05	0.54	0.009%	YES	U	0.0116%
34	Diethylphthalate	14	FR57-EF-G	5.3E-05	0.54	0.010%	YES	U	0.0116%
34	Diethylphthalate	16	FR57-EF-H	5.2E-05	0.54	0.010%	YES	U	0.0116%
35	Acetonitrile	2	TL-IN-A	1.1E-03	20	0.005%		J	0.00168%
35	Acetonitrile	4	TL-IN-B	4.9E-03	20	0.024%			0.00168%
35	Acetonitrile	6	TL-IN-C	1.5E-03	20	0.007%		J	0.00168%
35	Acetonitrile	8	TL-IN-D	1.5E-03	20	0.007%		J	0.00168%
35	Acetonitrile	10	TL-IN-E	1.8E-03	20	0.009%		J	0.00168%
35	Acetonitrile	12	TL-IN-F	1.1E-03	20	0.006%		J	0.00168%
35	Acetonitrile	14	TL-IN-G	2.0E-03	20	0.010%			0.00168%
35	Acetonitrile	16	TL-IN-H	1.2E-03	20	0.006%		J	0.00168%
35	Acetonitrile	2	TL-EF-A	1.5E-03	20	0.008%		J	0.00168%
35	Acetonitrile	4	TL-EF-B	4.0E-03	20	0.020%			0.00168%
35	Acetonitrile	6	TL-EF-C	1.1E-03	20	0.006%		J	0.00168%
35	Acetonitrile	8	TL-EF-D	2.1E-02	20	0.107%			0.00168%
35	Acetonitrile	10	TL-EF-E	6.7E-04	20	0.003%		J	0.00168%
35	Acetonitrile	12	TL-EF-F	1.6E-02	20	0.081%			0.00168%
35	Acetonitrile	14	TL-EF-G	1.0E-03	20	0.005%		J	0.00168%
35	Acetonitrile	16	TL-EF-H	1.0E-02	20	0.050%			0.00168%
35	Acetonitrile	2	FR57-IN-A	7.5E-03	20	0.038%			0.00168%
35	Acetonitrile	4	FR57-IN-B	4.5E-03	20	0.022%			0.00168%
35	Acetonitrile	6	FR57-IN-C	2.2E-03	20	0.011%			0.00168%
35	Acetonitrile	8	FR57-IN-D	6.0E-03	20	0.030%			0.00168%
35	Acetonitrile	10	FR57-IN-E	3.3E-03	20	0.017%			0.00168%
35	Acetonitrile	12	FR57-IN-F	9.0E-03	20	0.045%			0.00168%
35	Acetonitrile	14	FR57-IN-G		20				0.00168%
35	Acetonitrile	16	FR57-IN-H	1.3E-02	20	0.066%			0.00168%
35	Acetonitrile	2	FR57-EF-A	2.0E-03	20	0.010%			0.00168%
35	Acetonitrile	4	FR57-EF-B	2.7E-03	20	0.014%			0.00168%
35	Acetonitrile	6	FR57-EF-C	1.5E-02	20	0.077%			0.00168%
35	Acetonitrile	8	FR57-EF-D	1.1E-01	20	0.526%		E	0.00168%
35	Acetonitrile	10	FR57-EF-E	2.8E-03	20	0.014%			0.00168%
35	Acetonitrile	12	FR57-EF-F	8.5E-01	20	4.25%		EY	0.00168%
35	Acetonitrile	14	FR57-EF-G	9.1E-03	20	0.045%			0.00168%
35	Acetonitrile	16	FR57-EF-H	1.1E-02	20	0.055%			0.00168%
36	Propanenitrile	2	TL-IN-A	1.6E-04	6.0	0.003%	YES		0.00584%
36	Propanenitrile	4	TL-IN-B	4.3E-05	6.0	0.001%	YES		0.00584%
36	Propanenitrile	6	TL-IN-C	4.1E-05	6.0	0.001%	YES		0.00584%
36	Propanenitrile	8	TL-IN-D	3.7E-05	6.0	0.001%	YES		0.00584%
36	Propanenitrile	10	TL-IN-E	4.1E-05	6.0	0.001%	YES		0.00584%
36	Propanenitrile	12	TL-IN-F	4.4E-05	6.0	0.001%	YES		0.00584%
36	Propanenitrile	14	TL-IN-G	4.0E-05	6.0	0.001%	YES		0.00584%
36	Propanenitrile	16	TL-IN-H	3.1E-04	6.0	0.005%	YES		0.00584%
36	Propanenitrile	2	TL-EF-A	3.2E-04	6.0	0.005%	YES		0.00584%
36	Propanenitrile	4	TL-EF-B	3.5E-04	6.0	0.006%	YES		0.00584%
36	Propanenitrile	6	TL-EF-C	3.1E-04	6.0	0.005%	YES		0.00584%
36	Propanenitrile	8	TL-EF-D	3.0E-04	6.0	0.005%	YES		0.00584%
36	Propanenitrile	10	TL-EF-E	2.8E-04	6.0	0.005%	YES		0.00584%

Table D.2. PAPR Cartridge Testing 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)
36	Propanenitrile	12	TL-EF-F	2.8E-04	6.0	0.005%	YES		0.00584%
36	Propanenitrile	14	TL-EF-G	3.3E-04	6.0	0.005%	YES		0.00584%
36	Propanenitrile	16	TL-EF-H	3.3E-04	6.0	0.005%	YES		0.00584%
36	Propanenitrile	2	FR57-IN-A	1.2E-04	6.0	0.002%	YES		0.00584%
36	Propanenitrile	4	FR57-IN-B	2.9E-04	6.0	0.005%	YES	U	0.00584%
36	Propanenitrile	6	FR57-IN-C	2.9E-04	6.0	0.005%	YES	U	0.00584%
36	Propanenitrile	8	FR57-IN-D	3.0E-04	6.0	0.005%	YES	U	0.00584%
36	Propanenitrile	10	FR57-IN-E	2.9E-04	6.0	0.005%	YES	U	0.00584%
36	Propanenitrile	12	FR57-IN-F	2.9E-04	6.0	0.005%	YES	U	0.00584%
36	Propanenitrile	14	FR57-IN-G		6.0				0.00584%
36	Propanenitrile	16	FR57-IN-H	1.6E-04	6.0	0.003%	YES		0.00584%
36	Propanenitrile	2	FR57-EF-A	1.2E-04	6.0	0.002%	YES		0.00584%
36	Propanenitrile	4	FR57-EF-B	1.5E-04	6.0	0.002%	YES		0.00584%
36	Propanenitrile	6	FR57-EF-C	1.5E-04	6.0	0.002%	YES		0.00584%
36	Propanenitrile	8	FR57-EF-D	1.5E-04	6.0	0.002%	YES		0.00584%
36	Propanenitrile	10	FR57-EF-E	1.5E-04	6.0	0.003%	YES		0.00584%
36	Propanenitrile	12	FR57-EF-F	1.4E-04	6.0	0.002%	YES		0.00584%
36	Propanenitrile	14	FR57-EF-G	1.6E-04	6.0	0.003%	YES		0.00584%
36	Propanenitrile	16	FR57-EF-H	1.6E-04	6.0	0.003%	YES		0.00584%
37	Butanenitrile	2	TL-IN-A	1.3E-04	8.0	0.002%	YES		0.00224%
37	Butanenitrile	4	TL-IN-B	4.3E-05	8.0	0.001%	YES		0.00224%
37	Butanenitrile	6	TL-IN-C	4.1E-05	8.0	0.001%	YES		0.00224%
37	Butanenitrile	8	TL-IN-D	3.7E-05	8.0	0.000%	YES		0.00224%
37	Butanenitrile	10	TL-IN-E	4.0E-05	8.0	0.001%	YES		0.00224%
37	Butanenitrile	12	TL-IN-F	4.4E-05	8.0	0.001%	YES		0.00224%
37	Butanenitrile	14	TL-IN-G	3.9E-05	8.0	0.000%	YES		0.00224%
37	Butanenitrile	16	TL-IN-H	1.6E-04	8.0	0.002%	YES		0.00224%
37	Butanenitrile	2	TL-EF-A	1.6E-04	8.0	0.002%	YES		0.00224%
37	Butanenitrile	4	TL-EF-B	1.8E-04	8.0	0.002%	YES		0.00224%
37	Butanenitrile	6	TL-EF-C	1.6E-04	8.0	0.002%	YES		0.00224%
37	Butanenitrile	8	TL-EF-D	1.5E-04	8.0	0.002%	YES		0.00224%
37	Butanenitrile	10	TL-EF-E	1.6E-04	8.0	0.002%		J	0.00224%
37	Butanenitrile	12	TL-EF-F	1.5E-04	8.0	0.002%	YES		0.00224%
37	Butanenitrile	14	TL-EF-G	1.9E-04	8.0	0.002%		J	0.00224%
37	Butanenitrile	16	TL-EF-H	1.7E-04	8.0	0.002%	YES		0.00224%
37	Butanenitrile	2	FR57-IN-A	1.0E-04	8.0	0.001%	YES		0.00224%
37	Butanenitrile	4	FR57-IN-B	1.5E-04	8.0	0.002%	YES	U	0.00224%
37	Butanenitrile	6	FR57-IN-C	1.5E-04	8.0	0.002%	YES	U	0.00224%
37	Butanenitrile	8	FR57-IN-D	1.5E-04	8.0	0.002%	YES	U	0.00224%
37	Butanenitrile	10	FR57-IN-E	1.5E-04	8.0	0.002%	YES	U	0.00224%
37	Butanenitrile	12	FR57-IN-F	1.5E-04	8.0	0.002%	YES	U	0.00224%
37	Butanenitrile	14	FR57-IN-G		8.0				0.00224%
37	Butanenitrile	16	FR57-IN-H	1.4E-04	8.0	0.002%	YES		0.00224%
37	Butanenitrile	2	FR57-EF-A	1.1E-04	8.0	0.001%	YES		0.00224%
37	Butanenitrile	4	FR57-EF-B	1.3E-04	8.0	0.002%	YES		0.00224%
37	Butanenitrile	6	FR57-EF-C	1.3E-04	8.0	0.002%	YES		0.00224%
37	Butanenitrile	8	FR57-EF-D	1.3E-04	8.0	0.002%	YES		0.00224%
37	Butanenitrile	10	FR57-EF-E	1.3E-04	8.0	0.002%	YES		0.00224%
37	Butanenitrile	12	FR57-EF-F	1.2E-04	8.0	0.002%	YES		0.00224%
37	Butanenitrile	14	FR57-EF-G	1.4E-04	8.0	0.002%	YES		0.00224%
37	Butanenitrile	16	FR57-EF-H	1.4E-04	8.0	0.002%	YES		0.00224%
38	Pentanenitrile	2	TL-IN-A	1.1E-04	6.0	0.002%	YES		0.00276%
38	Pentanenitrile	4	TL-IN-B	4.6E-05	6.0	0.001%	YES		0.00276%
38	Pentanenitrile	6	TL-IN-C	4.3E-05	6.0	0.001%	YES		0.00276%
38	Pentanenitrile	8	TL-IN-D	4.0E-05	6.0	0.001%	YES		0.00276%
38	Pentanenitrile	10	TL-IN-E	4.3E-05	6.0	0.001%	YES		0.00276%
38	Pentanenitrile	12	TL-IN-F	4.7E-05	6.0	0.001%	YES		0.00276%
38	Pentanenitrile	14	TL-IN-G	4.2E-05	6.0	0.001%	YES		0.00276%
38	Pentanenitrile	16	TL-IN-H	1.4E-04	6.0	0.002%	YES		0.00276%
38	Pentanenitrile	2	TL-EF-A	1.5E-04	6.0	0.003%	YES		0.00276%

Table D.2. PAPR Cartridge Testing 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	4	TL-EF-B	1.7E-04	6.0	0.003%	YES		0.00276%
38	Pentanenitrile	6	TL-EF-C	1.5E-04	6.0	0.002%	YES		0.00276%
38	Pentanenitrile	8	TL-EF-D	1.4E-04	6.0	0.002%	YES		0.00276%
38	Pentanenitrile	10	TL-EF-E	1.3E-04	6.0	0.002%	YES		0.00276%
38	Pentanenitrile	12	TL-EF-F	1.3E-04	6.0	0.002%	YES		0.00276%
38	Pentanenitrile	14	TL-EF-G	1.5E-04	6.0	0.003%	YES		0.00276%
38	Pentanenitrile	16	TL-EF-H	1.6E-04	6.0	0.003%	YES		0.00276%
38	Pentanenitrile	2	FR57-IN-A	8.5E-05	6.0	0.001%	YES		0.00276%
38	Pentanenitrile	4	FR57-IN-B	1.4E-04	6.0	0.002%	YES	U	0.00276%
38	Pentanenitrile	6	FR57-IN-C	1.4E-04	6.0	0.002%	YES	U	0.00276%
38	Pentanenitrile	8	FR57-IN-D	1.4E-04	6.0	0.002%	YES	U	0.00276%
38	Pentanenitrile	10	FR57-IN-E	1.4E-04	6.0	0.002%	YES	U	0.00276%
38	Pentanenitrile	12	FR57-IN-F	1.4E-04	6.0	0.002%	YES	U	0.00276%
38	Pentanenitrile	14	FR57-IN-G		6.0				0.00276%
38	Pentanenitrile	16	FR57-IN-H	1.1E-04	6.0	0.002%	YES		0.00276%
38	Pentanenitrile	2	FR57-EF-A	8.7E-05	6.0	0.001%	YES		0.00276%
38	Pentanenitrile	4	FR57-EF-B	1.1E-04	6.0	0.002%	YES		0.00276%
38	Pentanenitrile	6	FR57-EF-C	1.0E-04	6.0	0.002%	YES		0.00276%
38	Pentanenitrile	8	FR57-EF-D	1.0E-04	6.0	0.002%	YES		0.00276%
38	Pentanenitrile	10	FR57-EF-E	1.1E-04	6.0	0.002%	YES		0.00276%
38	Pentanenitrile	12	FR57-EF-F	1.0E-04	6.0	0.002%	YES		0.00276%
38	Pentanenitrile	14	FR57-EF-G	1.1E-04	6.0	0.002%	YES		0.00276%
38	Pentanenitrile	16	FR57-EF-H	1.2E-04	6.0	0.002%	YES		0.00276%
39	Hexanenitrile	2	TL-IN-A	9.4E-05	6.0	0.002%	YES		0.00213%
39	Hexanenitrile	4	TL-IN-B	3.6E-05	6.0	0.001%	YES		0.00213%
39	Hexanenitrile	6	TL-IN-C	3.4E-05	6.0	0.001%	YES		0.00213%
39	Hexanenitrile	8	TL-IN-D	3.1E-05	6.0	0.001%	YES		0.00213%
39	Hexanenitrile	10	TL-IN-E	3.4E-05	6.0	0.001%	YES		0.00213%
39	Hexanenitrile	12	TL-IN-F	3.7E-05	6.0	0.001%	YES		0.00213%
39	Hexanenitrile	14	TL-IN-G	3.3E-05	6.0	0.001%	YES		0.00213%
39	Hexanenitrile	16	TL-IN-H	1.1E-04	6.0	0.002%	YES		0.00213%
39	Hexanenitrile	2	TL-EF-A	1.2E-04	6.0	0.002%	YES		0.00213%
39	Hexanenitrile	4	TL-EF-B	1.3E-04	6.0	0.002%	YES		0.00213%
39	Hexanenitrile	6	TL-EF-C	1.1E-04	6.0	0.002%	YES		0.00213%
39	Hexanenitrile	8	TL-EF-D	1.1E-04	6.0	0.002%	YES		0.00213%
39	Hexanenitrile	10	TL-EF-E	1.0E-04	6.0	0.002%	YES		0.00213%
39	Hexanenitrile	12	TL-EF-F	1.0E-04	6.0	0.002%	YES		0.00213%
39	Hexanenitrile	14	TL-EF-G	1.2E-04	6.0	0.002%	YES		0.00213%
39	Hexanenitrile	16	TL-EF-H	1.2E-04	6.0	0.002%	YES		0.00213%
39	Hexanenitrile	2	FR57-IN-A	7.3E-05	6.0	0.001%	YES		0.00213%
39	Hexanenitrile	4	FR57-IN-B	1.1E-04	6.0	0.002%	YES	U	0.00213%
39	Hexanenitrile	6	FR57-IN-C	1.1E-04	6.0	0.002%	YES	U	0.00213%
39	Hexanenitrile	8	FR57-IN-D	1.1E-04	6.0	0.002%	YES	U	0.00213%
39	Hexanenitrile	10	FR57-IN-E	1.1E-04	6.0	0.002%	YES	U	0.00213%
39	Hexanenitrile	12	FR57-IN-F	1.1E-04	6.0	0.002%	YES	U	0.00213%
39	Hexanenitrile	14	FR57-IN-G		6.0				0.00213%
39	Hexanenitrile	16	FR57-IN-H	9.7E-05	6.0	0.002%	YES		0.00213%
39	Hexanenitrile	2	FR57-EF-A	7.5E-05	6.0	0.001%	YES		0.00213%
39	Hexanenitrile	4	FR57-EF-B	9.1E-05	6.0	0.002%	YES		0.00213%
39	Hexanenitrile	6	FR57-EF-C	8.9E-05	6.0	0.001%	YES		0.00213%
39	Hexanenitrile	8	FR57-EF-D	8.9E-05	6.0	0.001%	YES		0.00213%
39	Hexanenitrile	10	FR57-EF-E	9.3E-05	6.0	0.002%	YES		0.00213%
39	Hexanenitrile	12	FR57-EF-F	8.6E-05	6.0	0.001%	YES		0.00213%
39	Hexanenitrile	14	FR57-EF-G	9.8E-05	6.0	0.002%	YES		0.00213%
39	Hexanenitrile	16	FR57-EF-H	9.9E-05	6.0	0.002%	YES		0.00213%
43	Ethylamine	2	TL-IN-A	4.3E-03	5.0	0.085%	YES		0.0948%
43	Ethylamine	4	TL-IN-B	4.7E-03	5.0	0.094%	YES		0.0948%
43	Ethylamine	6	TL-IN-C	4.4E-03	5.0	0.088%	YES		0.0948%
43	Ethylamine	8	TL-IN-D	4.5E-03	5.0	0.090%	YES		0.0948%
43	Ethylamine	10	TL-IN-E	4.7E-03	5.0	0.093%	YES		0.0948%

Table D.2. PAPR Cartridge Testing 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	12	TL-IN-F	4.7E-03	5.0	0.095%	YES		0.0948%
43	Ethylamine	14	TL-IN-G	4.7E-03	5.0	0.093%	YES		0.0948%
43	Ethylamine	16	TL-IN-H	4.7E-03	5.0	0.094%	YES		0.0948%
43	Ethylamine	2	TL-EF-A	4.2E-03	5.0	0.085%	YES		0.0948%
43	Ethylamine	4	TL-EF-B	4.6E-03	5.0	0.093%	YES		0.0948%
43	Ethylamine	6	TL-EF-C	4.2E-03	5.0	0.084%	YES		0.0948%
43	Ethylamine	8	TL-EF-D	4.6E-03	5.0	0.093%	YES		0.0948%
43	Ethylamine	10	TL-EF-E	4.3E-03	5.0	0.085%	YES		0.0948%
43	Ethylamine	12	TL-EF-F	4.2E-03	5.0	0.085%	YES		0.0948%
43	Ethylamine	14	TL-EF-G	4.4E-03	5.0	0.088%	YES		0.0948%
43	Ethylamine	16	TL-EF-H	4.4E-03	5.0	0.088%	YES		0.0948%
43	Ethylamine	2	FR57-IN-A	3.5E-03	5.0	0.071%	YES		0.0948%
43	Ethylamine	4	FR57-IN-B	4.3E-03	5.0	0.086%	YES		0.0948%
43	Ethylamine	6	FR57-IN-C	4.4E-03	5.0	0.087%	YES		0.0948%
43	Ethylamine	8	FR57-IN-D	4.4E-03	5.0	0.088%	YES		0.0948%
43	Ethylamine	10	FR57-IN-E	4.4E-03	5.0	0.088%	YES		0.0948%
43	Ethylamine	12	FR57-IN-F	4.3E-03	5.0	0.087%	YES		0.0948%
43	Ethylamine	14	FR57-IN-G	4.2E-03	5.0	0.085%	YES		0.0948%
43	Ethylamine	16	FR57-IN-H	4.4E-03	5.0	0.088%	YES		0.0948%
43	Ethylamine	2	FR57-EF-A	3.6E-03	5.0	0.072%	YES		0.0948%
43	Ethylamine	4	FR57-EF-B	4.3E-03	5.0	0.085%	YES		0.0948%
43	Ethylamine	6	FR57-EF-C	4.4E-03	5.0	0.089%	YES		0.0948%
43	Ethylamine	8	FR57-EF-D	4.5E-03	5.0	0.090%	YES		0.0948%
43	Ethylamine	10	FR57-EF-E	4.5E-03	5.0	0.089%	YES		0.0948%
43	Ethylamine	12	FR57-EF-F	4.5E-03	5.0	0.090%	YES		0.0948%
43	Ethylamine	14	FR57-EF-G	4.4E-03	5.0	0.087%	YES		0.0948%
43	Ethylamine	16	FR57-EF-H	4.3E-03	5.0	0.086%	YES		0.0948%
44	N-Nitrosodimethylamine	2	TL-IN-A	9.4E-03	0.000	**3130%**		DLa	6.72%
44	N-Nitrosodimethylamine	4	TL-IN-B	8.8E-03	0.000	**2943%**		DLa	6.72%
44	N-Nitrosodimethylamine	6	TL-IN-C	8.5E-03	0.000	**2822%**		DLa	6.72%
44	N-Nitrosodimethylamine	8	TL-IN-D	9.1E-03	0.000	**3048%**		DLa	6.72%
44	N-Nitrosodimethylamine	10	TL-IN-E	7.8E-03	0.000	**2587%**		DLa	6.72%
44	N-Nitrosodimethylamine	12	TL-IN-F	7.6E-03	0.000	**2527%**		DLa	6.72%
44	N-Nitrosodimethylamine	14	TL-IN-G	7.2E-03	0.000	**2411%**		DLa	6.72%
44	N-Nitrosodimethylamine	16	TL-IN-H	6.6E-03	0.000	**2213%**		DLa	6.72%
44	N-Nitrosodimethylamine	2	TL-EF-A	1.6E-05	0.000	**5.46%**	YES		6.72%
44	N-Nitrosodimethylamine	4	TL-EF-B	1.7E-05	0.000	**5.82%**	YES		6.72%
44	N-Nitrosodimethylamine	6	TL-EF-C	1.5E-05	0.000	**5.11%**	YES		6.72%
44	N-Nitrosodimethylamine	8	TL-EF-D	1.6E-05	0.000	**5.50%**	YES		6.72%
44	N-Nitrosodimethylamine	10	TL-EF-E	1.7E-05	0.000	**5.54%**	YES		6.72%
44	N-Nitrosodimethylamine	12	TL-EF-F	1.6E-05	0.000	**5.32%**	YES		6.72%
44	N-Nitrosodimethylamine	14	TL-EF-G	2.0E-05	0.000	**6.64%**	YES	La	6.72%
44	N-Nitrosodimethylamine	16	TL-EF-H	2.0E-05	0.000	**6.72%**	YES	La	6.72%
44	N-Nitrosodimethylamine	2	FR57-IN-A	5.0E-03	0.000	**1654%**		D	6.72%
44	N-Nitrosodimethylamine	4	FR57-IN-B	6.4E-03	0.000	**2127%**		D	6.72%
44	N-Nitrosodimethylamine	6	FR57-IN-C	5.9E-03	0.000	**1974%**		D	6.72%
44	N-Nitrosodimethylamine	8	FR57-IN-D	5.8E-03	0.000	**1941%**		D	6.72%
44	N-Nitrosodimethylamine	10	FR57-IN-E	4.7E-03	0.000	**1563%**		D	6.72%
44	N-Nitrosodimethylamine	12	FR57-IN-F	3.7E-03	0.000	**1222%**		D	6.72%
44	N-Nitrosodimethylamine	14	FR57-IN-G	3.3E-03	0.000	**1106%**		D	6.72%
44	N-Nitrosodimethylamine	16	FR57-IN-H	3.7E-03	0.000	**1222%**		D	6.72%
44	N-Nitrosodimethylamine	2	FR57-EF-A	1.2E-05	0.000	**4.14%**	YES		6.72%
44	N-Nitrosodimethylamine	4	FR57-EF-B	1.3E-05	0.000	**4.34%**	YES		6.72%
44	N-Nitrosodimethylamine	6	FR57-EF-C	1.3E-05	0.000	**4.46%**	YES		6.72%
44	N-Nitrosodimethylamine	8	FR57-EF-D	1.3E-05	0.000	**4.38%**	YES		6.72%
44	N-Nitrosodimethylamine	10	FR57-EF-E	1.4E-05	0.000	**4.55%**	YES		6.72%
44	N-Nitrosodimethylamine	12	FR57-EF-F	1.4E-05	0.000	**4.57%**	YES		6.72%
44	N-Nitrosodimethylamine	14	FR57-EF-G	1.2E-05	0.000	**4.11%**	YES		6.72%
44	N-Nitrosodimethylamine	16	FR57-EF-H	1.2E-05	0.000	**4.10%**	YES		6.72%
45	N-Nitrosodiethylamine	2	TL-IN-A	1.1E-05	0.000	**11.3%**	YES	a	13.2%

Table D.2. PAPR Cartridge Testing 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	4	TL-IN-B	1.3E-05	0.000	12.5%	YES	a	13.2%
45	N-Nitrosodiethylamine	6	TL-IN-C	1.3E-05	0.000	12.6%	YES	a	13.2%
45	N-Nitrosodiethylamine	8	TL-IN-D	1.3E-05	0.000	13.1%	YES	a	13.2%
45	N-Nitrosodiethylamine	10	TL-IN-E	1.3E-05	0.000	13.0%	YES	a	13.2%
45	N-Nitrosodiethylamine	12	TL-IN-F	1.3E-05	0.000	12.8%	YES	a	13.2%
45	N-Nitrosodiethylamine	14	TL-IN-G	1.3E-05	0.000	13.2%	YES	a	13.2%
45	N-Nitrosodiethylamine	16	TL-IN-H	1.3E-05	0.000	13.1%	YES	a	13.2%
45	N-Nitrosodiethylamine	2	TL-EF-A	1.2E-05	0.000	11.9%	YES		13.2%
45	N-Nitrosodiethylamine	4	TL-EF-B	1.3E-05	0.000	12.7%	YES		13.2%
45	N-Nitrosodiethylamine	6	TL-EF-C	1.1E-05	0.000	11.1%	YES		13.2%
45	N-Nitrosodiethylamine	8	TL-EF-D	1.2E-05	0.000	12.0%	YES		13.2%
45	N-Nitrosodiethylamine	10	TL-EF-E	1.2E-05	0.000	12.1%	YES		13.2%
45	N-Nitrosodiethylamine	12	TL-EF-F	1.2E-05	0.000	11.6%	YES		13.2%
45	N-Nitrosodiethylamine	14	TL-EF-G	1.3E-05	0.000	12.5%	YES	a	13.2%
45	N-Nitrosodiethylamine	16	TL-EF-H	1.3E-05	0.000	12.7%	YES	a	13.2%
45	N-Nitrosodiethylamine	2	FR57-IN-A	7.8E-06	0.000	7.79%	YES		13.2%
45	N-Nitrosodiethylamine	4	FR57-IN-B	9.0E-06	0.000	9.00%	YES		13.2%
45	N-Nitrosodiethylamine	6	FR57-IN-C	8.9E-06	0.000	8.91%	YES		13.2%
45	N-Nitrosodiethylamine	8	FR57-IN-D	8.8E-06	0.000	8.84%	YES		13.2%
45	N-Nitrosodiethylamine	10	FR57-IN-E	8.8E-06	0.000	8.80%	YES		13.2%
45	N-Nitrosodiethylamine	12	FR57-IN-F	8.9E-06	0.000	8.86%	YES		13.2%
45	N-Nitrosodiethylamine	14	FR57-IN-G	9.0E-06	0.000	9.02%	YES		13.2%
45	N-Nitrosodiethylamine	16	FR57-IN-H	8.9E-06	0.000	8.93%	YES		13.2%
45	N-Nitrosodiethylamine	2	FR57-EF-A	9.9E-06	0.000	9.91%	YES		13.2%
45	N-Nitrosodiethylamine	4	FR57-EF-B	1.0E-05	0.000	10.4%	YES		13.2%
45	N-Nitrosodiethylamine	6	FR57-EF-C	1.1E-05	0.000	10.7%	YES		13.2%
45	N-Nitrosodiethylamine	8	FR57-EF-D	1.0E-05	0.000	10.5%	YES		13.2%
45	N-Nitrosodiethylamine	10	FR57-EF-E	1.1E-05	0.000	10.9%	YES		13.2%
45	N-Nitrosodiethylamine	12	FR57-EF-F	1.1E-05	0.000	10.9%	YES		13.2%
45	N-Nitrosodiethylamine	14	FR57-EF-G	9.0E-06	0.000	8.95%	YES		13.2%
45	N-Nitrosodiethylamine	16	FR57-EF-H	8.9E-06	0.000	8.93%	YES		13.2%
46	N-Nitrosomethylethylamine	2	TL-IN-A	6.4E-05	0.000	21.5%		a	5.27%
46	N-Nitrosomethylethylamine	4	TL-IN-B	6.3E-05	0.000	20.8%		a	5.27%
46	N-Nitrosomethylethylamine	6	TL-IN-C	5.8E-05	0.000	19.5%		a	5.27%
46	N-Nitrosomethylethylamine	8	TL-IN-D	6.5E-05	0.000	21.7%		a	5.27%
46	N-Nitrosomethylethylamine	10	TL-IN-E	5.8E-05	0.000	19.3%		a	5.27%
46	N-Nitrosomethylethylamine	12	TL-IN-F	6.2E-05	0.000	20.6%		a	5.27%
46	N-Nitrosomethylethylamine	14	TL-IN-G	6.1E-05	0.000	20.3%		a	5.27%
46	N-Nitrosomethylethylamine	16	TL-IN-H	5.5E-05	0.000	18.3%		a	5.27%
46	N-Nitrosomethylethylamine	2	TL-EF-A	1.4E-05	0.000	4.59%	YES		5.27%
46	N-Nitrosomethylethylamine	4	TL-EF-B	1.5E-05	0.000	4.90%	YES		5.27%
46	N-Nitrosomethylethylamine	6	TL-EF-C	1.3E-05	0.000	4.30%	YES		5.27%
46	N-Nitrosomethylethylamine	8	TL-EF-D	1.4E-05	0.000	4.62%	YES		5.27%
46	N-Nitrosomethylethylamine	10	TL-EF-E	1.4E-05	0.000	4.66%	YES		5.27%
46	N-Nitrosomethylethylamine	12	TL-EF-F	1.3E-05	0.000	4.48%	YES		5.27%
46	N-Nitrosomethylethylamine	14	TL-EF-G	1.6E-05	0.000	5.21%	YES	a	5.27%
46	N-Nitrosomethylethylamine	16	TL-EF-H	1.6E-05	0.000	5.27%	YES	a	5.27%
46	N-Nitrosomethylethylamine	2	FR57-IN-A	4.3E-05	0.000	14.4%			5.27%
46	N-Nitrosomethylethylamine	4	FR57-IN-B	5.1E-05	0.000	17.0%			5.27%
46	N-Nitrosomethylethylamine	6	FR57-IN-C	4.8E-05	0.000	16.1%			5.27%
46	N-Nitrosomethylethylamine	8	FR57-IN-D	4.8E-05	0.000	15.9%			5.27%
46	N-Nitrosomethylethylamine	10	FR57-IN-E	4.0E-05	0.000	13.2%			5.27%
46	N-Nitrosomethylethylamine	12	FR57-IN-F	3.1E-05	0.000	10.3%			5.27%
46	N-Nitrosomethylethylamine	14	FR57-IN-G	3.0E-05	0.000	10.1%			5.27%
46	N-Nitrosomethylethylamine	16	FR57-IN-H	3.1E-05	0.000	10.4%			5.27%
46	N-Nitrosomethylethylamine	2	FR57-EF-A	1.1E-05	0.000	3.83%	YES		5.27%
46	N-Nitrosomethylethylamine	4	FR57-EF-B	1.2E-05	0.000	4.02%	YES		5.27%
46	N-Nitrosomethylethylamine	6	FR57-EF-C	1.2E-05	0.000	4.12%	YES		5.27%
46	N-Nitrosomethylethylamine	8	FR57-EF-D	1.2E-05	0.000	4.05%	YES		5.27%
46	N-Nitrosomethylethylamine	10	FR57-EF-E	1.3E-05	0.000	4.21%	YES		5.27%
46	N-Nitrosomethylethylamine	12	FR57-EF-F	1.3E-05	0.000	4.23%	YES		5.27%

Table D.2. PAPR Cartridge Testing 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)
46	N-Nitrosomethylethylamine	14	FR57-EF-G	1.0E-05	0.000	3.46%	YES		5.27%
46	N-Nitrosomethylethylamine	16	FR57-EF-H	1.0E-05	0.000	3.45%	YES		5.27%
47	N-Nitrosomorpholine	2	TL-IN-A	2.0E-05	0.001	3.31%		a	2.08%
47	N-Nitrosomorpholine	4	TL-IN-B	1.6E-05	0.001	2.68%		a	2.08%
47	N-Nitrosomorpholine	6	TL-IN-C	1.3E-05	0.001	2.13%		a	2.08%
47	N-Nitrosomorpholine	8	TL-IN-D	1.2E-05	0.001	2.06%	YES	a	2.08%
47	N-Nitrosomorpholine	10	TL-IN-E	1.2E-05	0.001	2.05%	YES	a	2.08%
47	N-Nitrosomorpholine	12	TL-IN-F	1.2E-05	0.001	2.03%	YES	a	2.08%
47	N-Nitrosomorpholine	14	TL-IN-G	1.2E-05	0.001	2.08%	YES	a	2.08%
47	N-Nitrosomorpholine	16	TL-IN-H	1.2E-05	0.001	2.07%	YES	a	2.08%
47	N-Nitrosomorpholine	2	TL-EF-A	1.0E-05	0.001	1.74%	YES		2.08%
47	N-Nitrosomorpholine	4	TL-EF-B	1.1E-05	0.001	1.86%	YES		2.08%
47	N-Nitrosomorpholine	6	TL-EF-C	9.8E-06	0.001	1.63%	YES		2.08%
47	N-Nitrosomorpholine	8	TL-EF-D	1.1E-05	0.001	1.75%	YES		2.08%
47	N-Nitrosomorpholine	10	TL-EF-E	1.1E-05	0.001	1.77%	YES		2.08%
47	N-Nitrosomorpholine	12	TL-EF-F	1.0E-05	0.001	1.70%	YES		2.08%
47	N-Nitrosomorpholine	14	TL-EF-G	1.2E-05	0.001	1.98%	YES	a	2.08%
47	N-Nitrosomorpholine	16	TL-EF-H	1.2E-05	0.001	2.00%	YES	a	2.08%
47	N-Nitrosomorpholine	2	FR57-IN-A	6.1E-06	0.001	1.01%	YES		2.08%
47	N-Nitrosomorpholine	4	FR57-IN-B	7.0E-06	0.001	1.17%	YES		2.08%
47	N-Nitrosomorpholine	6	FR57-IN-C	7.8E-06	0.001	1.31%			2.08%
47	N-Nitrosomorpholine	8	FR57-IN-D	6.9E-06	0.001	1.15%	YES		2.08%
47	N-Nitrosomorpholine	10	FR57-IN-E	6.9E-06	0.001	1.15%	YES		2.08%
47	N-Nitrosomorpholine	12	FR57-IN-F	6.9E-06	0.001	1.15%	YES		2.08%
47	N-Nitrosomorpholine	14	FR57-IN-G	7.1E-06	0.001	1.18%	YES		2.08%
47	N-Nitrosomorpholine	16	FR57-IN-H	7.0E-06	0.001	1.16%	YES		2.08%
47	N-Nitrosomorpholine	2	FR57-EF-A	8.7E-06	0.001	1.45%	YES		2.08%
47	N-Nitrosomorpholine	4	FR57-EF-B	9.1E-06	0.001	1.52%	YES		2.08%
47	N-Nitrosomorpholine	6	FR57-EF-C	9.4E-06	0.001	1.56%	YES		2.08%
47	N-Nitrosomorpholine	8	FR57-EF-D	9.2E-06	0.001	1.54%	YES		2.08%
47	N-Nitrosomorpholine	10	FR57-EF-E	9.6E-06	0.001	1.60%	YES		2.08%
47	N-Nitrosomorpholine	12	FR57-EF-F	9.6E-06	0.001	1.60%	YES		2.08%
47	N-Nitrosomorpholine	14	FR57-EF-G	7.0E-06	0.001	1.17%	YES		2.08%
47	N-Nitrosomorpholine	16	FR57-EF-H	7.0E-06	0.001	1.16%	YES		2.08%
48	Tributyl phosphate	2	TL-IN-A	6.0E-05	0.20	0.030%	YES	U	0.0356%
48	Tributyl phosphate	4	TL-IN-B	5.8E-05	0.20	0.029%	YES	U	0.0356%
48	Tributyl phosphate	6	TL-IN-C	6.1E-05	0.20	0.030%	YES	U	0.0356%
48	Tributyl phosphate	8	TL-IN-D	5.9E-05	0.20	0.030%	YES	U	0.0356%
48	Tributyl phosphate	10	TL-IN-E	6.1E-05	0.20	0.030%	YES	U	0.0356%
48	Tributyl phosphate	12	TL-IN-F	6.0E-05	0.20	0.030%	YES	U	0.0356%
48	Tributyl phosphate	14	TL-IN-G	6.0E-05	0.20	0.030%	YES	U	0.0356%
48	Tributyl phosphate	16	TL-IN-H	5.9E-05	0.20	0.030%	YES	U	0.0356%
48	Tributyl phosphate	2	TL-EF-A	5.9E-05	0.20	0.030%	YES	U	0.0356%
48	Tributyl phosphate	4	TL-EF-B	7.1E-05	0.20	0.036%	YES	U	0.0356%
48	Tributyl phosphate	6	TL-EF-C	6.0E-05	0.20	0.030%	YES	U	0.0356%
48	Tributyl phosphate	8	TL-EF-D	6.4E-05	0.20	0.032%	YES	U	0.0356%
48	Tributyl phosphate	10	TL-EF-E	5.9E-05	0.20	0.029%	YES	U	0.0356%
48	Tributyl phosphate	12	TL-EF-F	6.2E-05	0.20	0.031%	YES	QU	0.0356%
48	Tributyl phosphate	14	TL-EF-G	5.8E-05	0.20	0.029%	YES	U	0.0356%
48	Tributyl phosphate	16	TL-EF-H	6.0E-05	0.20	0.030%	YES	U	0.0356%
48	Tributyl phosphate	2	FR57-IN-A	4.7E-05	0.20	0.024%	YES	U	0.0356%
48	Tributyl phosphate	4	FR57-IN-B	5.8E-05	0.20	0.029%	YES	U	0.0356%
48	Tributyl phosphate	6	FR57-IN-C	6.4E-05	0.20	0.032%	YES	U	0.0356%
48	Tributyl phosphate	8	FR57-IN-D	6.6E-05	0.20	0.033%	YES	U	0.0356%
48	Tributyl phosphate	10	FR57-IN-E	6.4E-05	0.20	0.032%	YES	U	0.0356%
48	Tributyl phosphate	12	FR57-IN-F	6.2E-05	0.20	0.031%	YES	U	0.0356%
48	Tributyl phosphate	14	FR57-IN-G	6.3E-05	0.20	0.031%	YES	U	0.0356%
48	Tributyl phosphate	16	FR57-IN-H	6.2E-05	0.20	0.031%	YES	U	0.0356%
48	Tributyl phosphate	2	FR57-EF-A	5.0E-05	0.20	0.025%	YES	U	0.0356%
48	Tributyl phosphate	4	FR57-EF-B	5.7E-05	0.20	0.028%	YES	U	0.0356%

Table D.2. PAPR Cartridge Testing 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	6	FR57-EF-C	6.1E-05	0.20	0.031%	YES	U	0.0356%
48	Tributyl phosphate	8	FR57-EF-D	6.2E-05	0.20	0.031%	YES	U	0.0356%
48	Tributyl phosphate	10	FR57-EF-E	6.1E-05	0.20	0.031%	YES	U	0.0356%
48	Tributyl phosphate	12	FR57-EF-F	5.7E-05	0.20	0.029%	YES	U	0.0356%
48	Tributyl phosphate	14	FR57-EF-G	6.0E-05	0.20	0.030%	YES	U	0.0356%
48	Tributyl phosphate	16	FR57-EF-H	5.9E-05	0.20	0.030%	YES	U	0.0356%
49	Dibutyl butylphosphonate	2	TL-IN-A	2.3E-05	0.007	0.322%	YES	U	0.384%
49	Dibutyl butylphosphonate	4	TL-IN-B	2.2E-05	0.007	0.313%	YES	U	0.384%
49	Dibutyl butylphosphonate	6	TL-IN-C	2.3E-05	0.007	0.329%	YES	U	0.384%
49	Dibutyl butylphosphonate	8	TL-IN-D	2.2E-05	0.007	0.320%	YES	U	0.384%
49	Dibutyl butylphosphonate	10	TL-IN-E	2.3E-05	0.007	0.329%	YES	U	0.384%
49	Dibutyl butylphosphonate	12	TL-IN-F	2.3E-05	0.007	0.336%	YES	U	0.384%
49	Dibutyl butylphosphonate	14	TL-IN-G	2.3E-05	0.007	0.323%	YES	U	0.384%
49	Dibutyl butylphosphonate	16	TL-IN-H	2.2E-05	0.007	0.320%	YES	U	0.384%
49	Dibutyl butylphosphonate	2	TL-EF-A	2.2E-05	0.007	0.320%	YES	U	0.384%
49	Dibutyl butylphosphonate	4	TL-EF-B	2.7E-05	0.007	0.384%	YES	U	0.384%
49	Dibutyl butylphosphonate	6	TL-EF-C	2.3E-05	0.007	0.323%	YES	U	0.384%
49	Dibutyl butylphosphonate	8	TL-EF-D	2.4E-05	0.007	0.344%	YES	U	0.384%
49	Dibutyl butylphosphonate	10	TL-EF-E	2.2E-05	0.007	0.316%	YES	U	0.384%
49	Dibutyl butylphosphonate	12	TL-EF-F	2.3E-05	0.007	0.333%	YES	U	0.384%
49	Dibutyl butylphosphonate	14	TL-EF-G	2.2E-05	0.007	0.314%	YES	U	0.384%
49	Dibutyl butylphosphonate	16	TL-EF-H	2.3E-05	0.007	0.322%	YES	U	0.384%
49	Dibutyl butylphosphonate	2	FR57-IN-A	1.8E-05	0.007	0.255%	YES	U	0.384%
49	Dibutyl butylphosphonate	4	FR57-IN-B	2.2E-05	0.007	0.315%	YES	U	0.384%
49	Dibutyl butylphosphonate	6	FR57-IN-C	2.4E-05	0.007	0.346%	YES	U	0.384%
49	Dibutyl butylphosphonate	8	FR57-IN-D	2.5E-05	0.007	0.359%	YES	U	0.384%
49	Dibutyl butylphosphonate	10	FR57-IN-E	2.4E-05	0.007	0.345%	YES	U	0.384%
49	Dibutyl butylphosphonate	12	FR57-IN-F	2.4E-05	0.007	0.337%	YES	U	0.384%
49	Dibutyl butylphosphonate	14	FR57-IN-G	2.4E-05	0.007	0.340%	YES	U	0.384%
49	Dibutyl butylphosphonate	16	FR57-IN-H	2.3E-05	0.007	0.335%	YES	U	0.384%
49	Dibutyl butylphosphonate	2	FR57-EF-A	1.9E-05	0.007	0.268%	YES	U	0.384%
49	Dibutyl butylphosphonate	4	FR57-EF-B	2.1E-05	0.007	0.306%	YES	U	0.384%
49	Dibutyl butylphosphonate	6	FR57-EF-C	2.3E-05	0.007	0.332%	YES	U	0.384%
49	Dibutyl butylphosphonate	8	FR57-EF-D	2.3E-05	0.007	0.333%	YES	U	0.384%
49	Dibutyl butylphosphonate	10	FR57-EF-E	2.3E-05	0.007	0.332%	YES	U	0.384%
49	Dibutyl butylphosphonate	12	FR57-EF-F	2.2E-05	0.007	0.310%	YES	U	0.384%
49	Dibutyl butylphosphonate	14	FR57-EF-G	2.3E-05	0.007	0.322%	YES	U	0.384%
49	Dibutyl butylphosphonate	16	FR57-EF-H	2.2E-05	0.007	0.319%	YES	U	0.384%
52	Pyridine	2	TL-IN-A	1.9E-04	1.0	0.019%	YES		0.0468%
52	Pyridine	4	TL-IN-B	4.6E-04	1.0	0.046%	YES		0.0468%
52	Pyridine	6	TL-IN-C	4.3E-04	1.0	0.043%	YES		0.0468%
52	Pyridine	8	TL-IN-D	3.9E-04	1.0	0.039%	YES		0.0468%
52	Pyridine	10	TL-IN-E	4.3E-04	1.0	0.043%	YES		0.0468%
52	Pyridine	12	TL-IN-F	4.7E-04	1.0	0.047%	YES		0.0468%
52	Pyridine	14	TL-IN-G	4.2E-04	1.0	0.042%	YES		0.0468%
52	Pyridine	16	TL-IN-H	3.5E-04	1.0	0.035%	YES		0.0468%
52	Pyridine	2	TL-EF-A	3.7E-04	1.0	0.037%	YES		0.0468%
52	Pyridine	4	TL-EF-B	4.0E-04	1.0	0.040%	YES		0.0468%
52	Pyridine	6	TL-EF-C	3.5E-04	1.0	0.035%	YES		0.0468%
52	Pyridine	8	TL-EF-D	3.4E-04	1.0	0.034%	YES		0.0468%
52	Pyridine	10	TL-EF-E	3.2E-04	1.0	0.032%	YES		0.0468%
52	Pyridine	12	TL-EF-F	3.2E-04	1.0	0.032%	YES		0.0468%
52	Pyridine	14	TL-EF-G	3.7E-04	1.0	0.037%	YES		0.0468%
52	Pyridine	16	TL-EF-H	3.8E-04	1.0	0.038%	YES		0.0468%
52	Pyridine	2	FR57-IN-A	1.4E-04	1.0	0.014%	YES		0.0468%
52	Pyridine	4	FR57-IN-B	3.4E-04	1.0	0.034%	YES	U	0.0468%
52	Pyridine	6	FR57-IN-C	3.3E-04	1.0	0.033%	YES	U	0.0468%
52	Pyridine	8	FR57-IN-D	3.4E-04	1.0	0.034%	YES	U	0.0468%
52	Pyridine	10	FR57-IN-E	3.3E-04	1.0	0.033%	YES	U	0.0468%
52	Pyridine	12	FR57-IN-F	3.4E-04	1.0	0.034%	YES	U	0.0468%

Table D.2. PAPR Cartridge Testing 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	14	FR57-IN-G		1.0				0.0468%
52	Pyridine	16	FR57-IN-H	1.9E-04	1.0	0.019%	YES		0.0468%
52	Pyridine	2	FR57-EF-A	1.5E-04	1.0	0.015%	YES		0.0468%
52	Pyridine	4	FR57-EF-B	1.8E-04	1.0	0.018%	YES		0.0468%
52	Pyridine	6	FR57-EF-C	1.8E-04	1.0	0.018%	YES		0.0468%
52	Pyridine	8	FR57-EF-D	1.7E-04	1.0	0.017%	YES		0.0468%
52	Pyridine	10	FR57-EF-E	1.8E-04	1.0	0.018%	YES		0.0468%
52	Pyridine	12	FR57-EF-F	1.7E-04	1.0	0.017%	YES		0.0468%
52	Pyridine	14	FR57-EF-G	1.9E-04	1.0	0.019%	YES		0.0468%
52	Pyridine	16	FR57-EF-H	1.9E-04	1.0	0.019%	YES		0.0468%
53	2,4-Dimethylpyridine	2	TL-IN-A	1.1E-04	0.50	0.022%	YES		0.0543%
53	2,4-Dimethylpyridine	4	TL-IN-B	2.7E-04	0.50	0.053%	YES		0.0543%
53	2,4-Dimethylpyridine	6	TL-IN-C	2.5E-04	0.50	0.050%	YES		0.0543%
53	2,4-Dimethylpyridine	8	TL-IN-D	2.3E-04	0.50	0.046%	YES		0.0543%
53	2,4-Dimethylpyridine	10	TL-IN-E	2.5E-04	0.50	0.050%	YES		0.0543%
53	2,4-Dimethylpyridine	12	TL-IN-F	2.7E-04	0.50	0.054%	YES		0.0543%
53	2,4-Dimethylpyridine	14	TL-IN-G	2.4E-04	0.50	0.048%	YES		0.0543%
53	2,4-Dimethylpyridine	16	TL-IN-H	2.4E-04	0.50	0.047%	YES		0.0543%
53	2,4-Dimethylpyridine	2	TL-EF-A	2.5E-04	0.50	0.050%	YES		0.0543%
53	2,4-Dimethylpyridine	4	TL-EF-B	2.7E-04	0.50	0.054%	YES		0.0543%
53	2,4-Dimethylpyridine	6	TL-EF-C	2.4E-04	0.50	0.047%	YES		0.0543%
53	2,4-Dimethylpyridine	8	TL-EF-D	2.3E-04	0.50	0.046%	YES		0.0543%
53	2,4-Dimethylpyridine	10	TL-EF-E	2.1E-04	0.50	0.043%	YES		0.0543%
53	2,4-Dimethylpyridine	12	TL-EF-F	2.2E-04	0.50	0.044%	YES		0.0543%
53	2,4-Dimethylpyridine	14	TL-EF-G	2.5E-04	0.50	0.050%	YES		0.0543%
53	2,4-Dimethylpyridine	16	TL-EF-H	2.5E-04	0.50	0.051%	YES		0.0543%
53	2,4-Dimethylpyridine	2	FR57-IN-A	8.4E-05	0.50	0.017%	YES		0.0543%
53	2,4-Dimethylpyridine	4	FR57-IN-B	2.3E-04	0.50	0.045%	YES	U	0.0543%
53	2,4-Dimethylpyridine	6	FR57-IN-C	2.2E-04	0.50	0.045%	YES	U	0.0543%
53	2,4-Dimethylpyridine	8	FR57-IN-D	2.3E-04	0.50	0.046%	YES	U	0.0543%
53	2,4-Dimethylpyridine	10	FR57-IN-E	2.2E-04	0.50	0.045%	YES	U	0.0543%
53	2,4-Dimethylpyridine	12	FR57-IN-F	2.3E-04	0.50	0.045%	YES	U	0.0543%
53	2,4-Dimethylpyridine	14	FR57-IN-G		0.50				0.0543%
53	2,4-Dimethylpyridine	16	FR57-IN-H	1.1E-04	0.50	0.022%	YES		0.0543%
53	2,4-Dimethylpyridine	2	FR57-EF-A	8.6E-05	0.50	0.017%	YES		0.0543%
53	2,4-Dimethylpyridine	4	FR57-EF-B	1.0E-04	0.50	0.021%	YES		0.0543%
53	2,4-Dimethylpyridine	6	FR57-EF-C	1.0E-04	0.50	0.020%	YES		0.0543%
53	2,4-Dimethylpyridine	8	FR57-EF-D	1.0E-04	0.50	0.020%	YES		0.0543%
53	2,4-Dimethylpyridine	10	FR57-EF-E	1.1E-04	0.50	0.021%	YES		0.0543%
53	2,4-Dimethylpyridine	12	FR57-EF-F	9.8E-05	0.50	0.020%	YES		0.0543%
53	2,4-Dimethylpyridine	14	FR57-EF-G	1.1E-04	0.50	0.022%	YES		0.0543%
53	2,4-Dimethylpyridine	16	FR57-EF-H	1.1E-04	0.50	0.023%	YES		0.0543%
Data below is obtained through secondary analysis methods									
16	Butanal/Butyraldehyde	2	TL-IN-A	3.2E-03	25	0.013%			0.00297%
16	Butanal/Butyraldehyde	4	TL-IN-B	2.5E-03	25	0.010%			0.00297%
16	Butanal/Butyraldehyde	6	TL-IN-C	3.2E-03	25	0.013%			0.00297%
16	Butanal/Butyraldehyde	8	TL-IN-D	4.0E-03	25	0.016%			0.00297%
16	Butanal/Butyraldehyde	10	TL-IN-E	3.9E-03	25	0.016%			0.00297%
16	Butanal/Butyraldehyde	12	TL-IN-F	3.8E-03	25	0.015%			0.00297%
16	Butanal/Butyraldehyde	14	TL-IN-G	3.8E-03	25	0.015%			0.00297%
16	Butanal/Butyraldehyde	16	TL-IN-H	3.7E-03	25	0.015%			0.00297%
16	Butanal/Butyraldehyde	2	TL-EF-A	7.0E-04	25	0.003%	YES		0.00297%
16	Butanal/Butyraldehyde	4	TL-EF-B	7.4E-04	25	0.003%	YES		0.00297%
16	Butanal/Butyraldehyde	6	TL-EF-C	7.0E-04	25	0.003%	YES		0.00297%
16	Butanal/Butyraldehyde	8	TL-EF-D	6.6E-04	25	0.003%	YES		0.00297%
16	Butanal/Butyraldehyde	10	TL-EF-E	7.0E-04	25	0.003%	YES		0.00297%
16	Butanal/Butyraldehyde	12	TL-EF-F	7.0E-04	25	0.003%	YES		0.00297%
16	Butanal/Butyraldehyde	14	TL-EF-G	6.9E-04	25	0.003%	YES		0.00297%
16	Butanal/Butyraldehyde	16	TL-EF-H	7.0E-04	25	0.003%	YES		0.00297%
16	Butanal/Butyraldehyde	2	FR57-IN-A	2.8E-03	25	0.011%			0.00297%

Table D.2. PAPR Cartridge Testing 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	4	FR57-IN-B	3.7E-03	25	0.015%			0.00297%
16	Butanal/Butyraldehyde	6	FR57-IN-C	3.3E-03	25	0.013%			0.00297%
16	Butanal/Butyraldehyde	8	FR57-IN-D	3.6E-03	25	0.015%			0.00297%
16	Butanal/Butyraldehyde	10	FR57-IN-E	3.8E-03	25	0.015%			0.00297%
16	Butanal/Butyraldehyde	12	FR57-IN-F	4.0E-03	25	0.016%			0.00297%
16	Butanal/Butyraldehyde	14	FR57-IN-G	3.9E-03	25	0.015%			0.00297%
16	Butanal/Butyraldehyde	16	FR57-IN-H	4.1E-03	25	0.016%			0.00297%
16	Butanal/Butyraldehyde	2	FR57-EF-A	5.7E-04	25	0.002%	YES		0.00297%
16	Butanal/Butyraldehyde	4	FR57-EF-B	6.9E-04	25	0.003%	YES		0.00297%
16	Butanal/Butyraldehyde	6	FR57-EF-C	7.0E-04	25	0.003%	YES		0.00297%
16	Butanal/Butyraldehyde	8	FR57-EF-D	7.0E-04	25	0.003%	YES		0.00297%
16	Butanal/Butyraldehyde	10	FR57-EF-E	7.0E-04	25	0.003%	YES		0.00297%
16	Butanal/Butyraldehyde	12	FR57-EF-F	6.7E-04	25	0.003%	YES		0.00297%
16	Butanal/Butyraldehyde	14	FR57-EF-G	6.9E-04	25	0.003%	YES		0.00297%
16	Butanal/Butyraldehyde	16	FR57-EF-H	6.8E-04	25	0.003%	YES		0.00297%
20	Furan	2	TL-IN-A	2.2E-05	0.001	2.24%	YES	U	4.94%
20	Furan	4	TL-IN-B	2.2E-05	0.001	2.20%	YES	U	4.94%
20	Furan	6	TL-IN-C	2.3E-05	0.001	2.26%	YES	U	4.94%
20	Furan	8	TL-IN-D	2.3E-05	0.001	2.32%	YES	U	4.94%
20	Furan	10	TL-IN-E	2.4E-05	0.001	2.37%	YES	U	4.94%
20	Furan	12	TL-IN-F	2.4E-05	0.001	2.38%	YES	U	4.94%
20	Furan	14	TL-IN-G	2.4E-05	0.001	2.35%	YES	U	4.94%
20	Furan	16	TL-IN-H	2.4E-05	0.001	2.41%	YES	U	4.94%
20	Furan	2	TL-EF-A	2.2E-05	0.001	2.24%	YES	U	4.94%
20	Furan	4	TL-EF-B	2.5E-05	0.001	2.52%	YES	U	4.94%
20	Furan	6	TL-EF-C	2.3E-05	0.001	2.28%	YES	U	4.94%
20	Furan	8	TL-EF-D	2.4E-05	0.001	2.37%	YES	U	4.94%
20	Furan	10	TL-EF-E	2.3E-05	0.001	2.28%	YES	U	4.94%
20	Furan	12	TL-EF-F	2.2E-05	0.001	2.24%	YES	U	4.94%
20	Furan	14	TL-EF-G	2.2E-05	0.001	2.20%	YES	U	4.94%
20	Furan	16	TL-EF-H	2.2E-05	0.001	2.19%	YES	U	4.94%
20	Furan	2	FR57-IN-A	3.8E-05	0.001	3.79%	YES	U	4.94%
20	Furan	4	FR57-IN-B	4.6E-05	0.001	4.63%	YES	U	4.94%
20	Furan	6	FR57-IN-C	4.9E-05	0.001	4.88%	YES	U	4.94%
20	Furan	8	FR57-IN-D	4.9E-05	0.001	4.94%	YES	U	4.94%
20	Furan	10	FR57-IN-E	4.8E-05	0.001	4.79%	YES	U	4.94%
20	Furan	12	FR57-IN-F	4.6E-05	0.001	4.58%	YES	U	4.94%
20	Furan	14	FR57-IN-G	4.6E-05	0.001	4.55%	YES	U	4.94%
20	Furan	16	FR57-IN-H	4.6E-05	0.001	4.62%	YES	U	4.94%
20	Furan	2	FR57-EF-A	3.7E-05	0.001	3.69%	YES	U	4.94%
20	Furan	4	FR57-EF-B	4.5E-05	0.001	4.53%	YES	U	4.94%
20	Furan	6	FR57-EF-C	4.8E-05	0.001	4.77%	YES	U	4.94%
20	Furan	8	FR57-EF-D	4.8E-05	0.001	4.81%	YES	U	4.94%
20	Furan	10	FR57-EF-E	4.8E-05	0.001	4.76%	YES	U	4.94%
20	Furan	12	FR57-EF-F	4.6E-05	0.001	4.63%	YES	U	4.94%
20	Furan	14	FR57-EF-G	4.6E-05	0.001	4.61%	YES	U	4.94%
20	Furan	16	FR57-EF-H	4.6E-05	0.001	4.64%	YES	U	4.94%
22	2,5-Dihydrofuran	2	TL-IN-A	1.8E-05	0.001	1.84%	YES	U	4.03%
22	2,5-Dihydrofuran	4	TL-IN-B	1.8E-05	0.001	1.81%	YES	U	4.03%
22	2,5-Dihydrofuran	6	TL-IN-C	1.9E-05	0.001	1.86%	YES	U	4.03%
22	2,5-Dihydrofuran	8	TL-IN-D	1.9E-05	0.001	1.91%	YES	U	4.03%
22	2,5-Dihydrofuran	10	TL-IN-E	1.9E-05	0.001	1.94%	YES	U	4.03%
22	2,5-Dihydrofuran	12	TL-IN-F	2.0E-05	0.001	1.96%	YES	U	4.03%
22	2,5-Dihydrofuran	14	TL-IN-G	1.9E-05	0.001	1.93%	YES	U	4.03%
22	2,5-Dihydrofuran	16	TL-IN-H	2.0E-05	0.001	1.98%	YES	U	4.03%
22	2,5-Dihydrofuran	2	TL-EF-A	1.8E-05	0.001	1.84%	YES	U	4.03%
22	2,5-Dihydrofuran	4	TL-EF-B	2.1E-05	0.001	2.07%	YES	U	4.03%
22	2,5-Dihydrofuran	6	TL-EF-C	1.9E-05	0.001	1.87%	YES	U	4.03%
22	2,5-Dihydrofuran	8	TL-EF-D	2.0E-05	0.001	1.95%	YES	U	4.03%
22	2,5-Dihydrofuran	10	TL-EF-E	1.9E-05	0.001	1.88%	YES	U	4.03%

Table D.2. PAPR Cartridge Testing 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	12	TL-EF-F	1.8E-05	0.001	1.84%	YES	U	4.03%
22	2,5-Dihydrofuran	14	TL-EF-G	1.8E-05	0.001	1.81%	YES	U	4.03%
22	2,5-Dihydrofuran	16	TL-EF-H	1.8E-05	0.001	1.80%	YES	U	4.03%
22	2,5-Dihydrofuran	2	FR57-IN-A	3.1E-05	0.001	3.10%	YES	U	4.03%
22	2,5-Dihydrofuran	4	FR57-IN-B	3.8E-05	0.001	3.78%	YES	U	4.03%
22	2,5-Dihydrofuran	6	FR57-IN-C	4.0E-05	0.001	3.99%	YES	U	4.03%
22	2,5-Dihydrofuran	8	FR57-IN-D	4.0E-05	0.001	4.03%	YES	U	4.03%
22	2,5-Dihydrofuran	10	FR57-IN-E	3.9E-05	0.001	3.92%	YES	U	4.03%
22	2,5-Dihydrofuran	12	FR57-IN-F	3.7E-05	0.001	3.75%	YES	U	4.03%
22	2,5-Dihydrofuran	14	FR57-IN-G	3.7E-05	0.001	3.72%	YES	U	4.03%
22	2,5-Dihydrofuran	16	FR57-IN-H	3.8E-05	0.001	3.78%	YES	U	4.03%
22	2,5-Dihydrofuran	2	FR57-EF-A	3.0E-05	0.001	3.02%	YES	U	4.03%
22	2,5-Dihydrofuran	4	FR57-EF-B	3.7E-05	0.001	3.71%	YES	U	4.03%
22	2,5-Dihydrofuran	6	FR57-EF-C	3.9E-05	0.001	3.90%	YES	U	4.03%
22	2,5-Dihydrofuran	8	FR57-EF-D	3.9E-05	0.001	3.93%	YES	U	4.03%
22	2,5-Dihydrofuran	10	FR57-EF-E	3.9E-05	0.001	3.89%	YES	U	4.03%
22	2,5-Dihydrofuran	12	FR57-EF-F	3.8E-05	0.001	3.78%	YES	U	4.03%
22	2,5-Dihydrofuran	14	FR57-EF-G	3.8E-05	0.001	3.77%	YES	U	4.03%
22	2,5-Dihydrofuran	16	FR57-EF-H	3.8E-05	0.001	3.79%	YES	U	4.03%
23	2-Methylfuran	2	TL-IN-A	2.0E-05	0.001	2.00%	YES	U	2.75%
23	2-Methylfuran	4	TL-IN-B	2.0E-05	0.001	1.96%	YES	U	2.75%
23	2-Methylfuran	6	TL-IN-C	2.0E-05	0.001	2.02%	YES	U	2.75%
23	2-Methylfuran	8	TL-IN-D	2.1E-05	0.001	2.07%	YES	U	2.75%
23	2-Methylfuran	10	TL-IN-E	2.1E-05	0.001	2.11%	YES	U	2.75%
23	2-Methylfuran	12	TL-IN-F	2.1E-05	0.001	2.13%	YES	U	2.75%
23	2-Methylfuran	14	TL-IN-G	2.1E-05	0.001	2.10%	YES	U	2.75%
23	2-Methylfuran	16	TL-IN-H	2.1E-05	0.001	2.15%	YES	U	2.75%
23	2-Methylfuran	2	TL-EF-A	2.0E-05	0.001	2.00%	YES	U	2.75%
23	2-Methylfuran	4	TL-EF-B	2.2E-05	0.001	2.25%	YES	U	2.75%
23	2-Methylfuran	6	TL-EF-C	2.0E-05	0.001	2.04%	YES	U	2.75%
23	2-Methylfuran	8	TL-EF-D	2.1E-05	0.001	2.12%	YES	U	2.75%
23	2-Methylfuran	10	TL-EF-E	2.0E-05	0.001	2.04%	YES	U	2.75%
23	2-Methylfuran	12	TL-EF-F	2.0E-05	0.001	2.00%	YES	U	2.75%
23	2-Methylfuran	14	TL-EF-G	2.0E-05	0.001	1.97%	YES	U	2.75%
23	2-Methylfuran	16	TL-EF-H	2.0E-05	0.001	1.96%	YES	U	2.75%
23	2-Methylfuran	2	FR57-IN-A	2.1E-05	0.001	2.11%	YES	U	2.75%
23	2-Methylfuran	4	FR57-IN-B	2.6E-05	0.001	2.57%	YES	U	2.75%
23	2-Methylfuran	6	FR57-IN-C	2.7E-05	0.001	2.71%	YES	U	2.75%
23	2-Methylfuran	8	FR57-IN-D	2.7E-05	0.001	2.75%	YES	U	2.75%
23	2-Methylfuran	10	FR57-IN-E	2.7E-05	0.001	2.67%	YES	U	2.75%
23	2-Methylfuran	12	FR57-IN-F	2.5E-05	0.001	2.55%	YES	U	2.75%
23	2-Methylfuran	14	FR57-IN-G	2.5E-05	0.001	2.53%	YES	U	2.75%
23	2-Methylfuran	16	FR57-IN-H	2.6E-05	0.001	2.57%	YES	U	2.75%
23	2-Methylfuran	2	FR57-EF-A	2.1E-05	0.001	2.05%	YES	U	2.75%
23	2-Methylfuran	4	FR57-EF-B	2.5E-05	0.001	2.52%	YES	U	2.75%
23	2-Methylfuran	6	FR57-EF-C	2.7E-05	0.001	2.65%	YES	U	2.75%
23	2-Methylfuran	8	FR57-EF-D	2.7E-05	0.001	2.67%	YES	U	2.75%
23	2-Methylfuran	10	FR57-EF-E	2.6E-05	0.001	2.65%	YES	U	2.75%
23	2-Methylfuran	12	FR57-EF-F	2.6E-05	0.001	2.57%	YES	U	2.75%
23	2-Methylfuran	14	FR57-EF-G	2.6E-05	0.001	2.57%	YES	U	2.75%
23	2-Methylfuran	16	FR57-EF-H	2.6E-05	0.001	2.58%	YES	U	2.75%
35	Acetonitrile	2	TL-IN-A	4.5E-01	20	2.23%	YES		2.60%
35	Acetonitrile	4	TL-IN-B	5.2E-01	20	2.60%	YES		2.60%
35	Acetonitrile	6	TL-IN-C	4.9E-01	20	2.45%	YES		2.60%
35	Acetonitrile	8	TL-IN-D	5.1E-01	20	2.53%	YES		2.60%
35	Acetonitrile	10	TL-IN-E	5.0E-01	20	2.51%	YES		2.60%
35	Acetonitrile	12	TL-IN-F	4.9E-01	20	2.45%	YES		2.60%
35	Acetonitrile	14	TL-IN-G	4.8E-01	20	2.41%	YES		2.60%
35	Acetonitrile	16	TL-IN-H	4.8E-01	20	2.42%	YES		2.60%
35	Acetonitrile	2	TL-EF-A	4.7E-01	20	2.36%	YES		2.60%

Table D.2. PAPR Cartridge Testing 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	4	TL-EF-B	5.1E-01	20	2.56%	YES		2.60%
35	Acetonitrile	6	TL-EF-C	4.8E-01	20	2.40%	YES		2.60%
35	Acetonitrile	8	TL-EF-D	5.1E-01	20	2.57%	YES		2.60%
35	Acetonitrile	10	TL-EF-E	4.8E-01	20	2.38%	YES		2.60%
35	Acetonitrile	12	TL-EF-F	5.0E-01	20	2.50%	YES		2.60%
35	Acetonitrile	14	TL-EF-G	5.0E-01	20	2.49%	YES		2.60%
35	Acetonitrile	16	TL-EF-H	5.1E-01	20	2.54%	YES		2.60%
35	Acetonitrile	2	FR57-IN-A	4.1E-01	20	2.03%	YES		2.60%
35	Acetonitrile	4	FR57-IN-B	4.8E-01	20	2.41%	YES		2.60%
35	Acetonitrile	6	FR57-IN-C	4.8E-01	20	2.39%	YES		2.60%
35	Acetonitrile	8	FR57-IN-D	4.9E-01	20	2.43%	YES		2.60%
35	Acetonitrile	10	FR57-IN-E	4.8E-01	20	2.40%	YES		2.60%
35	Acetonitrile	12	FR57-IN-F	4.7E-01	20	2.36%	YES		2.60%
35	Acetonitrile	14	FR57-IN-G	4.7E-01	20	2.36%	YES		2.60%
35	Acetonitrile	16	FR57-IN-H	4.7E-01	20	2.36%	YES		2.60%
35	Acetonitrile	2	FR57-EF-A	4.2E-01	20	2.11%	YES		2.60%
35	Acetonitrile	4	FR57-EF-B	4.9E-01	20	2.43%	YES		2.60%
35	Acetonitrile	6	FR57-EF-C	4.9E-01	20	2.45%	YES		2.60%
35	Acetonitrile	8	FR57-EF-D	5.0E-01	20	2.48%	YES		2.60%
35	Acetonitrile	10	FR57-EF-E	5.0E-01	20	2.48%	YES		2.60%
35	Acetonitrile	12	FR57-EF-F	5.0E-01	20	2.49%	YES		2.60%
35	Acetonitrile	14	FR57-EF-G	5.0E-01	20	2.49%	YES		2.60%
35	Acetonitrile	16	FR57-EF-H	4.8E-01	20	2.41%	YES		2.60%
52	Pyridine	2	TL-IN-A	1.3E-03	1.0	0.130%	YES		0.134%
52	Pyridine	4	TL-IN-B	1.2E-03	1.0	0.125%	YES		0.134%
52	Pyridine	6	TL-IN-C	1.3E-03	1.0	0.128%	YES		0.134%
52	Pyridine	8	TL-IN-D	1.3E-03	1.0	0.128%	YES		0.134%
52	Pyridine	10	TL-IN-E	1.3E-03	1.0	0.128%	YES		0.134%
52	Pyridine	12	TL-IN-F	1.3E-03	1.0	0.134%	YES		0.134%
52	Pyridine	14	TL-IN-G	1.2E-03	1.0	0.121%	YES		0.134%
52	Pyridine	16	TL-IN-H	1.3E-03	1.0	0.132%	YES		0.134%
52	Pyridine	2	TL-EF-A	1.2E-03	1.0	0.125%	YES		0.134%
52	Pyridine	4	TL-EF-B	1.3E-03	1.0	0.133%	YES		0.134%
52	Pyridine	6	TL-EF-C	1.3E-03	1.0	0.126%	YES		0.134%
52	Pyridine	8	TL-EF-D	1.2E-03	1.0	0.123%	YES		0.134%
52	Pyridine	10	TL-EF-E	1.2E-03	1.0	0.123%	YES		0.134%
52	Pyridine	12	TL-EF-F	1.2E-03	1.0	0.124%	YES		0.134%
52	Pyridine	14	TL-EF-G	1.2E-03	1.0	0.124%	YES		0.134%
52	Pyridine	16	TL-EF-H	1.2E-03	1.0	0.122%	YES		0.134%
52	Pyridine	2	FR57-IN-A	9.5E-04	1.0	0.095%	YES		0.134%
52	Pyridine	4	FR57-IN-B	1.2E-03	1.0	0.118%	YES		0.134%
52	Pyridine	6	FR57-IN-C	1.1E-03	1.0	0.114%	YES		0.134%
52	Pyridine	8	FR57-IN-D	1.2E-03	1.0	0.116%	YES		0.134%
52	Pyridine	10	FR57-IN-E	1.2E-03	1.0	0.120%	YES		0.134%
52	Pyridine	12	FR57-IN-F	1.2E-03	1.0	0.120%	YES		0.134%
52	Pyridine	14	FR57-IN-G	1.2E-03	1.0	0.119%	YES		0.134%
52	Pyridine	16	FR57-IN-H	1.2E-03	1.0	0.124%	YES		0.134%
52	Pyridine	2	FR57-EF-A	1.2E-03	1.0	0.119%	YES		0.134%
52	Pyridine	4	FR57-EF-B	1.2E-03	1.0	0.123%	YES		0.134%
52	Pyridine	6	FR57-EF-C	1.2E-03	1.0	0.123%	YES		0.134%
52	Pyridine	8	FR57-EF-D	1.2E-03	1.0	0.125%	YES		0.134%
52	Pyridine	10	FR57-EF-E	1.3E-03	1.0	0.132%	YES		0.134%
52	Pyridine	12	FR57-EF-F	1.3E-03	1.0	0.126%	YES		0.134%
52	Pyridine	14	FR57-EF-G	1.3E-03	1.0	0.126%	YES		0.134%
52	Pyridine	16	FR57-EF-H	1.3E-03	1.0	0.127%	YES		0.134%
53	2,4-Dimethylpyridine	2	TL-IN-A	9.6E-04	0.50	0.193%	YES		0.197%
53	2,4-Dimethylpyridine	4	TL-IN-B	9.2E-04	0.50	0.184%	YES		0.197%
53	2,4-Dimethylpyridine	6	TL-IN-C	9.4E-04	0.50	0.189%	YES		0.197%
53	2,4-Dimethylpyridine	8	TL-IN-D	9.5E-04	0.50	0.189%	YES		0.197%
53	2,4-Dimethylpyridine	10	TL-IN-E	9.4E-04	0.50	0.188%	YES		0.197%

Table D.2. PAPR Cartridge Testing 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	12	TL-IN-F	9.9E-04	0.50	0.197%	YES		0.197%
53	2,4-Dimethylpyridine	14	TL-IN-G	8.9E-04	0.50	0.178%	YES		0.197%
53	2,4-Dimethylpyridine	16	TL-IN-H	9.8E-04	0.50	0.195%	YES		0.197%
53	2,4-Dimethylpyridine	2	TL-EF-A	9.2E-04	0.50	0.184%	YES		0.197%
53	2,4-Dimethylpyridine	4	TL-EF-B	9.8E-04	0.50	0.197%	YES		0.197%
53	2,4-Dimethylpyridine	6	TL-EF-C	9.3E-04	0.50	0.186%	YES		0.197%
53	2,4-Dimethylpyridine	8	TL-EF-D	9.1E-04	0.50	0.181%	YES		0.197%
53	2,4-Dimethylpyridine	10	TL-EF-E	9.1E-04	0.50	0.182%	YES		0.197%
53	2,4-Dimethylpyridine	12	TL-EF-F	9.2E-04	0.50	0.183%	YES		0.197%
53	2,4-Dimethylpyridine	14	TL-EF-G	9.2E-04	0.50	0.183%	YES		0.197%
53	2,4-Dimethylpyridine	16	TL-EF-H	9.0E-04	0.50	0.180%	YES		0.197%
53	2,4-Dimethylpyridine	2	FR57-IN-A	7.0E-04	0.50	0.140%	YES		0.197%
53	2,4-Dimethylpyridine	4	FR57-IN-B	8.7E-04	0.50	0.174%	YES		0.197%
53	2,4-Dimethylpyridine	6	FR57-IN-C	8.4E-04	0.50	0.168%	YES		0.197%
53	2,4-Dimethylpyridine	8	FR57-IN-D	8.6E-04	0.50	0.171%	YES		0.197%
53	2,4-Dimethylpyridine	10	FR57-IN-E	8.8E-04	0.50	0.177%	YES		0.197%
53	2,4-Dimethylpyridine	12	FR57-IN-F	8.9E-04	0.50	0.177%	YES		0.197%
53	2,4-Dimethylpyridine	14	FR57-IN-G	8.8E-04	0.50	0.175%	YES		0.197%
53	2,4-Dimethylpyridine	16	FR57-IN-H	9.2E-04	0.50	0.183%	YES		0.197%
53	2,4-Dimethylpyridine	2	FR57-EF-A	8.8E-04	0.50	0.176%	YES		0.197%
53	2,4-Dimethylpyridine	4	FR57-EF-B	9.1E-04	0.50	0.181%	YES		0.197%
53	2,4-Dimethylpyridine	6	FR57-EF-C	9.1E-04	0.50	0.182%	YES		0.197%
53	2,4-Dimethylpyridine	8	FR57-EF-D	9.2E-04	0.50	0.184%	YES		0.197%
53	2,4-Dimethylpyridine	10	FR57-EF-E	9.7E-04	0.50	0.195%	YES		0.197%
53	2,4-Dimethylpyridine	12	FR57-EF-F	9.3E-04	0.50	0.186%	YES		0.197%
53	2,4-Dimethylpyridine	14	FR57-EF-G	9.3E-04	0.50	0.186%	YES		0.197%
53	2,4-Dimethylpyridine	16	FR57-EF-H	9.3E-04	0.50	0.187%	YES		0.197%

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

1,3-Butadiene *(see Figure E.1)* – The reporting limit (RL) for 1,3-Butadiene corresponds to 2.0% of its Occupational Exposure Limit (OEL). All measured inlet concentrations for the SCOTT 7422-SD1 cartridge were less than the RL except for the 8-hour measurement, which was 6.6% of the OEL. All measured outlet concentrations for the same cartridge were less than the RL, except for the 14-hour measurement, which was 6.4 % of the OEL. Because one inlet and one outlet measurement exceeded the RL at different times, and outlet concentrations returned to less than the RL after the single above-report measurement, no clear trend of breakthrough could be determined. All measured inlet and outlet concentrations for the SCOTT 7422-SC1 cartridge were less than the RL. Based on the data for both cartridges no clear evidence of breakthrough was observed over the measured time period for either cartridge tested.

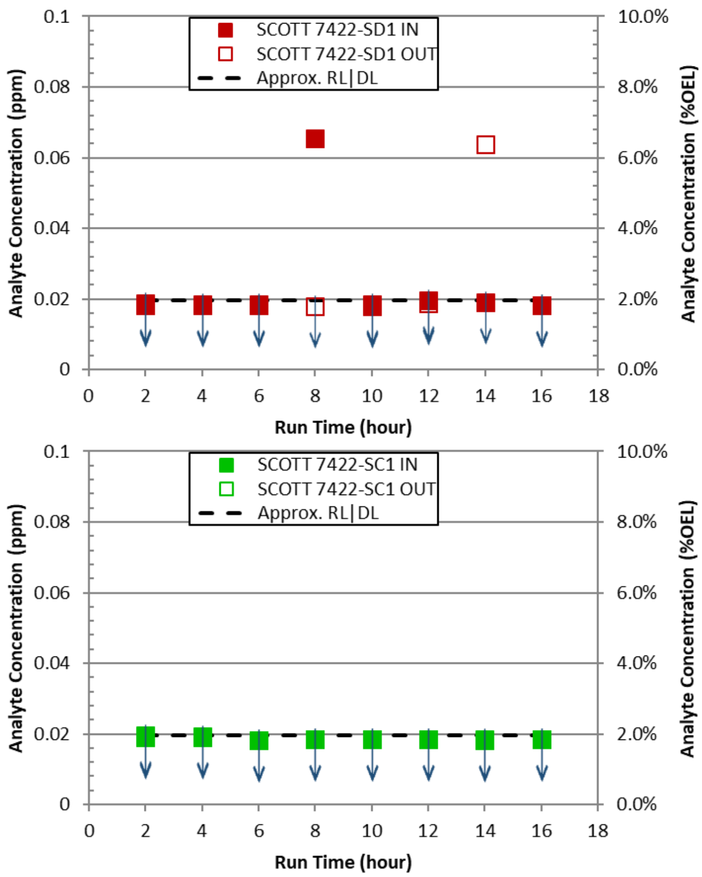


Figure E.1. Plots of Measured 1,3-Butadiene Concentrations for the Two APR Cartridges Tested (SCOTT 7422-SD1 and SCOTT 7422-SC1). Data points noted with ↓ indicate measurements less than the DL or RL. Outlet data points not visible are obscured by the inlet data points.

Formaldehyde *(see Figure E.2)* – The detection limit (DL) for formaldehyde corresponds to 0.6% of its OEL. For the SCOTT 7422-SD1 cartridge, several inlet and outlet measurements exceeded the DL but were <1% of the OEL. For the SCOTT 7422-SC1 cartridge, the outlet measurements for the last three measurements consistently were >1% of the OEL, which could suggest early breakthrough. However, because none of the corresponding inlet concentrations were as high as the last three outlet concentrations, some source of contamination is suspected. None of the measured inlet or outlet values for either cartridge were >10% and were all specifically <2.7%, thus there is no clear evidence of breakthrough over the measured time period for either cartridge tested.

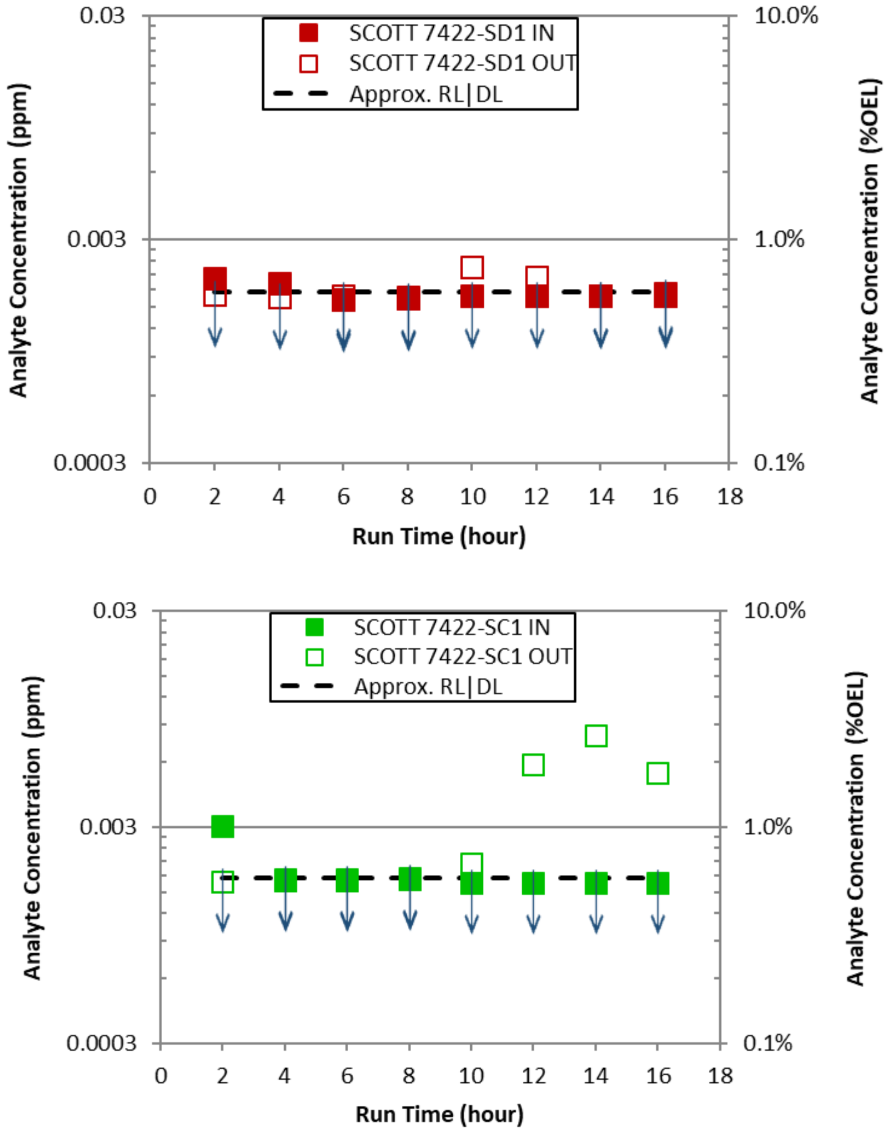


Figure E.2. Plots of Measured Formaldehyde Concentrations for the Two APR Cartridges Tested (SCOTT 7422-SD1 and SCOTT 7422-SC1). Data points noted with ↓ indicate measurements less than the DL or RL. Outlet data points not visible are obscured by the inlet data points.

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. 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, 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-methylfuran, 2,5-dimethylfuran, 2-pentylfuran, 2-heptyfuran, and 2-propylfuran 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.

N-nitrosodiethylamine – The RL for NDEA is 12.5% of the OEL, which is >2.0% of the OEL threshold for discussion in this appendix. All measured inlet and outlet concentrations of NDEA were less than the DL. Therefore, there is no evidence of breakthrough over the measured time period for either cartridge tested. No plot of the NDEA data is included here because all of the data points were less than the RL.

***N*-nitrosomorpholine** *(see Figure E.3)* – The DL for N-nitrosomorpholine is 1.8% of the OEL. For SCOTT 7422-SD1 cartridge, all of the inlet and outlet concentrations measured were less than the DL. For SCOTT 7422-SC1 cartridge, several of the initial inlet measurements were >2.0% of the OEL, reaching as high as 3.3% of the OEL. All of the outlet measurements for the SCOTT 7422-SC1 cartridge were below the analytical DL. Thus, there is no evidence of breakthrough over the measured time period for either cartridge tested.

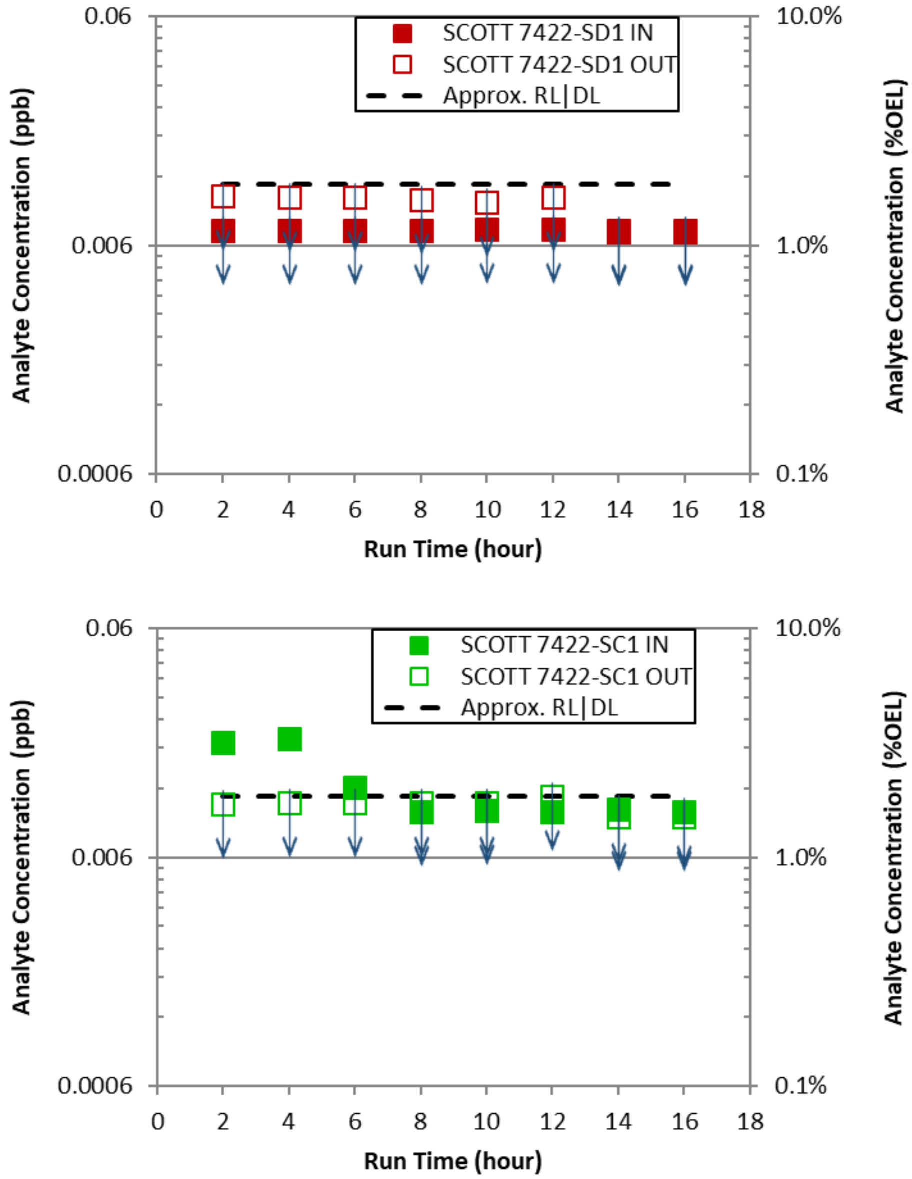


Figure E.3. Plots of Measured N-nitrosomorpholine Concentrations for the Two APR Cartridges Tested (SCOTT 7422-SD1 and SCOTT 7422-SC1). Data points noted with ↓ indicate measurements less than the DL or RL. Outlet data points not visible are obscured by the inlet data points.

E.2 PAPR Cartridge Testing on AP Exhauster

1,3-Butadiene *(see Figure E.4)* – The RL for 1,3-Butadiene corresponds to 2.0% of its OEL. The measured inlet concentrations for the MSA TL cartridge were less than the RL except for a measurement after 14 hours, which was at 3.5 % of the OEL. All of the corresponding outlet concentrations were less than the RL except for the 14-hour measurement, which was 2.4 % of the OEL. For the 3M FR-57 cartridge all of the measured inlet and outlet concentrations were less than the RL, except for the 12-hour measurement for the outlet which was at 2.1% of the OEL. The corresponding higher inlet and outlet concentrations from the MSA TL 14-hour sample could indicate limited impact from the cartridge. Nevertheless, based on the data from both cartridges there was no evidence of breakthrough over the measured time period.

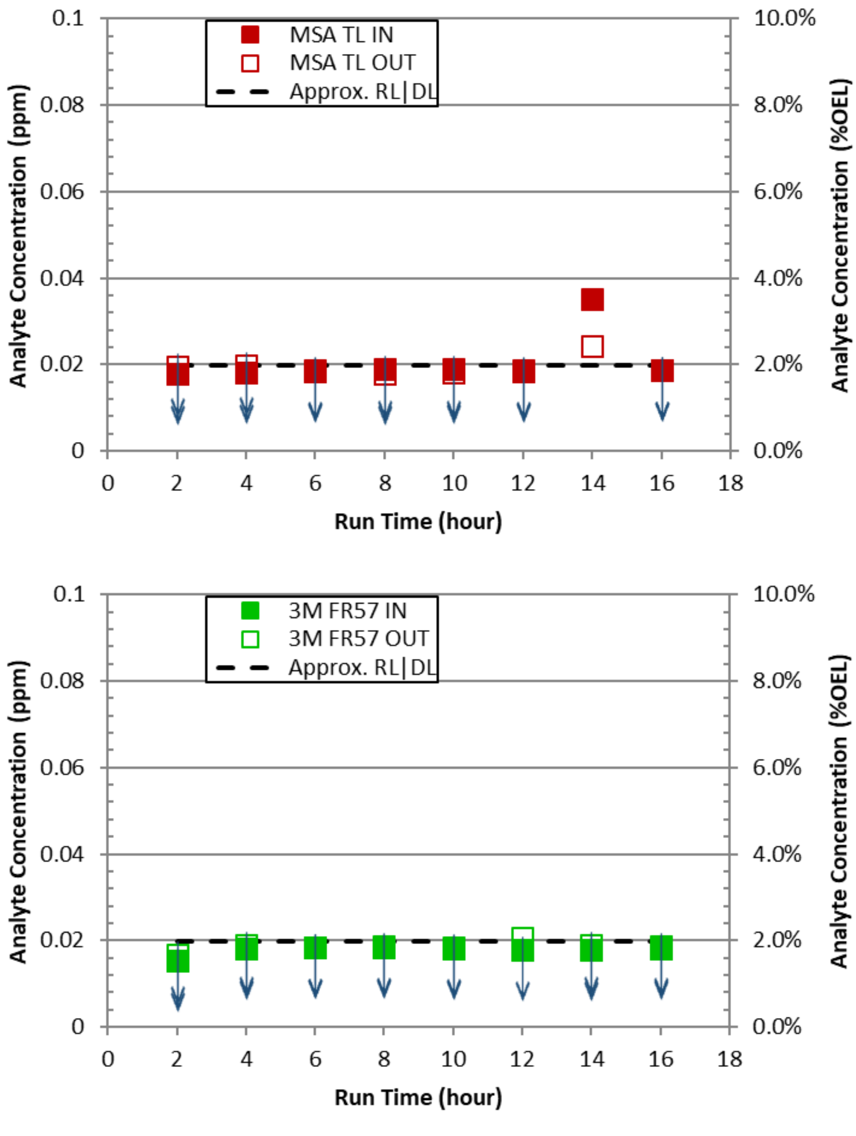


Figure E.4. Plots of Measured 1,3-Butadiene Concentrations for the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Data points noted with ↓ indicate measurements less than the DL or RL. Outlet data points not visible are obscured by the inlet data points.

Formaldehyde *(see Figure E.5)* – The DL for formaldehyde corresponds to approximately 0.6% of its OEL. For both the MSA TL and 3M FR-57 cartridges, the later inlet and outlet concentrations, after 10 hours, were higher than the DL, reaching a maximum of 3.6% of the OEL. Baseline inlet and outlet samples taken prior to cartridge testing with ambient air produced similar formaldehyde concentrations. This data could suggest limited influence from either cartridge on formaldehyde retention. However, because all of the measurements were <10% of the OEL, no evidence of breakthrough above 10% was observed for either cartridge.

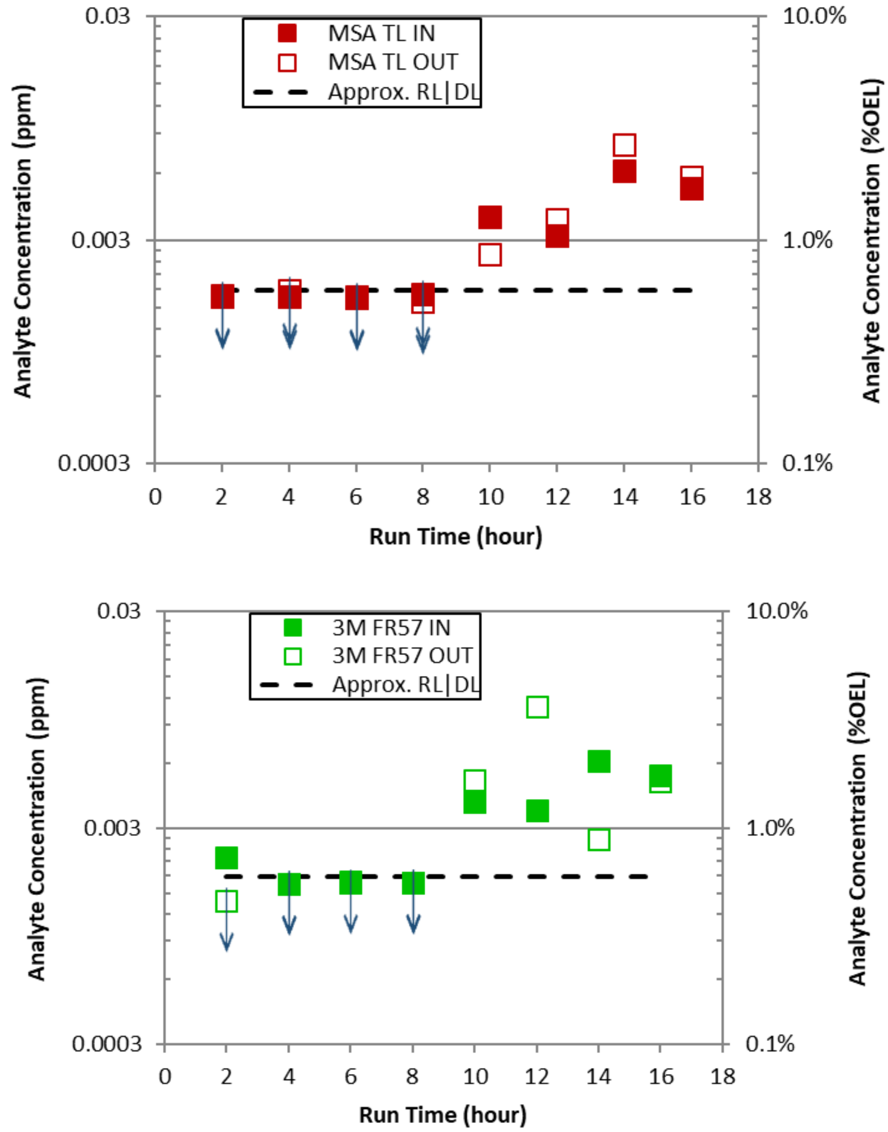


Figure E.5. Plot of Measured Formaldehyde Concentrations for the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Data points noted with ↓ indicate measurements less than the DL or RL. Outlet data points not visible are obscured by the inlet data points.

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. 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 DLs for all furan COPCs were >2% of the OEL, the threshold for discussion in this appendix. For both PAPR cartridges, all measured inlet and outlet concentrations of 2,3-dihydrofuran, 2,5-dimethylfuran, 2,5-dimethylfuran, 2-pentylfuran, 2-heptylfuran, and 2-proylfuran 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 the data points were less than the DLs and RLs.

2-Methylfuran *(see Figure E.6)* – The DL for 2-methylfuran corresponds to 11% of its OEL and the RL corresponds to 101%. All inlet and outlet measurements for MSA TL cartridge were less than the DL. All inlet measurements for 3M FR-57 cartridge were less than the DL, except for the first inlet measurement at 6.9% of the OEL. All outlet measurements for 3M FR-57 were less than the DL; therefore, there is no evidence of breakthrough over the measured time period for either cartridge tested.

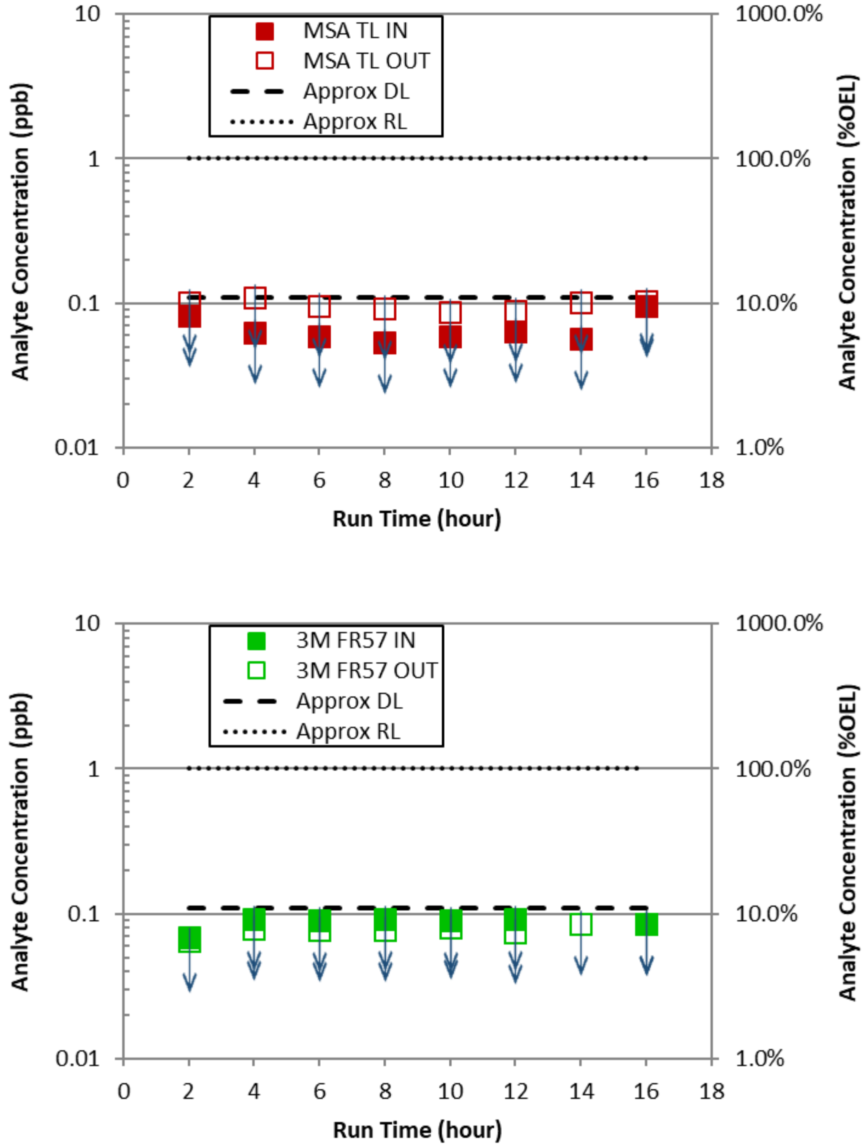


Figure E.6. Plot of Measured 2-Methylfuran Concentrations for the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Data points noted with ↓ indicate measurements less than the DL or RL. Outlet data points not visible are obscured by the inlet data points.

***2-Heptylfuran** (see Figure E.7)* – The DL for 2-heptylfuran corresponds to 2.9% of its OEL and the RL corresponds to 8.2%. All inlet and outlet measurements for MSA TL cartridge were less than the DL. All inlet and outlet measurements for 3M FR-57 cartridge were less than the DL, except for two outlet measurements (after 8 hours and 14 hours) reaching as high as 3.4 % of the OEL. Based on the data there is no evidence of breakthrough above 10% of the OEL over the measured time period for either cartridge tested.

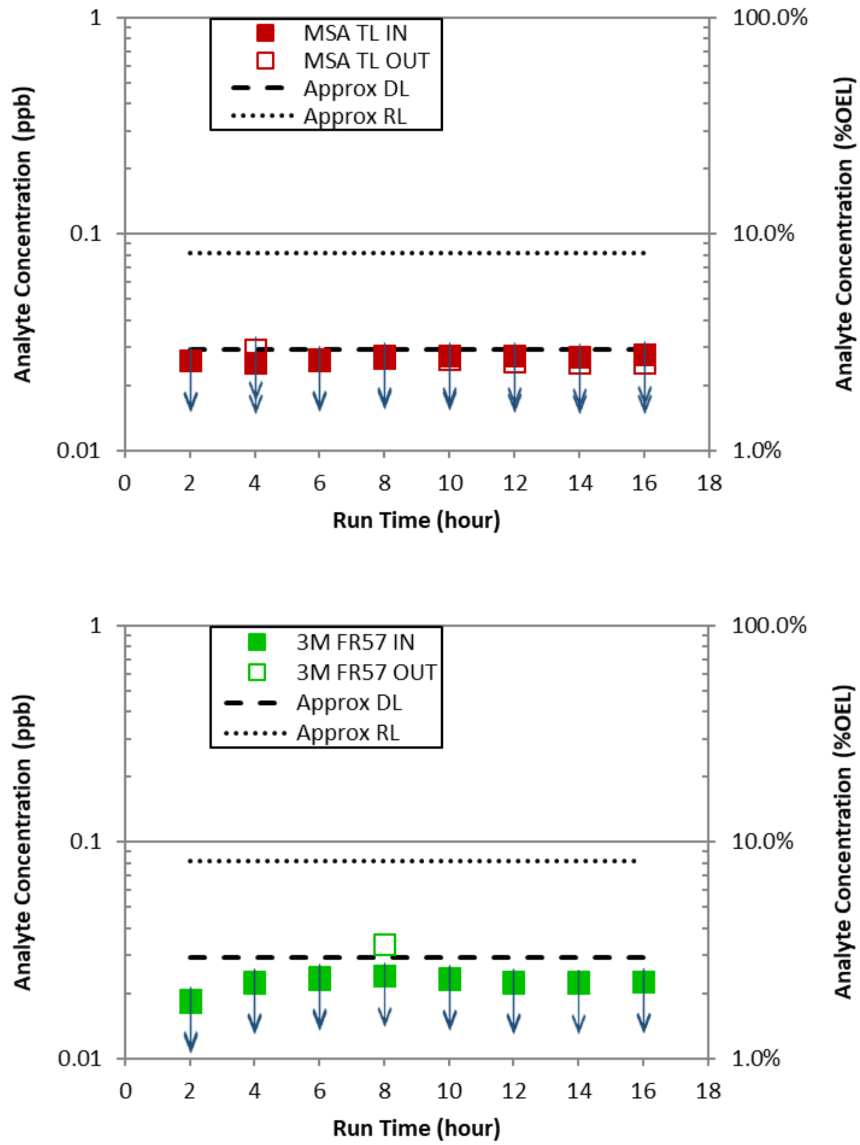
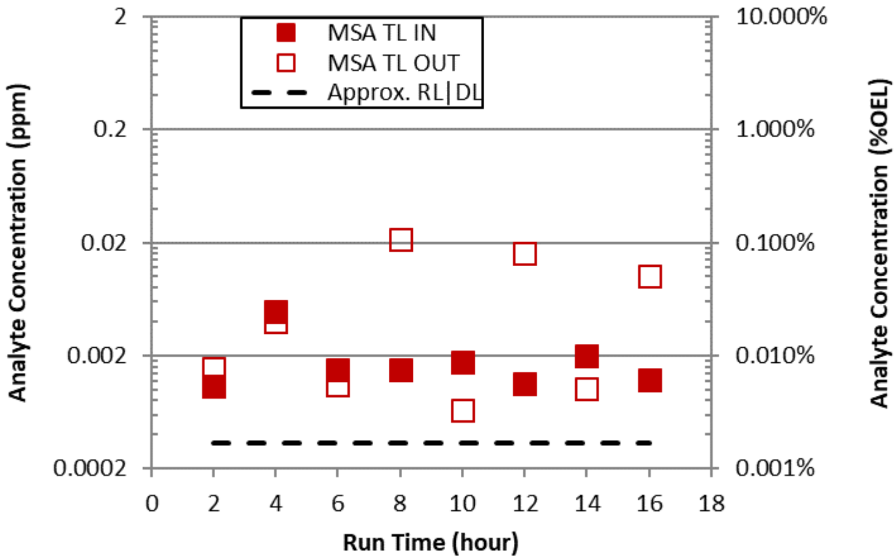


Figure E.7. Plot of Measured 2-Heptylfuran Concentrations for the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Data points noted with ↓ indicate measurements less than the DL or RL. Outlet data points not visible are obscured by the inlet data points.

Acetonitrile *(see Figure E.8)* – The DL for acetonitrile corresponds to 0.002% of its OEL. For both the MSA TL and 3M FR-57 cartridges, all of the outlet concentrations measured were higher than the DL but <4.3%. For both cartridges the maximum inlet concentrations were >2%, such that the corresponding outlet concentrations were higher than inlet concentrations. Analytical data for the two highest outlet measurements had quality flags that indicated the calibration range of the instrument had been exceeded. Based on the data, there is no evidence of breakthrough above 10% of the OEL over the measured time period for either cartridge tested.



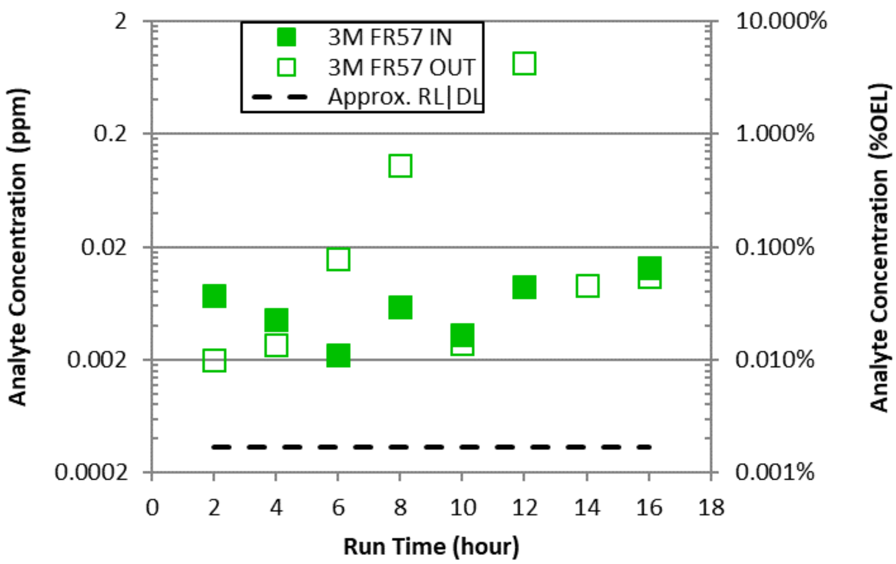
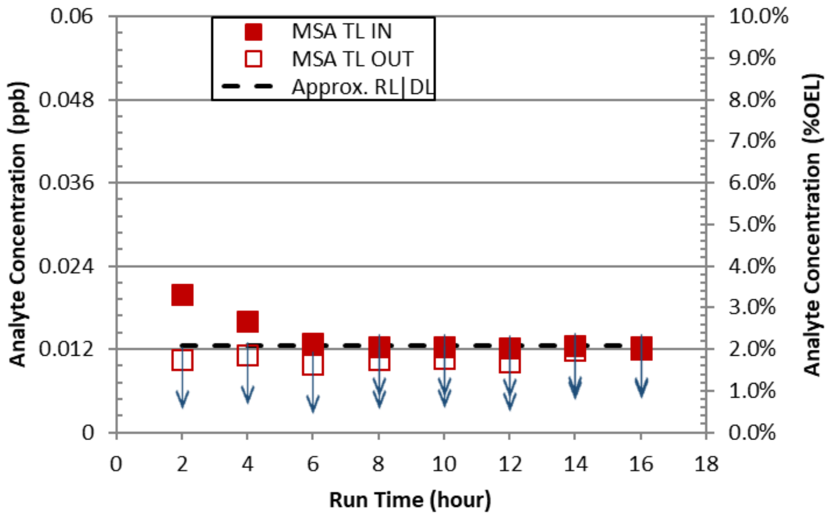


Figure E.8. Plot of Measured Acetonitrile Concentrations for the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Data points noted with ↓ indicate measurements less than the DL or RL. Outlet data points not visible are obscured by the inlet data points.

N-nitrosodiethylamine – The RL for NDEA is 13.2% of the OEL, which exceeds the 2.0% OEL threshold for discussion in this appendix. All measured inlet and outlet concentrations of NDEA were less than the RL. Therefore, there is no evidence of breakthrough over the measured time period for either cartridge tested. No plot of the NDEA data is included here because all of the data points were less than the RL.

N-nitrosomorpholine *(see Figure E.9)* – The DL for N-nitrosomorpholine is 2.1% of the OEL. For the MSA TL cartridge the initial inlet concentrations were greater than the DL, but specifically <3.3% of the OEL. All outlet measurements for the MSA TL cartridge were lower than the DL indicating no evidence of breakthrough over the measured period. All of the inlet and outlet measurements for the 3M FR-57 cartridge were below the analytical DL such that there was no evidence of breakthrough over the measured time period for that cartridge.



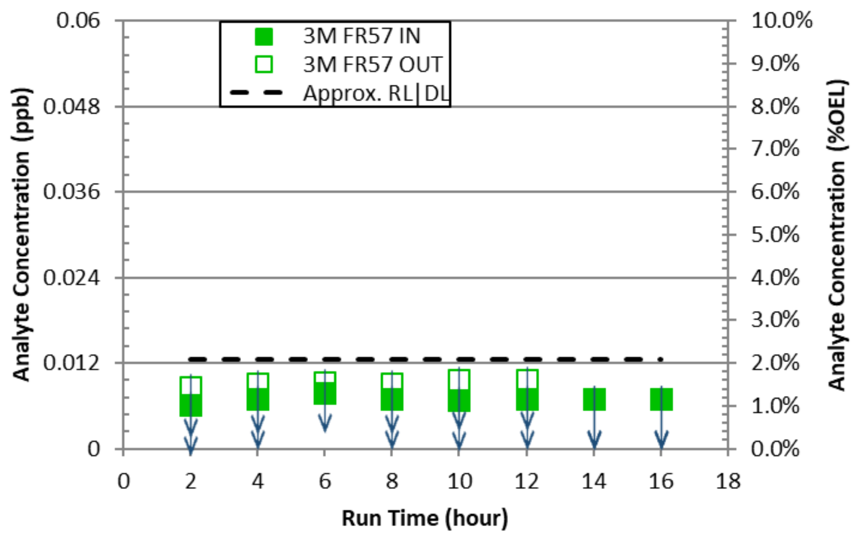


Figure E.9. Plot of Measured N-nitrosomorpholine Concentrations for the Two PAPR Cartridges Tested (MSA TL and 3M FR-57). Data points noted with ↓ indicate measurements less than the DL or RL. Outlet data points not visible are obscured by the inlet data points.

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 were obtained via a TWINS query on June 20, 2016, for TWINS HS,[19] and another query on May 9, 2018, for TWINS IH.[20,21] 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." However, the SWIHD HS dataset contained no data for any exhauster. In addition, the TWINS HS database contained exhauster data only from samples taken in 2000, which was before the AP exhauster upgrade that was completed September 8, 2016. Therefore, neither of these HS databases were used in the present study, which applies only to the AP exhauster data taken after September 8, 2016.

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 the 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.

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 IH data were eliminated from consideration as "bad" if they:

[19] 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.

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

[21] The last AP exhaust survey in the May 9, 2018, download of the TWINS IH database was dated December 21, 2017. Although later surveys might provide higher historical maxima, the AP exhauster data in the May 2018 download are expected to provide a sufficiently complete basis for comparison.

- 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 or q)
- 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)
- Were marked as qualitative (Data Qualifier flag Q).

Note that, unlike historical data, cartridge inlet concentration data were not necessarily eliminated from consideration if they had one of 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.

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 measurements that were below-reports—less than the reporting limit (RL) for the analyte were excluded in PNNL-26820 and were not excluded 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 AP exhauster, only stack, ventilation system, or exhauster measurements were considered appropriate. Therefore, the data were filtered to make sure the historical sampling location was similar to the cartridge test sampling location. AP Farm data whose survey titles indicated sampling from valve pits, motor housings, or other non-stack sources were excluded from this analysis.

F.2 Data Tabulation

Maximum and average[22] concentrations were found for each analyte for the TWINS IH database. These maxima and averages are given in Table F.1 and Table F.2,[(23)] together with Occupational Exposure Limits (OELs) and counts of the number of samples. The historical data for the two tables are the same; only the cartridge inlet data are different, with APR cartridge data in Table F.1 and PAPR cartridge data in Table F.2. The notation “n/a” is used where there were no measurements of the analyte.

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 where there was a maximum concentration that was singularly high, compared to all other measurements. These kinds of information are shown in Table F.1 and Table F.2 using the conventions described below.

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[22] Arithmetic average

[23] All % OEL values were calculated from concentration data that had been rounded to a minimum of 3 significant figures.

Each entry may be either a single value, or one value that is not in parentheses followed by another that is in parentheses. If there is a single value, it is based only on below-report data if it is preceded by “<”; 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 may help to clarify this tabulation convention.

- If the number of values is given as “46 (35),” there were 46 total data points, 35 above-reports and 11 below-reports (i.e., 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 like “<0.04 (0.01),” it means 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),” it means 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.

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 TWINS IH data 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.

Note that procedures already in place prevent air-purifying respirators 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 more protective equipment such as self-contained breathing apparatus or supplied air. Thus, maxima that come 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.

Waste transfers, waste 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.

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 suspected of reflecting the effects of 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 (post-2000).[24] These databases are related to Best Basis Inventory[25] 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 PAPR and APR cartridge testing in late March 2018, when there were no waste-disturbing activities, were compared to the maximum and average historical concentrations. Where differences were found, the historical data were examined for possible explanations in the type or circumstances of sampling (e.g., waste disturbance during historical sampling). The maximum cartridge inlet concentrations for the two types of APR cartridges (SC1 and SD1) and the two types of PAPR cartridges (MSA TL and 3M FR-57) are not discussed separately except when they are different enough to justify it; for example, when one falls below the significant-discrepancy limit of 20% of historical and the other does not. Otherwise, the inlet maximum over both cartridge types is used.

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. (2020), which discusses the difference between DLs and RLs for furans.

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 detection limit (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.

[24] 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.

[25] 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).

F.5 Comparison with AP Stack Historical Data Taken After September 2016 Exhauster Upgrade

The AP Farm contains six actively ventilated double-shell tanks, all of which are exhausted through the AP stack. Waste transfers involving these tanks are frequent, potentially leading to changes in the concentrations of COPCs in the wastes in the tanks and in the exhaust from the headspaces. However, there were no waste transfers or water additions in any AP tank during March 23–24, 2018, the date of the FY 2018 cartridge-testing campaign.[26]

As of September 8, 2016, after the AP cartridge-testing campaign that had been conducted during June 24–26, 2016, the AP exhauster was upgraded to change the active ventilation rate. Consequently it was necessary to compare the FY 2018 cartridge-testing inlet concentrations to data taken after the exhauster upgrade, omitting earlier stack samples. In addition, because of the exhauster change it is not appropriate to compare the FY 2018 AP cartridge-inlet concentrations to those measured during the FY 2016 cartridge-testing campaign.

F.5.1 Ammonia

The maximum cartridge inlet concentration was 102% of the OEL. The cartridge inlet maximum is low compared to the historical maximum concentration of 103 ppm (412% of the OEL). This historical measurement was made on January 26, 2017, about a month after the last preceding transfer of 6 kgal from AP-102 to AY-102 on December 31, 2016. The cartridge-inlet maximum falls between 20% and 50% of the historical maximum, but not below the 20% level that is considered to be significantly below historical.

F.5.2 Nitrous Oxide

Nitrous oxide was not measured in cartridge testing, nor was it measured at the AP exhauster after September 8, 2016.

F.5.3 Mercury

The maximum cartridge inlet concentration was 16.2% of the OEL. The historical maximum was a below-report TWINS IH measurement with an RL of 0.0125 mg/m^3 (50.0% OEL). The highest historical above-report measurement was 0.00791 mg/m^3 (31.6% OEL). The cartridge-inlet maximum was approximately 50% of the historical maximum but is not below the 20% level that is considered significantly below historical.

[26] Although there were no waste-disturbing operations during cartridge-test sampling, the previous week there had been a transfer of 17 kgal of supernatant liquid from AP-103 to AN-101 (March 17-18, 2018). Some residual elevation in headspace concentration might have remained, leading to increased concentration at the stack; on the other hand, the transfer was relatively small.

F.5.4 Furan

The maximum PAPR cartridge inlet concentration of 57.3% OEL, and the maximum APR cartridge inlet concentration of 104% OEL, both of which were measured by the Carbotrap 300 TDU method, are much lower than the maximum in the TWINS IH database, which is 7.15 ppb (715% of the OEL). This above-report concentration was measured on March 22, 2017, more than a month after the last preceding tank activity. Both the cartridge inlet APR and PAPR maximum concentrations are <20% of the more recent historical maximum. The cartridge inlet concentration is considered significantly less than historical.

F.5.5 2,3-Dihydrofuran, 2,5-Dihydrofuran, 2-Methylfuran, 2,5-Dimethylfuran, 2-Pentylfuran, 2-Propylfuran, 2-Heptylfuran

For all of the substituted furans, the cartridge-inlet maxima were below detection limits and the historical maxima were below the detection limits, with details as follow:

- 2,3-dihydrofuran: APR <3.28%, PAPR <8.19%, historical <73.2% (furans method)
- 2,5-dihydrofuran: APR <25.8%, PAPR <25.5%, historical <290% (Carbotrap 300 TDU method)
- 2-methylfuran: APR <10.3%, PAPR 6.93%[27], historical <247% (Carbotrap 300 TDU method)
- 2,5-dimethylfuran: APR <3.09%, PAPR <4.09%, historical <53.4% (furans method)
- 2-pentylfuran: APR <3.11%, PAPR <3.09%, historical <37.1% (furans method)
- 2-heptylfuran: APR <2.93%, PAPR <2.91%, historical <30.9% (furans method)
- 2-propylfuran: APR <1.85%, PAPR <2.98%, historical <46.6% (furans method).

The methods listed are for the historical data. 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.5.6 N-nitrosodimethylamine (NDMA)

The maximum PAPR and APR cartridge inlet concentrations of NDMA were 3130% and 2681% of the OEL, respectively. The historical maximum was 15.8 ppb (5267% OEL). It was measured on August 8, 2017, less than a month after a transfer of 273 kgal from the 242-A evaporator to AP-104 (July 1–13, 2017). This historical maximum at the stack might have included a component from residual elevated headspace concentration in AP-104 because of the large transfer. However, the second-highest historical NDMA concentration was almost the same, 15.7 ppb, and there had been no activity for about five months preceding that datum. The cartridge-inlet maxima are >50% of the historical maximum and are not considered significantly below historical.

[27] This measurement, for the TL2 cartridge, was the only above-detect of the TL2 inlet samples. The other samples had higher detection limits.

All the NDMA inlet concentrations for the MSA TL PAPR cartridge had multiple data-quality flags, "DLa," and all of the 3M FR-57 cartridge data had the single flag "D." The "DLa" notation indicates dilution of sample to put concentration in the instrument range ("D"), calibration-standard measurement outside its specified range at the low end of the calibration range ("L"), and spike recovery outside its specified range ("a"). The maximum PAPR cartridge inlet concentration, 3130% of the OEL, came from the MSA TL data set. The maximum inlet concentration for the PAPR 3M FR-57 cartridge data alone was 2127% of the OEL.

The NDMA inlet concentrations for the SC1 APR cartridge all have "DLa" flags except for one "Da," and the NDMA inlet concentrations SD1 APR cartridge all have "D" flags. The maximum APR cartridge inlet concentration over both cartridges, 2681% of the OEL, came from the SC1 data set. The maximum inlet concentration for the APR SD1 cartridge data alone was 1733% of the OEL.

The APR and PAPR cartridge maxima are suspect because of multiple data-quality flags in the PAPR MSA TL and APR 7422-SC1 cartridge inlet data. However, the PAPR 3M FR-57 and APR 7422-SD1 maxima, like the overall maxima, are >20% of the historical maximum. The NDMA cartridge maxima can be considered consistent with the historical maximum.

F.5.7 N-nitrosodiethylamine (NDEA)

All APR and PAPR cartridge-inlet concentrations of NDEA were less than the detection limit, which was about 13% OEL for both cartridge types. The historical maximum was a below-report with a reporting limit of 0.0478 ppb (47.8% OEL). The maximum of the above-report measurements was 0.0169 ppb (16.9% OEL), measured on December 13, 2016, with no tank activity during sampling or in the preceding seven months. It is possible that the cartridge-inlet maxima are consistent with the historical above-report maximum, because the cartridge-inlet DL is close to the historical datum. However, in the absence of above-report cartridge-inlet data for NDEA, no conclusion about consistency can be drawn.

F.5.8 N-nitrosomethylethylamine (NMEA)

The maximum APR and PAPR cartridge inlet concentrations of NMEA were nearly equal to each other at 21 to 22% of the OEL. The historical maximum was 0.148 ppb (49.3% OEL). It was measured on August 8, 2017, less than a month after a large transfer of 273 kgal from the 242-A evaporator to AP-104 (July 1-13, 2017). This historical maximum at the stack might have included a component of residual elevated headspace concentration in AP-104 because of the large transfer. However, the second-highest historical NMEA concentration was almost the same, 0.137 ppb, and there had been no activity in the five months preceding that datum. The cartridge-inlet maxima are between 20% and 50% of the historical maximum but is not below the 20% level that is considered significantly below historical.

All the NMEA inlet concentrations for the MSA TL PAPR and SC1 APR cartridges had the single flag "a," denoting spike recovery outside its specified range. The maximum PAPR and APR cartridge inlet concentrations came from the MSA TL and SC1 data sets. There were low recoveries of nitrosamines for the MSA TL and SC1 samples because of a change in extraction procedure, but the 222-S laboratory considers the data usable.[28] For comparison, the maximum for the TL2 cartridge was 17.0% and was not flagged.

The NMEA cartridge maxima can be considered consistent with the historical maximum.

[28] E-mail from DR Hansen (222-S Laboratory) to LA Mahoney (PNNL), "RE: Two residual questions (both AP)," March 27, 2019 12:39 PM.

F.5.9 N-nitrosomorpholine

The maximum PAPR and APR cartridge inlet concentrations of N-nitrosomorpholine were nearly equal to each other at 3.3% of the OEL. The historical maximum was 0.0944 ppb (15.7% of the OEL). It was measured on August 22, 2017, more than a month after the last preceding transfer. The cartridge-inlet maxima are a little more than 20% of the historical maximum. The range from 20% to 50% is not considered significantly discrepant from historical, although this nitrosamine is on the borderline of discrepancy.

All the N-nitrosomorpholine inlet concentrations for the MSA TL PAPR and SC1 APR cartridges had the single flag "a," and the maximum PAPR and APR cartridge inlet concentrations came from the MSA TL and SC1 data sets. There were low recoveries of nitrosamines for the MSA TL and SC1 samples because of a change in extraction procedure, but the 222-S laboratory considers the data usable.[28] The presence of low recoveries suggests that the actual cartridge-inlet concentrations for MSA TL and SC1 may have been higher than measured.

The N-nitrosomorpholine cartridge maxima can be considered consistent with the historical maxima.

F.5.10 Dibutyl Butylphosphonate

The maximum cartridge inlet concentrations of dibutyl butylphosphonate are below their detection limits of 0.64% OEL for APR and 0.38% OEL for PAPR. The historical maximum concentration was a below-report datum with an RL of 0.0007 ppm (<10.2% of the OEL). There were no above-report historical data, so no conclusion can be drawn about where the cartridge inlet dibutyl butylphosphonate concentrations lie with respect to historical data.

F.5.11 Summary of Historical Data Comparisons

In summary, for the AP exhauster, after its September 8, 2016, upgrade, the maximum cartridge inlet concentrations that were substantially lower than historical data can be described as follows:

- Differences arose from using historical data taken during disturbance as the historical maximum: none.
- Differences arose from using the RLs of below-report data for the historical maximum: none.
- Differences arose from using data for vapor produced by a no-longer-existing inventory for the historical maximum: none.
- Differences 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-pentylfuran, 2-heptylfuran, 2-propylfuran, N-nitrosodiethylamine, dibutyl butylphosphonate.
- Cartridge inlet concentrations were determined to be significantly lower than above-report historical concentrations: furan.

Table F.1. APR Cartridge-Inlet Comparison to Historical Measurements of COPCs from AP Exhauster

						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)
Inorganic														
1	Ammonia	7664-41-7	-28	Poling et al., 2007[2]	25 ppm	40 (28)	103	36.1 (51.4)	412%	144% (206%)	94.9%	75.5%	12.7%	2.43% (RL)
2	Nitrous Oxide	10024-97-2	-127	Poling et al., 2007	50 ppm	0	n/a	n/a	n/a	n/a	Not Measured			
3	Mercury	7439-97-6	674	Poling et al., 2007	0.025 mg/m^3	16 (1)	<0.0125 (0.00791)	0.00817 (0.00791)	<50.0% (31.6%)	32.7% (31.6%)	16.2%	13.2%	13.0%	6.85% (RL)
Hydrocarbons														
4	1,3-Butadiene	106-99-0	24	Poling et al., 2007	1 ppm	1	<0.0107	<0.0107	<1.07%	<1.07%	6.55%	2.15%	6.39%	1.97% (RL)
5	Benzene	71-43-2	176	Poling et al., 2007	0.5 ppm	26	<0.0111	<0.0022	<2.22%	<0.44%	0.063%	0.040%	0.11%	0.036% (DL)
6	Biphenyl	92-52-4	491	Poling et al., 2007	0.2 ppm	23	<0.0012	<0.0007	<0.58%	<0.37%	<DL	<DL	<DL	0.046% (DL)
Alcohols														
7	1-Butanol	71-36-3	243	NIOSH[3]	20 ppm	20	0.0457	0.0228	0.23%	0.11%	0.058%	0.031%	<DL	0.022% (DL)
8	Methanol	67-56-1	148	Poling et al., 2007	200 ppm	0	n/a	n/a	n/a	n/a	Not Measured			
Ketones														
9	2-Hexanone	591-78-6	262	NIOSH	5 ppm	26	<0.0110	<0.0018	<0.22%	<0.036%	0.005%	<DL	<DL	0.002% (DL)
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	25	<0.0018	<0.0012	<0.36%	<0.25%	<DL	<DL	<DL	0.021% (DL)
12	6-Methyl-2-heptanone	928-68-7	333	Predicted ACD/Labs	8 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
13	3-Buten-2-one	78-94-4	179	CRC Handbook 1989	0.2 ppm	26 (1)	<0.0108 (0.0034)	0.0024 (0.0034)	<5.40% (1.73%)	1.20% (1.73%)	0.41%	<DL	<DL	0.17% (DL)
Aldehydes														
14	Formaldehyde	50-00-0	-6	NIOSH	0.3 ppm	6	0.0067	0.0047	2.24%	1.58%	1.01%	0.60%	2.66%	0.58% (RL)
15	Acetaldehyde	75-07-0	69	NIOSH	25 ppm	5 (4)	0.0236	0.0179 (0.0194)	0.094%	0.072% (0.078%)	0.062%	0.048%	0.025%	0.005% (RL)
16	Butanal	123-72-8	167	Oxford safety data[6]	25 ppm	23 (2)	<0.0102 (0.0019)	0.0024 (0.0019)	<0.041% (0.008%)	0.009% (0.008%)	0.003%	0.002%	<DL	0.002% (DL)
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	5	<0.0119	<0.0035	<11.9%	<3.48%	<DL	<DL	<DL	0.93% (DL)

Table F.1. APR (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)
Furans														
19	Furan	110-00-9	88	Poling et al., 2007	1 ppb	42 (15)	7.15	2.26 (4.13)	715%	226% (413%)	104%	53.8%	<DL	DL | RL[12] 23.0% | 115%[13]
20	2,3-Dihydrofuran	1191-99-7	130	Alfa Aesar[8]	1 ppb	17	<0.732	<0.555	<73.2%	<55.5%	<DL	<DL	<DL	3.28% | 19.6%
21	2,5-Dihydrofuran	1708-29-8	152	Aldrich[9]	1 ppb	42	<2.90	<1.43	<290%	<143%	<DL	<DL	<DL	25.8% | 111%[13]
22	2-Methylfuran	534-22-5	147	Oxford safety data	1 ppb	42	<2.47	<1.22	<247%	<122%	<DL	<DL	<DL	10.3% | 95.2%[13]
23	2,5-Dimethylfuran	625-86-5	199	Alfa Aesar	1 ppb	17	<0.534	<0.405	<53.4%	<40.5%	<DL	<DL	<DL	3.09% | 14.3%
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	17	<0.371	<0.281	<37.1%	<28.1%	<DL	<DL	<DL	3.11% | 9.93%
28	2-Heptylfuran	3777-71-7	410	Alfa Aesar	1 ppb	17	<0.309	<0.234	<30.9%	<23.4%	<DL	<DL	<DL	2.93% | 8.25%
29	2-Propylfuran	4229-91-8	231	Alfa Aesar	1 ppb	17	<0.466	<0.353	<46.6%	<35.3%	<DL	<DL	<DL	1.85% | 12.5%
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	23	<0.0074	<0.0047	<0.15%	<0.094%	<DL	<DL	0.022%	0.019% (DL)

Table F.1. APR (continued)

	COPC Number and Name	CAS Number	Boiling Point (°F)	Boiling Point Source	Occupational Exposure Limit (OEL)	Historical Measurements[1] Number of Values	Maximum Value (in OEL units)	Average Value (in OEL units)	Maximum Value (%OEL)	Average Value (%OEL)	Measurements in this study Max Inlet (%OEL)	Avg. Inlet (%OEL)	Max outlet (%OEL)	Approx. DL[12] (%OEL)
Nitriles														
34	Acetonitrile	75-05-8	179	NIOSH	20 ppm	39 (19)	<0.998 (0.0505)	0.360 (0.0149)	<4.99% (0.25%)	1.80% (0.07%)	0.051%	0.016%	0.22%	0.002% (DL)
35	Propanenitrile	107-12-0	207	NIOSH	6 ppm	25	<0.0024	<0.0017	<0.041%	<0.028%	<DL	<DL	<DL	0.006% (DL)
36	Butanenitrile	109-74-0	244	NIOSH	8 ppm	25	<0.0029	<0.0021	<0.037%	<0.026%	<DL	<DL	<DL	0.002% (DL)
37	Pentanenitrile	110-59-8	284	Alfa Aesar	6 ppm	25	<0.0024	<0.0017	<0.041%	<0.028%	<DL	<DL	<DL	0.003% (DL)
38	Hexanenitrile	628-73-9	328	Predicted ACD/Labs	6 ppm	25	<0.0021	<0.0015	<0.035%	<0.024%	<DL	<DL	<DL	0.002% (DL)
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	20 (1)	<0.0138 (0.0117)	0.0054 (0.0117)	<0.28% (0.23%)	0.11% (0.23%)	<RL	<RL	<RL	0.094% (RL)
Nitrosamines														
43	N-Nitrosodimethylamine	62-75-9	306	NIOSH	0.3 ppb	20	15.8	8.27	5267%	2757%	2681%	1762%	<RL	5.76% (RL)
44	N-Nitrosodiethylamine	55-18-5	351	Oxford safety data	0.1 ppb	20 (1)	<0.0478 (0.0169)	0.0302 (0.0169)	<47.8% (16.9%)	30.2% (16.9%)	<RL	<RL	<RL	12.5% (RL)
45	N-Nitrosomethylethylamine	10595-95-6	310	Predicted ACD/Labs	0.3 ppb	20 (16)	0.148	0.0896 (0.102)	49.3%	29.9% (34.0%)	20.7%	15.2%	<RL	4.84% (RL)
46	N-Nitrosomorpholine	59-89-2	435	Oxford safety data	0.6 ppb	20 (7)	0.0944	0.0379 (0.0520)	15.7%	6.32% (8.67%)	3.28%	<RL	<RL	1.84% (RL)
Organophosphates														
47	Tributyl phosphate	126-73-8	552	NIOSH	0.2 ppm	23	<0.0007	<0.0004	<0.34%	<0.22%	<DL	<DL	<DL	0.059% (DL)
48	Dibutyl butylphosphonate	78-46-6	602	Predicted ACD/Labs	0.007 ppm	23	<0.0007	<0.0005	<10.2%	<6.57%	<DL	<DL	<DL	0.64% (DL)
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	25	<0.0026	<0.0019	<0.26%	<0.19%	<RL	<RL	<RL	0.044% (RL)
52	2,4-Dimethylpyridine	108-47-4	318	Alfa Aesar	0.5 ppm	25	<0.0020	<0.0014	<0.39%	<0.28%	<RL	<RL	<RL	0.051% (RL)

Table F.1. APR (continued)

	COPC Number and Name	CAS Number	Boiling Point (°F)	Boiling Point Source	Occupational Exposure Limit (OEL)	Historical Measurements[1]: Number of Values	Maximum Value (in OEL units)	Average Value (in OEL units)	Maximum Value (%OEL)	Average Value (%OEL)	Measurements in this study: 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)	12 (6)	0.0003	0.00008 (0.0002)	2.54%	0.68% (1.34%)	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.*

Table F.2. PAPR Cartridge-Inlet Comparison to Historical Measurements of COPCs from AP Exhauster

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	40 (28)	103	36.1 (51.4)	412%	144% (206%)	102%	88.5%	57.3%	2.48% (RL)
2	Nitrous Oxide	10024-97-2	-127	Poling et al., 2007	50 ppm	0	n/a	n/a	n/a	n/a	Not Measured			
3	Mercury	7439-97-6	674	Poling et al., 2007	0.025 mg/m^3	16 (1)	<0.0125 (0.00791)	0.00817 (0.00791)	<50.0% (31.6%)	32.7% (31.6%)	12.4%	10.9%	<RL	7.02% (RL)
Hydrocarbons														
4	1,3-Butadiene	106-99-0	24	Poling et al., 2007	1 ppm	1	<0.0107	<0.0107	<1.07%	<1.07%	3.52%	1.92% (<RL)	2.42%	1.98% (RL)
5	Benzene	71-43-2	176	Poling et al., 2007	0.5 ppm	26	<0.0111	<0.0022	<2.22%	<0.44%	0.13%	0.080%	0.14%	0.039% (DL)
6	Biphenyl	92-52-4	491	Poling et al., 2007	0.2 ppm	23	<0.0012	<0.0007	<0.58%	<0.37%	<DL	<DL	<DL	0.027% (DL)
Alcohols														
7	1-Butanol	71-36-3	243	NIOSH[3]	20 ppm	20	0.0457	0.0228	0.23%	0.11%	0.014%	0.011 (<DL)	0.004%	0.023% (DL)
8	Methanol	67-56-1	148	Poling et al., 2007	200 ppm	0	n/a	n/a	n/a	n/a	0.60%	0.21%	<RL	0.21% (RL)
Ketones														
9	2-Hexanone	591-78-6	262	NIOSH	5 ppm	26	<0.0110	<0.0018	<0.22%	<0.036%	0.003%	<DL	<DL	0.002% (DL)
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	25	<0.0018	<0.0012	<0.36%	<0.25%	<DL	<DL	<DL	0.022% (DL)
12	6-Methyl-2-heptanone	928-68-7	333	Predicted ACD/Labs	8 ppm	0	n/a	n/a	n/a	n/a	Not Detected - TIC			
13	3-Buten-2-one	78-94-4	179	CRC Handbook 1989	0.2 ppm	26 (1)	<0.0108 (0.0034)	0.0024 (0.0034)	<5.40% (1.73%)	1.20% (1.73%)	0.12%	0.12% (<DL)	0.082%	0.18% (DL)
Aldehydes														
14	Formaldehyde	50-00-0	-6	NIOSH	0.3 ppm	6	0.0067	0.0047	2.24%	1.58%	2.04%	1.06%	3.66%	0.595% (RL)
15	Acetaldehyde	75-07-0	69	NIOSH	25 ppm	5 (4)	0.0236	0.0179 (0.0194)	0.094%	0.072% (0.078%)	0.050%	0.043%	0.033%	0.005% (RL)
16	Butanal	123-72-8	167	Oxford safety data[6]	25 ppm	23 (2)	<0.0102 (0.0019)	0.0024 (0.0019)	<0.041% (0.008%)	0.009% (0.008%)	0.002%	0.001% (<DL)	<DL	0.002% (DL)
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	5	<0.0119	<0.0035	<11.9%	<3.48%	<DL	<DL	<DL	0.96% (DL)

Table F.2. PAPR (continued)

COPC Number and Name		CAS Number	Boiling Point (°F)	Boiling Point Source	Occupational Exposure Limit (OEL)	Historical Measurements[1] Number of Values	Maximum Value (in OEL units)	Average Value (in OEL units)	Maximum Value (%OEL)	Average Value (%OEL)	Measurements in this study 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	42 (15)	7.15	2.26 (4.13)	715%	226% (413%)	57.3%	20.5% (<DL)	<DL	DL | RL[12] 24.3% | 121%[13]
20	2,3-Dihydrofuran	1191-99-7	130	Alfa Aesar[8]	1 ppb	17	<0.732	<0.555	<73.2%	<55.5%	<DL	<DL	<DL	8.19% | 19.4%
21	2,5-Dihydrofuran	1708-29-8	152	Aldrich[9]	1 ppb	42	<2.90	<1.43	<290%	<143%	<DL	<DL	<DL	25.5% | 118%[13]
22	2-Methylfuran	534-22-5	147	Oxford safety data	1 ppb	42	<2.47	<1.22	<247%	<122%	6.93%	7.60% (<DL)	<DL	10.9% | 101%[13]
23	2,5-Dimethylfuran	625-86-5	199	Alfa Aesar	1 ppb	17	<0.534	<0.405	<53.4%	<40.5%	<DL	<DL	<DL	4.09% | 14.2%
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	17	<0.371	<0.281	<37.1%	<28.1%	<DL	<DL	<DL	3.09% | 9.86%
28	2-Heptylfuran	3777-71-7	410	Alfa Aesar	1 ppb	17	<0.309	<0.234	<30.9%	<23.4%	<DL	<DL	3.36%	2.91% | 8.20%
29	2-Propylfuran	4229-91-8	231	Alfa Aesar	1 ppb	17	<0.466	<0.353	<46.6%	<35.3%	<DL	<DL	<DL	2.98% | 12.4%
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	23	<0.0074	<0.0047	<0.15%	<0.094%	0.022%	0.012%	<DL	0.012% (DL)

Table F.2. PAPR (continued)

COPC Number and Name		CAS Number	Boiling Point (°F)	Boiling Point Source	Occupational Exposure Limit (OEL)	Historical Measurements[1] Number of Values	Maximum Value (in OEL units)	Average Value (in OEL units)	Maximum Value (%OEL)	Average Value (%OEL)	Measurements in this study Max Inlet (%OEL)	Avg. Inlet (%OEL)	Max outlet (%OEL)	Approx. DL[12] (%OEL)
Nitriles														
34	Acetonitrile	75-05-8	179	NIOSH	20 ppm	39 (19)	<0.998 (0.0505)	0.360 (0.0149)	<4.99% (0.25%)	1.80% (0.07%)	0.066%	0.020%	4.25%	0.002% (DL)
35	Propanenitrile	107-12-0	207	NIOSH	6 ppm	25	<0.0024	<0.0017	<0.041%	<0.028%	<DL	<DL	<DL	0.006% (DL)
36	Butanenitrile	109-74-0	244	NIOSH	8 ppm	25	<0.0029	<0.0021	<0.037%	<0.026%	<DL	<DL	0.002%	0.002% (DL)
37	Pentanenitrile	110-59-8	284	Alfa Aesar	6 ppm	25	<0.0024	<0.0017	<0.041%	<0.028%	<DL	<DL	<DL	0.003% (DL)
38	Hexanenitrile	628-73-9	328	Predicted ACD/Labs	6 ppm	25	<0.0021	<0.0015	<0.035%	<0.024%	<DL	<DL	<DL	0.002% (DL)
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	20 (1)	<0.0138 (0.0117)	0.0054 (0.0117)	<0.28% (0.23%)	0.11% (0.23%)	<RL	<RL	<RL	0.095% (RL)
Nitrosamines														
43	N-Nitrosodimethylamine	62-75-9	306	NIOSH	0.3 ppb	20	15.8	8.27	5267%	2757%	3130%	2156%	<RL	6.72% (RL)
44	N-Nitrosodiethylamine	55-18-5	351	Oxford safety data	0.1 ppb	20 (1)	<0.0478 (0.0169)	0.0302 (0.0169)	<47.8% (16.9%)	30.2% (16.9%)	<RL	<RL	<RL	13.2% (RL)
45	N-Nitrosomethylethylamine	10595-95-6	310	Predicted ACD/Labs	0.3 ppb	20 (16)	0.148	0.0896 (0.102)	49.3%	29.9% (34.0%)	21.7%	16.8%	<RL	5.27% (RL)
46	N-Nitrosomorpholine	59-89-2	435	Oxford safety data	0.6 ppb	20 (7)	0.0944	0.0379 (0.0520)	15.7%	6.32% (8.67%)	3.31%	1.73% (<RL)	<RL	2.08% (RL)
Organophosphates														
47	Tributyl phosphate	126-73-8	552	NIOSH	0.2 ppm	23	<0.0007	<0.0004	<0.337%	<0.216%	<DL	<DL	<DL	0.036% (DL)
48	Dibutyl butylphosphonate	78-46-6	602	Predicted ACD/Labs	0.007 ppm	23	<0.0007	<0.0005	<10.2%	<6.57%	<DL	<DL	<DL	0.38% (DL)
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	25	<0.0026	<0.0019	<0.26%	<0.19%	<RL	<RL	<RL	0.047% (RL)
52	2,4-Dimethylpyridine	108-47-4	318	Alfa Aesar	0.5 ppm	25	<0.0020	<0.0014	<0.39%	<0.28%	<RL	<RL	<RL	0.054% (RL)

Table F.2. PAPR (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)	12 (6)	0.0003	0.00008 (0.0002)	2.54%	0.68% (1.34%)	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 References

Agnew SF, J. Boyer, RA Corbin, TB Duran, JR FitzPatrick, KA Jurgensen, TP Ortiz, and BL Young. 1997. *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4*. LA-UR-96-3860, Los Alamos National Laboratory, Los Alamos, New Mexico.

Freeman CJ, J Liu, C Clayton, SK Nune, LA Mahoney, CL Bottenus, TM Brouns, P Humble, and MJ Minette. 2020. *Overview of 2016 through 2018 Testing of Respirator Cartridge Performance on Multiple Hanford Tank Headspaces and Exhausters*. PNNL-26821 Rev. 1, Pacific Northwest National Laboratory, Richland, Washington.

Huckaby, JL, LA Mahoney, JG Droppo, and JE Meacham. 2004. *Overview of Hanford Site High-Level Waste Tank Gas and Vapor Dynamics*. PNNL-14831, Pacific Northwest National Laboratory, Richland, Washington. https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-14831.pdf.

Mahoney LA and EW Hoppe. 2017. *Hanford Tank Vapors FY 2017 Chemicals of Potential Concern*. PNNL-26820 Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

Appendix G

Manufacturer's Service-Life Estimation

Appendix G

Manufacturer's Service-Life Estimation

The experimental breakthrough times for ammonia from the AP exhauster cartridge testing were compared to the estimated service life of the cartridges, using the online calculators provided by the vendor (i.e., 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 possibly 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 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 linearly 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.

Because of the uncertainty in the inlet concentration measurement and sensitivity of the estimated service life on the inlet concentrations, two types of inlet concentrations are used in the vendor calculator analyses—maximum inlet concentrations and average inlet concentrations. The maximum inlet concentrations were the highest concentrations measured for the inlet stream. The average inlet concentrations were determined up until the breakthrough point (included). The measured gas stream properties including temperature, relative humidity, and pressure also were determined up until the breakthrough point (included) for our vendor calculator analyses in both maximum and average inlet concentration cases. For the APR cartridge test, the set flow rate is 30 L/min per cartridge, and for the PAPR cartridge test, the set flow rate is 95 L/min per cartridge. When the experimental flow rate is significantly different from the set flow rate, the average flow rate also is used for our vendor calculator analyses. Therefore, the results obtained from the vendor calculator analyses will include estimated service lives based on a combination of different inlet concentration and gas properties, which will provide a good understanding on how to effectively compare or apply the vendor's calculator to conditions that are specific to vapors from a tank. Note that the data sources are from Appendix C and Appendix D. The comparison results for the PAPR cartridges are summarized in Table G.1.

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	AP_2018	52.8	73.0	25	10	21.5	95	698.3	>16	102.5	15.6
	TL2	AP_2018	57.4	87.6	25	10	22.6	95	699.6	5.5	57*	5.4

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	AP_2018	52.8	73.0	25	10	25.4	95	698.3	>16	102.5	13.7
	TL2	AP_2018	57.4	87.6	25	10	24.2	95	699.6	5.5	57*	5.2

*The flow rate per cartridge used in the NIOSH test (see Figure G.1).

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)[29] PAPR cartridge from 3M. The flow rate in the calculators provided by vendors are converted to flow rate per cartridge for the comparison. The estimated service life for TL1 cartridge was obtained with the parameters in Table G.1 using the online calculator provided by MSA. When the average inlet concentration was used (top panel of Table G.1), the calculated service life of 15.6 hours is conservative for TL1 compared to the experimental breakthrough time (>16 hours). When the maximum inlet concentration was used (bottom panel of Table G.1), the calculated service life is 13.7 hours, which is more than 2 hours less than using the average inlet concentration. This shows that the service-life projections are particularly sensitive to the low concentrations encountered in this study (e.g., 100% of the OEL). The estimated service life for the TL2 cartridge was obtained with the parameters in Table G.1 using the estimation method provided by 3M as shown in the supporting email communications (Figure G.1). The results obtained using both average and maximum inlet concentrations indicate that the estimated service lives for the TL2 cartridge are consistent with the experimental breakthrough time but not as conservative as in the case of TL1 cartridge from MSA. Therefore, there is greater uncertainty in results obtained from the interpolation algorithm for the 3M FR-57 cartridge.

No safety factor was used in either the MSA or the 3M estimation methods. For the APR cartridge service life estimation using the SureLife calculator, a “smart” safety factor was applied based on the most conservative service life estimated with built-in uncertainties of key parameters (i.e., ±10% uncertainty for concentration, relative humidity, and pressure and 5% uncertainty for temperature).

The comparison results for the APR cartridges are summarized in Table G.2. Here, 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).

[29] Email from P Jones October 2017.

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.

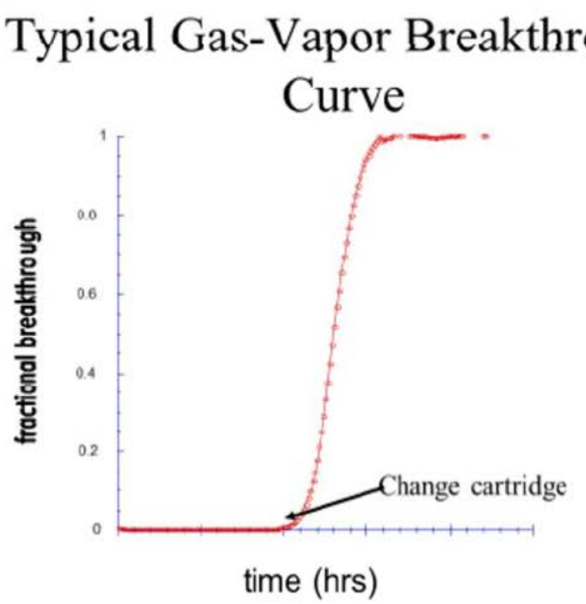

Figure G.1. Email Correspondence between PNNL and 3M Regarding the Estimation of the Service Life of the FR-57 Cartridge for Ammonia

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

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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

Figure G.1. (continued)

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	AP_2018	56.0	76.3	25	10	19.4	~30	727.3	15.2	30	22.2
	SC1	AP_2018	52.6	78.2	25	10	18.3	~30	724.4	>16	30	26.4

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	AP_2018	56.0	76.3	25	10	23.7	~30	727.3	15.2	30	19.2
	SC1	AP_2018	52.6	78.2	25	10	21.8	~30	724.4	>16	30	23.2

* There are two cartridges in the SCOTT APR respirators. The flowrates were converted to a per cartridge base.

The estimated service life for SD1 and SC1 cartridges were obtained with the parameters in Table G.2 using the SureLife calculator by specialists at SCOTT Safety (3M). Both the average (top panel) and maximum (bottom panel) inlet concentrations were used. The results indicate that a small difference in inlet concentrations (e.g., approximately 4 ppm), results in 3 hours difference in the estimated service life for these two cases. Based on comparisons in Table G.2, the estimated service life for the SD1 cartridge is slightly longer than the experimental results, and the estimated service life for the SC1 cartridge is generally consistent with the experimental results because the results were both longer than the test duration. Sensitivity cases were estimated using the SCOTT SureLife Calculator for these test conditions to assess the impact of small differences in ammonia concentration (e.g., average versus maximum). At the lower ammonia inlet concentrations (e.g., 100% of the OEL) consistent with this test, the service-life estimates are particularly sensitive to small changes in ammonia concentration. Therefore, differences in estimated versus observed breakthrough are likely the result of uncertainty between the average measured inlet concentration and the actual concentration to which the cartridge was subjected over the duration of the test.

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