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Annual Data Summary Report for the Chemical Speciation of PM2.5 Filter Samples Project

January 1 through December 31, 2009

Prepared for:
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711

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Executive Summary

Introduction

The U.S. Environmental Protection Agency (EPA) established a $PM_{2.5}$ Chemical Speciation Network (CSN) in 1999. The CSN included the Speciation Trends Network (STN) (a core set of 54 speciation trends analysis sites), as well as some 128 other sites. RTI is assisting in the $PM_{2.5}$ CSN by shipping ready-to-use filter packs and denuders to all the field sites and by conducting gravimetric and chemical analyses of several types of filters used in the samplers. RTI staff performed an extensive array of quality assurance/quality control (QA/QC) activities to ensure that the data provided to EPA and the States are of the highest quality. The laboratory QA activities in terms of accuracy, precision, data completion, and any corrective actions taken on the chemical speciation of samples from the CSN sites from January 1 to December 31, 2009, are described in this report. RTI re-won the CSN contract in 2008, and the new contract became effective in early 2009. Sampling and filter processing under the new contract began in early March. Consequently, this report includes data for filters sampled and analyzed under both contracts.

Data Quality

Analytical completeness exceeded 95%, and laboratory accuracy and precision were under control as demonstrated by routine QC samples, laboratory audits, and instrument intercomparison. The RTI International laboratories were audited by EPA personnel during September 2009. In addition, RTI and DRI received performance audit samples as part of a multi-lab study conducted by EPA's Montgomery Laboratory. These encompassed all the major analyses being performed under the CSN contract. the RTI team's results (RTI and DRI laboratories) compared well with results from the other speciation laboratories and the EPA reference laboratory (EDXRF only).

Laboratory Performance

Section 3.0 of this report provides the details of accuracy, precision, and other measures of laboratory performance. The laboratories consistently met their QC goals of routine analyses, which are detailed in Sections 3.1 (Gravimetry Laboratory), 3.2 (Ion Analysis), 3.3 (CSN Organic and Elemental Carbon), 3.4 Organic and Elemental Carbon IMPROVE_A, and 3.5 (X-ray Fluorescence).

Problems with the weighing chamber environmental controls in the Gravimetry Laboratory (Section 3.1) were dealt with aggressively so that a minimum of data had to be flagged as outside holding time or environmental criteria. In 2005, a problem was noted with a manufacturer's lot of Teflon filters. In response, the Standard Operating Procedure (SOP) for gravimetric analysis was updated to increase the frequency of re-weighing in the laboratory to quickly recognize and correct future filter debris problems. This enhanced procedure has continued, and data quality for gravimetric mass results was generally found to be satisfactory during 2009.

Minimal problems with laboratory operations and filter media were reported by the Ion and Organic and Elemental Carbon (OC/EC) laboratories (RTI and DRI) during 2009.

Interlaboratory performance comparison results were satisfactory. New URG 3000N samplers have now been deployed throughout the entire CSN network to sample quartz filters for OC/EC. DRI analyzes all filters from the 3000N samplers using the IMPROVE_A protocol. RTI continues to analyze a reduced number of quartz filters from selected sites by the original STN/CSN method as part of a study to establish comparability between the data produced the old and new methods.

The XRF laboratories operated by RTI and subcontractor Chester LabNet (CLN) generally met the prescribed QC criteria for analysis (Sections 3.5.1 and 3.5.2). Both laboratories had equipment downtime, which affected sample analysis logistics, but this had no effect on data quality. The RTI and CLN laboratories participate in an intercomparison (round-robin) program described in Section 3.5.2.4. Interlaboratory performance comparison results performed by EPA's National Air and Radiation Environmental Laboratory were satisfactory.

Operations in RTI's Sampling Handling and Archiving Laboratory (SHAL) proceeded normally during 2009. A small number of samples were missed due to late return of coolers from the field sites. Shipping containers ("coolers") were changed since 2006 to a lighter type of container, thus reducing shipping expenses. No significant effect on shipping temperature was noted after the change in containers. No significant quality issues were reported by the denuder refurbishment laboratory (Section 3.7).

No significant quality issues were reported by the data processing and data validation functions during 2009 (Sections 4.0 and 5.0). Data continues to be reviewed and posted to a secure Web site on a monthly basis for review. Finalized data are posted to the EPA AQS database approximately 60 days after initial posting (Section 4.0). A number of data users contacted SHAL, data processing, and QA personnel with questions about specific data items, or to request explanations about apparent discrepancies. RTI attempts to answer such questions promptly, and works with the agencies to determine the most appropriate data flags for particular situations.

Estimation of MDLs and Uncertainties

Method Detection Limits (MDLs) for all laboratory methods are provided in Appendix A. Uncertainties are estimated based on laboratory QC data, augmented by a 5% concentration-proportional term to account for field handling and sample volume uncertainties. Results from collocated samplers (Section 5.3) indicate that this uncertainty model is reasonable for most chemical species.

Quality Issues

There were no Corrective Action Requests (CARs) issued during 2009. There are some ongoing issues that have not been assigned CARs because there was no specific action that RTI could take, or because they required input and cooperation from others outside RTI. These issues are summarized in the following table.

CAR Number	Lab	Description	Response	Effect on Data
None	SHAL	Late-arriving coolers	DOPO and others are notified whenever coolers are received late from the field	Data are flagged as missing

1.0 Introduction

1.1 Program Overview

In 1997, the U.S. Environmental Protection Agency (EPA) promulgated the new National Ambient Air Quality Standards (NAAQS) for particulate matter (PM). The regulations (given in 40 CFR Parts 50, 53, and 58) apply to the mass concentrations (µg/m^3 of air) of particles with aerodynamic diameters less than 10 micrometers (the PM_{10} standard) and less than 2.5 micrometers (the $PM_{2.5}$ standard).

Currently, a 1500-site mass measurements network and a 182-site chemical speciation monitoring network have been established. The ambient air data from the first network, which measures solely the mass of PM, will be used principally for NAAQS comparison purposes in identifying areas that meet or do not meet the NAAQS criteria and in supporting designation of an area as attainment or non-attainment. The smaller Chemical Speciation Network (CSN) included the Speciation Trends Network (STN) (a core set of 54 speciation trends analysis sites) and some 128 other sites from State and local agencies that are supported by RTI International (RTI).

This data summary report covers the quality assurance (QA) aspects of the collection and chemical analysis of samples from the CSN sites from January 1 through December 31, 2009. RTI is supporting the $PM_{2.5}$ CSN by shipping ready-to-use filter packs and denuders to the field sites and by conducting gravimetric and chemical analyses of the several types of filters used in the samplers. The details of the QA activities being performed are described in the RTI QA Project Plan (QAPP) for this project. The QAPP focuses on the QA activities associated with RTI's role in performing these analyses, as well as in validating and reporting the data, and should be considered a companion document to this annual QA report.

1.2 Project/Task Description

The CSN laboratory contract involves four broad areas:

1. Supplying each site or State with sample collection media (loaded filter packs, denuders, and absorbent cartridges) and field data documentation forms. RTI ships the collection media to monitoring agencies on a schedule specified by the Delivery Order Project Officer (DOPO).

2. Receiving the samples from the field sites and analyzing the sample media for mass and for an array of chemical constituents, including elements (by energy-dispersive x-ray fluorescence [EDXRF]), soluble anions and cations (by ion chromatography), and carbonaceous species (using the Sunset Labs thermal-optical transmittance system). Desert Research Institute (DRI) has performed the IMPROVE_A carbon analysis for filters collected by URG 3000N samplers using thermal-optical analysis in both the reflectance and transmittance mode. Analysis of semi-volatile organic compounds, optical density and examination of particles by electron or optical microscopy have not been performed.

3. Assembling validated sets of data from the analyses, preparing data reports for EPA management and the State Agencies, and entering data into the Air Quality System (AQS) data bank 60 days after initial data reports are first submitted to the DOPO and the State Agencies.

4. Establishing and applying a comprehensive QA/quality control (QC) system. RTI's Quality Management Plan (QMP), QAPP, and associated Standard Operating Procedures (SOPs) provide the documentation for RTI's quality system.

1.3 Major Laboratory Operational Areas

This report addresses the operation of RTI's Sample Handling and Archiving Laboratory (SHAL) and QA/QC for the four major analytical areas active during the time period of January 1 through December 31, 2009. These analytical areas are the (1) gravimetric determination of particulate mass on Teflon® filters; (2) determination of 33 elements on Teflon® filters using X-ray fluorescence (XRF) spectrometry; (3) determination of nitrate, sulfate, sodium, ammonium, and potassium on nylon or Teflon filters using ion chromatography; and (4) determination of organic carbon, elemental carbon, total carbon, and five other peaks (PK1C, PK2C, PK3C, PK4C, and PyrolC) on quartz filters using thermal optical transmittance. DRI is performing the IMPROVE_A carbon analysis using the thermal optical reflectance for the samples collected by URG 3000N samplers. Also addressed is denuder refurbishment, data processing, and QA and data validation.

2.0 Quality Issues and Corrective Actions

2.1 Data Quality

RTI staff perform an extensive array of QA/QC activities to ensure that the data provided to EPA and the States are of the highest quality. Further, RTI makes every effort to provide data that can serve as the basis for making important decisions.

Data quality for the CSN has several dimensions, but the primary goal should be usefulness to data users and understanding of the data set's characteristics. There are several metrics that are typically considered in assessing the quality of the CSN data set:

- Accuracy. All analyses standardized to reference values that are traceable to the National Institute of Standards and Technology (NIST.)
- Precision. Measured both as laboratory and whole-system through regular QC replicates and results from samplers collocated at the same site.
- Completeness. Excellent completeness (>95%) is demonstrated overall. Some individual sites may have lower completeness, typically due to site maintenance or shipping problems.
- Spatial coverage. Selection of sites for CSN is outside of RTI's control. The CSN sites are generally selected to evaluate population-based health effects and tend to be in populated areas. Because of this, the CSN has relatively little coverage of rural sites in the western United States, where IMPROVE sites predominate.
- Comparability. Intercomparison studies recently conducted by EPA have shown good agreement with programs such as the Federal Reference Methods (FRM) network and IMPROVE results for most of the major chemical species. Other dimensions of comparability include comparability between the four different sampler types currently or formerly in use in the CSN program: MetOne SASS, Andersen RAAS, URG MASS, URG3000N,and the R&P 2300. In addition, the data are often intercompared with data gathered by three additional sampler types: IMPROVE, URG 3000N, $PM_{2.5}$ FRM, and R&P 2025 (used in Texas). All these samplers operate at a variety of different flow rates, use different modes of flow control, and utilize different particle-sizing technologies.
- Representativeness. Primary site selection and field-sampling operations are out of RTI's control.
- Sensitivity/Detection. The ability to quantify major species, such as gravimetric mass, organic carbon, sulfate, nitrate, ammonium, and iron, is adequate; however, many of the trace elements are routinely below limits of detection. Data users should carefully screen out species that are present in such low levels that their inclusion would only add noise to their analysis. Method Detection Limits (MDLs) are provided in **Appendix A** of this report.

In addition to these data quality assessment criteria, there are other issues that affect data usability. The following quality-related issues and other characteristics of the data set should be taken into account in an overall assessment of the data set:

- Lack of blank correction. The main concern is the artifact in organic carbon (OC) measurement. The IMPROVE network includes blank correction for OC in its reported data. This is a fundamental difference between the data reported by CSN and IMPROVE. The appropriate OC correction factor may differ among the four different CSN sampler types.
- Intermittent media contamination issues. Equipment and media contamination issues arise from time to time and may cause the occasional outliers reported by the monitoring agencies, in which the CSN mass differs from the mass reported by a nearby FRM sampler. RTI makes an effort to flag data, retroactively if necessary, to invalidate or mark as suspicious any events reported by the monitoring agencies.
- Improvement of uncertainty estimates.
  - Comparability between CSN and other networks. RTI is working with the University of California at Davis (UC Davis) and other experts in XRF to define an acceptable method for determining XRF uncertainty. This work by RTI has resulted in a White Paper that was delivered to EPA in 2006.[1] A peer-reviewed publication has been submitted to the Journal of the Air and Waste Management Association.[2]
  - Realism of total uncertainty estimates based on statistics from sites with side-by-side collocation of samplers. Collocation results in the 2005 and 2006 reports and extended in the present report indicate that uncertainties reported to AQS for several major species may be overestimated by a factor of 2x or 3x. These include sulfate, nitrate, and elemental carbon. Average uncertainties currently being reported for the majority of other species appear to be in reasonable agreement with uncertainties calculated from the collocation results.[3]

2.2 Summary of Data Completeness

Data completeness network-wide exceeded 95% for 2009. Completeness is defined as the number of valid measurement values divided by the potential number of values. Data records with AQS validity status codes ("suspicious" data) are included in the completeness figure, but data records with an AQS null value code are counted as missing data.

[1] Gutknecht, W. F., J. B. Flanagan, and A. McWilliams, "Harmonization of Interlaboratory X-ray Fluorescence Measurement Uncertainties." RTI/0208858/TO2/04D, August 4, 2006.
[2] Gutknecht, W.F., J.B. Flanagan, A. McWilliams, R.K.M. Jayanty, et al. 2009. Harmonization of uncertainties of X-ray fluorescence data from $PM_{2.5}$ air filter analysis. *Journal of the Air and Waste Management Association*, 60:184 - 194, February, 2010.
[3] Flanagan, James B., R.K.M. Jayanty, E. Edward Rickman, Jr., and Max R. Peterson, "PM2.5 Speciation Trends Network: Evaluation of Whole-system Uncertainties Using Data from Sites with Collocated Samplers," *Journal of the Air and Waste Management Association,* 2006, 56, 492-499.

Appendix B of this report includes more details of the sampling events and completeness for the Reporting Batches delivered in 2009. **Table B.1** shows the percentage of routine exposure records for the "core" network of STN sites that were valid (i.e., not invalidated with an AQS Null Value Code) relative to the number of records for scheduled events for that batch for all trends sites. **Table B.2** shows the percentage of routine exposure records for each of the non-STN sites that were valid (i.e., not invalidated with an AQS Null Value Code) relative to the number of records for scheduled events for that batch for all non-TRENDS sites. Blank cells indicate that no analyses were scheduled for a site during a particular delivery batch interval. Percentages less than 80 are usually the result of a sampler being out of service or one or more exposures being missed because of problems at the site or problems with the shipping.

2.3 Corrective Actions

To ensure ongoing quality work, RTI reacts quickly and decisively to any unacceptable changes in data quality. These reactions are usually in the form of corrective actions. Most of these corrective actions have been in response to very short-term problems, such that very few results were impacted negatively. The following subsections describe corrective actions undertaken in each laboratory area during 2009.

2.3.1 Gravimetric Mass

No significant quality issues were identified in the Gravimetric Laboratory in 2009. However, the laboratory continued to monitor mass balance data and to perform enhanced inspection of the Teflon filters purchased for use in the program as a result of the problem identified in 2005 and documented under CAR 008. This inspection is performed in RTI's Optical Microscopy Laboratory on randomly selected filters. A technician examines filters under enhanced lighting using a stereomicroscope at magnifications of 10x to 45x. No pervasive problem with extraneous contaminating debris was identified in 2009 in either this enhanced inspection or in routine visual inspection in the chamber.

2.3.2 Elemental Analysis

See Section 3.4.1.1 for a description of quality issues and maintenance from Chester Labnet, which performs some of the elemental analysis by XRF for the CSN contract.

There were no quality issues or corrective actions during the reporting period.

2.3.3 Ion Analysis

There were no corrective actions taken during this reporting period.

2.3.4 Organic Carbon/Elemental Carbon Analysis

There were no corrective actions taken during this reporting period.

2.3.5 Sample Handling and Archiving Laboratory (SHAL)

There were no corrective actions taken in the SHAL during 2009.

2.3.6 Data Processing

There were no corrective actions taken during this reporting period. The uncertainties for the carbon values for the samples collected by URG 3000N have not yet been posted into AQS, pending direction from EPA about the method to be used for calculations. Blank-corrected IMPROVE_A carbon measurements rely on the same set of calculations, and these have also not been posted, pending direction from EPA.

Updated values for Organic and Elemental Carbon were uploaded to AQS under work assignment 1-10 of contract EP-D-08-047. The purpose of the updates was to ensure that the data produced during the early part of the CSN contract were calculated with the same software as later data.

2.4 Other Quality Issues

None.

3.0 Laboratory Quality Control Summaries

3.1 Gravimetric Laboratory

The RTI Gravimetric Laboratory's two weigh chambers were used to tare 16,316 Teflon filters for the $PM_{2.5}$ speciation program between January 1 and December 31, 2009. During the same time period, the laboratory performed final (post-sampling) weighings of 15,525 Teflon filters for the program. The difference between the number of tared filters and the number of final filters is partly due to the inherent lag time between the initial and final weighing sessions. Determination of $PM_{2.5}$ mass is based on two separate weighings performed several weeks apart. The total also reflects a contingency buffer factored into the number of filters tared each week to ensure an adequate number of tared filters for sampling and extra filters for use in-house blanks contamination monitoring. Filter weighing totals given in this report are those recorded by the laboratory's database application.

3.1.1 Quality Issues and Corrective Actions

No significant filter quality issues were identified in the Gravimetric Laboratory in 2009. The laboratory continued to proactively monitor mass balance data and to perform enhanced inspection of the Teflon filters purchased for use in the program. This inspection is performed in RTI's Optical Microscopy Laboratory on randomly selected filters. A technician examines filters under enhanced lighting using a stereomicroscope at magnifications of 10x to 45x. No pervasive problem with extraneous contaminating debris was identified in 2009 in either this enhanced inspection or in the routine visual inspection in the chamber. Lot stability tests indicated the four Teflon filter lots used for the program in 2009 did not have issues with debris or outgassing.

The laboratory's environmental chambers experienced little downtime due to system failure in 2009. However, two fan motors were discovered inoperable during the annual calibration and preventive maintenance of Chamber 1 in January. The chamber has a bank of six fans and can maintain temperature and humidity controls even when multiple fan motors are burned out, so no loss of acceptable conditioning environment was experienced. In response, RTI ordered replacement motors from the chamber vendor, Environmental Specialties, for installation at a scheduled downtime. System component design modifications made by the vendor since the chamber's original installation also required the ordering of additional blower wheels. RTI is investigating motor replacements consistent with the new design. The chamber continues to function appropriately to maintain a stable environment. Chamber 2's dehumidifier damper actuator was replaced in March 2009 to correct low humidity issues. RTI's HVAC department ordered and replaced the motor quickly, minimizing the downtime that would have occurred if RTI had had to schedule repair by Environmental Specialties. Chamber 2's drier motor failed in July 2009, resulting in high humidity. The motor was also ordered and installed by RTI's HVAC Department. In all cases, weighing was suspended pending repair and stabilization of the chamber environment.

One 200-mg working mass standard was removed from use at the end of the year pending re-verification by the state.

3.1.2 Description of QC Checks Applied

Internal QC checks applied in the Gravimetric Laboratory are described in **Table 3-1**, along with results achieved during this reporting period.

Table 3-1. Summary of QC Checks Applied and Results Achieved in the Gravimetric Laboratory

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
Working standard reference weights (mass reference standards)	Verified value ± 3 µg [Standard reference weights initially calibrated by Troemner. Verified by North Carolina Department of Agriculture and Consumer Services (NCDA&CS) Standards Laboratory in 2009. Verified by the laboratory in conjunction with 2009 internal balance audit performed by RTI Quality Systems Program. 2010 NCDA&CS verifications have already been scheduled for March 2010 and July 2010.]	Chamber 1 100-mg S/N 41145 03/07/07 Verification: 99.99805 mg ± 0.00086 Laboratory Tolerance Interval: 99.994–100.002 mg	Average = 99.996 mg Std Dev = 0.0007 for 226 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		01/11/09 Verification: 99.99643 mg ± 0.00081 Laboratory Tolerance Interval: 99.993 – 100.000 mg	Average = 99.996 mg Std Dev = 0.0007 for 284 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		200-mg S/N 41147 03/07/07 Verification: 200.00646 mg ± 0.00086 Laboratory Tolerance Interval: 200.003–200.010 mg	Average = 200.003 mg Std Dev = 0.0007 for 226 weighings	Laboratory average falls within tolerance interval. Fourteen individual weighings of 200.002 mg fell 1 µg below lower limit. Weight was removed from service.
		04/11/09 Verification: 200.00737 mg ± 0.00078 Laboratory Tolerance Interval: 200.003–200.010 mg	Average = 200.003 mg Std Dev = 0.0006 for 285 weighings	Laboratory average falls within tolerance interval. Fifteen individual weighings of 200.002 mg fell 1 µg below lower limit. Weight was removed from service.
		Chamber 2 100-mg S/N 58096 03/07/07 Verification: 100.00290 mg ± 0.00086 Laboratory Tolerance Interval: 99.999–100.007 mg	Average = 100.001 mg Std Dev = 0.0007 for 154 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		04/11/09 Verification: 100.00051 mg ± 0.00081 Laboratory Tolerance	Average = 100.001 mg Std Dev = 0.0010 for 655 weighings	Laboratory average falls within tolerance interval.

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
		Interval: 99.997–100.004 mg		No weighing exceeded tolerance interval.
		100-mg S/N 58097 03/07/07 Verification: 100.00259 mg ± 0.00086 Laboratory Tolerance Interval: 99.999–100.006 mg	Average = 100.002 mg Std Dev = 0.0008 for 190 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval
		04/11/09 Verification: 99.998 mg ± 0.0081 Laboratory Tolerance Interval: 99.996–100.004 mg	Average = 100.000 mg Std Dev = 0.0010 for 679 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval
		100-mg S/N 18659 07/21/08 Verification: 99.98681 mg ± 0.00069 Laboratory Tolerance Interval: 99.983–99.991 mg	Average = 99.986 mg Std Dev = 0.0008 for 436 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval
		100-mg S/N 41144 07/21/08 Verification: 99.99927 mg ± 0.00069 Laboratory Tolerance Interval: 99.996 – 100.003 mg	Average = 99.999 mg Std Dev = 0.0007 for 534 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval
		200-mg S/N 58098 03/07/07 Verification: 200.00886 mg ± 0.00086 Laboratory Tolerance Interval: 200.005–200.013 mg	Mean = 200.004 mg Std Dev = 0.0009 for 154 weighings	Laboratory average does not fall within tolerance interval. Weight was removed from service.
		04/11/09 Verification: 200.00415 mg ± 0.00078 Laboratory Tolerance Interval: 200.000–200.008 mg	Mean = 200.005 mg Std Dev = 0.0018 for 654 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		200-mg S/N 58099 03/07/07 Verification: 200.00548 mg ± 0.00086 Laboratory Tolerance Interval: 200.001–200.009 mg	Mean = 200.004 mg Std Dev = 0.0007 for 190 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		04/11/09 Verification: 200.00371 mg ±	Mean = 200.003 mg Std Dev = 0.0008	Laboratory

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
		0.00078 Laboratory Tolerance Interval: 200.000 – 200.007 mg	for 679 weighings	average falls within tolerance interval. No weighing exceeded tolerance interval.
		200-mg S/N RTI01 07/21/08 Verification: 199.97816 mg ± 0.00075 Laboratory Tolerance Interval: 199.974 – 199.982 mg	Mean = 199.977 mg Std Dev = 0.0009 for 436 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
		200-mg S/N 41148 0721/08 Verification: 200.00151 mg ± 0.00075 Laboratory Tolerance Interval: 199.998 – 200.005 mg	Mean = 200.000 mg Std Dev = 0.0007 for 534 weighings	Laboratory average falls within tolerance interval. No weighing exceeded tolerance interval.
Balance calibrations	Auto (internal) calibration daily	Daily	N/A	
	External calibration annually or as needed	All balances inspected and externally calibrated by Mettler Toledo on August 18, 2009, using NIST-traceable weight	N/A	Next inspection and external calibration scheduled for August 2010
Balance audits	Annually	Audits of all balances performed by RTI Quality Systems Program personnel on November 12, 2009, using Class S-1 NIST-traceable weights	N/A	Audit included environmental evaluation, level test, scale-clarity test, zero-adjustment test, off-center (corner load) test, precision test, and accuracy test; all balances performed satisfactorily.
RH/T monitoring devices calibrations	Annually	Chamber temperature and humidity sensors, temperature and humidity controllers, and process alarm control board (mother board) calibrated by Environmental Specialties – LUWA on January 13, 2009	N/A	Chamber sensors, controllers, and process boards are calibrated on-site annually by Environmental Specialties
		Chamber data loggers calibrated by Veriteq Data Logger Test and Calibration Services on August 28, 2009	N/A	Next calibration due August 2010

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
Laboratory (Filter) blanks	Initial weight ± 15 μg	1864 total replicate weighings of 354 individual laboratory blanks	Average difference between final and initial weight = 3.0 μg Std Dev = 4.0 Min wt change = -20 μg Max wt change = 31.3 μg	18 total replicate weighings of 8 individual laboratory blank filters (1.0% of the replicate weighings; 1.1% of the individual laboratory blanks) exceeded the 15 μg criterion.
Replicates	Initial weight ± 15 μg	16,720 individual filters were weighed as pre-sampling (tared) replicates	Average = 0.3 μg	76 replicate weighings (0.5% of the weighings) exceeded the 15 μg criterion on the first pass. Outliers were reweighed in order to confirm a mass value with two weights within 5 μg of each other. The third weighings of all 76 individual outlier filters were within the 15 μg acceptance range.
		5,818 individual filters were weighed as post-sampling replicates	Average = 0.1 μg	38 replicate weighings (0.7% of the weighings) exceeded the 15 μg criterion on the first pass. Outliers were reweighed to confirm value with two weights within 5 μg of each other. The third weighings of the 38 individual outlier filters except for 1 filter were all within the 15 μg acceptance range.

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
Lot blanks (Lot stability filters) All lot stability tests performed on 12 filters – 2 filters randomly selected from each of 6 randomly selected boxes]	24-hour weight change < ± 5 µg	Whatman Lot 8274008 (rec'd 2/16/2009)	24 hours = +1 µg 48 hours = +2 µg 72 hours = +2 µg 96 hours = +3 µg	Weight changes fall within required range
			24 hours = +1 µg 48 hours = +1 µg 72 hours = +2 µg 96 hours = +2 µg	Weight changes fall within required range
			24 hours = +3 µg 48 hours = +2 µg 72 hours = -1 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = +2 µg 48 hours = +2 µg 72 hours = +4 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = +2 µg 48 hours = +1 µg 72 hours = +5 µg 96 hours = -5 µg	Weight changes fall within required range
			24 hours = +1 µg 48 hours = +2 µg 72 hours = +2 µg 96 hours = -4 µg	Weight changes fall within required range
			24 hours = +4 µg 48 hours = 0 µg 72 hours = +4 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = +3 µg 72 hours = +2 µg 96 hours = +2 µg	Weight changes fall within required range
			24 hours = +2 µg 48 hours = +4 µg 72 hours = -2 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = +4 µg 72 hours = 0 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = +4 µg 72 hours = +1 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = +4 µg 48 hours = +1 µg 72 hours = 0 µg 96 hours = -2 µg	Weight changes fall within required range

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
Lot blanks (Lot stability filters) (cont'd)	24-hour weight change < ± 5 µg	Whatman Lot 8274008 (rec'd 9/14/2009)	24 hours = -1 µg 48 hours = -1 µg 72 hours = +4 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = +1 µg 48 hours = -1 µg 72 hours = +2 µg 96 hours = -3 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = +1 µg 72 hours = 0 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = +2 µg 48 hours = -3 µg 72 hours = 0 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = -8 µg 48 hours = -5 µg 72 hours = +5 µg 96 hours = -5 µg	Weight changes fall within required range
			24 hours = -2 µg 48 hours = -5 µg 72 hours = +4 µg 96 hours = -5 µg	Weight changes fall within required range
			24 hours = +4 µg 48 hours = -5 µg 72 hours = +4 µg 96 hours = -6 µg	Weight changes fall within required range
			24 hours = +7 µg 48 hours = -6 µg 72 hours = +3 µg 96 hours = -4 µg	Weight changes fall within required range
			24 hours = +1 µg 48 hours = 0 µg 72 hours = +1 µg 96 hours = -3 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = -3 µg 72 hours = -1 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = +2 µg 48 hours = -2 µg 72 hours = 0 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = +5 µg 48 hours = -3 µg 72 hours = -1 µg 96 hours = -2 µg	Weight changes fall within required range

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
Lot blanks (Lot stability filters) (cont'd)	24-hour weight change < ± 5 µg	Whatman Lot 9026005	24 hours = +3 µg 48 hours = +1 µg 72 hours = +1 µg 96 hours = -6 µg	Weight changes fall within required range
			24 hours = -4 µg 48 hours = -1 µg 72 hours = 0 µg 96 hours = -3 µg	Weight changes fall within required range
			24 hours = +4 µg 48 hours = -3 µg 72 hours = 0 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = +7 µg 48 hours = -5 µg 72 hours = -2 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = +4 µg 48 hours = -3 µg 72 hours = +1 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = +2 µg 72 hours = -2 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = +2 µg 48 hours = -1 µg 72 hours = 0 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = +12 µg 48 hours = -10 µg 72 hours = 0 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = +3 µg 48 hours = 0 µg 72 hours = +2 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = +3 µg 48 hours = 0 µg 72 hours = 0 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = +1 µg 48 hours = -1 µg 72 hours = 0 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = +6 µg 48 hours = 0 µg 72 hours = -1 µg 96 hours = -1 µg	Weight changes fall within required range

QC Check	Requirements	QC Checks Applied in RTI Laboratory	Average Value Determined by Lab	Comments
Lot blanks (Lot stability filters) (cont'd)	24-hour weight change < ± 5 µg	Whatman Lot 9155021	24 hours = -10 µg 48 hours = +1 µg 72 hours = -2 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = -1 µg 72 hours = 0 µg 96 hours = -3 µg	Weight changes fall within required range
			24 hours = +2 µg 48 hours = -1 µg 72 hours = +1 µg 96 hours = -2 µg	Weight changes fall within required range
			24 hours = +1 µg 48 hours = -1 µg 72 hours = -1 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = +1 µg 48 hours = -2 µg 72 hours = 0 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = +1 µg 48 hours = -1 µg 72 hours = 0 µg 96 hours = 0 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = -1 µg 72 hours = +1 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = -1 µg 72 hours = +1 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = -1 µg 48 hours = -2 µg 72 hours = 0 µg 96 hours = +1 µg	Weight changes fall within required range
			24 hours = +2 µg 48 hours = -1 µg 72 hours = +1 µg 96 hours = -1 µg	Weight changes fall within required range
			24 hours = 0 µg 48 hours = 0 µg 72 hours = -1 µg 96 hours = +2 µg	Weight changes fall within required range
			24 hours = +1 µg 48 hours = 0 µg 72 hours = -1 µg 96 hours = 0 µg	Weight changes fall within required range

3.1.3 Summary of QC Results

Internal QC values generated by the laboratory usually met the criteria shown in **Table 3-1**; however, a small number of outliers were noted. Three of the 18 outlier laboratory blank weighings fell above the upper warning limit, suggesting dust fall-out. In response, the chamber continued to be wet-wiped monthly. Fifteen of the outlier laboratory blank weighings for 3 individual laboratory blank filters fell below the lower warning limit. These weighings occurred over the course of the entire year; therefore, it is not believed to be a systematic issue of debris on Teflon. In the case of outlier replicates, Gravimetric Laboratory analysts reweighed outliers to validate weights. There was 1 third weighing of the 38 individual outlier filters that did not fall within the 15 µg acceptance range. This individual instance is not believed to be an indication of a issue in the laboratory and is a random occurrence. Although the balance test weights used in the laboratory are working standards and may fall out of tolerance due to wear (scratches or nicks during handling) or environmental contamination, the weights were quite stable in 2009. The laboratory's primary standards are maintained by RTI's Quality Systems personnel and are used to audit the microbalances and verify the working mass standards annually.

3.1.4 Determination of Uncertainties and Method Detection Limits

The Gravimetric Laboratory's MDL calculations are based on replicate weighings of a large number of filters from filter lot acceptance batches. Because determination of gravimetric mass requires two separate weighings, each of which contributes to the total uncertainty, a multiplicative factor of 1.414 is included to account for the fact that each filter must be weighed twice to generate the final net mass. MDLs reported to AQS are shown in Appendix A. All balances use the same MDLs.

3.1.5 Audits, Performance Evaluations, Training, and Accreditations

Table 3-2 contains information regarding audits, performance evaluations (PEs), training, and accreditations for the Gravimetric Laboratory.

Table 3-2. Description of Audits, PEs, Training, and Accreditations

Type of Evaluation	Date	Administered by	Significant Findings/Comments
Internal Audit	January 23, 2009	RTI FRM Project QA Officer	The auditor noted that the gravimetric chambers were clean and that the log books and records were up to date.
Proficiency Evaluation (PE)	September 9, 2009 (results finalized)	EPA National Air and Radiation Environmental Laboratory (NAREL)	EPA NAREL finalized and published the results of the experimental inter-comparison of speciation laboratories completed in the fall of 2007. Analyses were performed on real-world samples collected in Montgomery, AL. RTI's Gravimetric Laboratory performance in the study was good, with the RTI lab agreeing with the EPA NAREL lab within 5 µg on exposed (sampled) filters.
	November 2009		EPA NAREL initiated an experimental inter-comparison of speciation laboratories. Analyses were performed on real-world samples collected in Montgomery, AL. RTI's analysis and report of the PT samples will be submitted to NAREL in January 2010 and results are expected spring 2010.
External Audit	September 1, 2009	EPA's audit team included Jewell Smiley and Steve Taylor, from NAREL, with Dennis Crumpler, David Shelow, and Solomon Ricks from the Office of Air Quality Planning and Standards (OAQPS)	A Technical Systems Audit (TSA) was conducted as part of the EPA's quality assurance oversight for the PM2.5 Chemical Speciation Network (CSN). Perfect agreement between RTI and NAREL was found for the metallic weights. As expected, agreement was not as good for the filters. Several factors could contribute to the differences in the NAREL/RTI filter mass comparisons, including the short equilibration time, static charge, and loose debris falling off the filters. Other observations made during the audit of the gravimetric laboratory area indicated excellent management of the area, well trained analysts, very good record keeping and very good quality control practices.
Accreditation	Certificate issued July 1, 2009	National Environmental Laboratory Accreditation Program (NELAP)	RTI transitioned from "state" accreditation to National Environmental Laboratory Accreditation Program (NELAP) accreditation through the Louisiana Environmental Laboratory Accreditation Program (LELAP).

3.2 Ions Analysis Laboratory

The Ion Analysis Laboratory used ten ion chromatographs to analyze 20,344 filter samples for cations (sodium, potassium, and ammonium) and 21,262 filter samples for anions (nitrate and sulfate). The analyses were performed for the CSN program during the period January 1 through December 31, 2009.

3.2.1 Quality Issues and Corrective Actions

There were no quality issues or corrective actions during the reporting period.

3.2.2 Description of QA/QC Checks Applied

Ion chromatographic analyses are performed by personnel from RTI's Environmental Industrial Chemistry Department (EICD). Ten Dionex ion chromatographic systems were used for performance of the measurements and are summarized in **Table 3-3**. Distribution of samples among these ten instruments was determined by laboratory workload and instrument availability.

Table 3-3. Description of Ion Chromatographic Systems Used for Analysis of $PM_{2.5}$ Filter Samples

System No.	Dionex IC Model	Ions Measured
A1	DX-500	SO_4, NO_3
A2	DX-500	SO_4, NO_3
A3	DX-600	SO_4, NO_3
A4	DX-600	SO_4, NO_3
A5	DX-600	SO_4, NO_3
A6	ICS-2000	SO_4, NO_3
C1	DX-500	Na, NH_4, K
C2	DX-600	Na, NH_4, K
C3	ICS-2000	Na, NH_4, K
C4	DX-600	Na, NH_4, K

QA/QC checks for ion analyses are summarized in **Table 3-4**. For ion analyses, a daily multipoint calibration (7 points for cations; 8 points for anions) is performed over the range 0.05 to 25.0 ppm for each ion (Na^+, NH_4^+, and K^+ for cation analyses; NO_3^- and SO_4^{2-} for anion analyses) followed by QA/QC samples, including (1) an RTI-prepared QC sample containing concentrations of each ion in the mid- to high-range of the calibration standard concentrations, (2) an RTI-prepared QC sample containing concentrations of each ion at the lower end of the calibration standard concentrations, and (3) a commercially-prepared, NIST-traceable QA sample containing known concentrations of each ion.

Table 3-4. Ion Analysis of $PM_{2.5}$ Quality Control/ Quality Assurance Checks

QA/QC Check	Frequency	Requirements
Calibration Regression Parameters	Daily	r ≥0.999
Initial QA/QC Checks: ▪ RTI prepared QC sample at mid- to high-range concentration ▪ RTI prepared QC sample at lower-end concentration ▪ Commercially prepared, NIST traceable QA sample	Daily, immediately after calibration Daily, immediately after calibration Daily, immediately after calibration	Measured concentrations within 10% of known values Measured concentrations within 10% of known values Measured concentrations within 10% of known values
Periodic QA/QC Checks: ▪ Replicate sample † ▪ QA/QC sample ▪ Matrix spiked sample extract ▪ Duplicates ‡	Every 20 samples Every 20 samples Every 20 samples At least one per day	RPD = 5% at 100x MDL* RPD = 10% at 10x MDL* RPD = 100% at MDL* Measured concentrations within 10% of known values Recoveries within 90 to 100% of target values No limit set. This data gathered for comparability studies.
▪ Reagent Blanks	One reagent blank per reagent used (DI H20 and/or eluent sample set extracted)	No limit set. This data gathered for comparability studies.

The regression parameters (a,b,c, and correlation coefficient, r) for the standard curve for each ion are compared with those obtained in the past. Typically, a correlation coefficient of 0.999 or better is obtained for each curve. If the correlation coefficient is < 0.999, the analyst carefully examines the individual chromatograms for the calibration standards and reruns any standard that is judged to be out of line with respect to the other standards or to values (peak area and/or height) obtained in the past for the same standard. Possible causes for an invalid standard run include instrumental problems, such as incomplete sampling by the autosampler. If necessary, a complete recalibration is performed.

When all individual calibrations have been judged acceptable, the results for the QA/QC samples are carefully examined. If the observed value for any ion being measured differs by more than 10% from the known value, the problem is identified and corrected. Any field samples are then analyzed.

During an analysis run, a replicate sample, a QA/QC sample, and a spiked sample are analyzed at the rate of at least one for every 20 field samples. Precision objectives for replicate analyses are ±5% for concentrations that equal or exceed 100 times the MDL, ±10% for concentrations at 10 times the MDL, and ±100% for concentrations at the MDL. MDLs for each instrument and analyte are listed in **Table 3-5**. The observed value for any ion being measured must be within 10% of the known value for the QA/QC samples (**Table 3-6**), and ion recoveries for the spiked samples must be within 90 to 110% of the target value. If these acceptance criteria are not met for any QA/QC or spiked sample, the problem is identified and corrected. All field samples analyzed since the last acceptable check sample are then reanalyzed.

Table 3-5. Minimum Detection Limit* for Each Instrument and Analyte

Instrument	Nitrate	Sulfate	Sodium	Ammonium	Potassium
A1	0.059	0.066	na	na	na
A2	0.058	0.090	na	na	na
A3	0.066	0.074	na	na	na
A4	0.070	0.100	na	na	na
A5	0.070	0.100	na	na	na
A6	0.211	0.036	na	na	na
C1	na	na	0.290	0.160	0.134
C2	na	na	0.290	0.160	0.134
C3	na	na	0.109	0.244	0.228
C4	na	na	0.290	0.160	0.134

* In µg/filter

Table 3-6. Definitions and Specifications for QA/QC Samples

Ion	Sample ID	Description/Specification
Anions	QA-CPI_LOW	0.6 ppm nitrate, 1.2 ppm sulfate
	QA-CPI_MED-HI	3.0 ppm nitrate, 6.0 ppm sulfate
	RTI-QC-HIGH	6.0 ppm nitrate, 12.0 ppm sulfate
	RTI-QC-LOW	0.6 ppm nitrate, 1.2 ppm sulfate
	RTI-QC-MED	1.5 ppm nitrate, 3.0 ppm sulfate
Cations	GFS 0.4 PPM QA	0.4 ppm each sodium, ammonium, and potassium
	GFS 4.0 PPM QA	4.0 ppm each sodium, ammonium, and potassium
	RTI 2.0 PPM QC Reg Std	2.0 ppm each sodium, ammonium, and potassium
	RTI 5.0 PPM QC	5.0 ppm each sodium, ammonium, and potassium

3.2.3 Summary of QC Results

QC checks performed included the following:

- Percent recovery for QC samples (standards prepared by RTI)
- Percent recovery for QA samples (commercial standards)
- Relative percent difference (RPD) for replicates
- Spike recovery
- Reagent blank (elution solution and DI water).

Table 3-7 shows recoveries for all five analytes (nitrate, sulfate, sodium, ammonium, and potassium) with low, medium, and high QC (prepared by RTI) samples and with low and medium-high QA samples (commercially prepared and NIST-traceable) for all of the instruments used for analysis.

Table 3-7. Average Percent Recovery for QA and QC Samples

Analyte	Sample ID	Count	Conc. µg/mL	Avg % Rec *	SD	Min	Max
Nitrate	QA-CPI_LOW	379	0.6	98.9%	2.8%	0.556	0.823
	QA-CPI_MED-HI	303	3.0	101.8%	1.8%	2.901	3.333
	RTI-QC-HIGH	300	6.0	101.9%	1.1%	5.826	6.507
	RTI-QC-LOW	584	0.6	97.8%	2.9%	0.549	0.833
	RTI-QC-MED	711	1.5	98.6%	1.9%	1.361	1.823
Sulfate	QA-CPI_LOW	379	1.2	98.9%	1.5%	1.118	1.342
	QA-CPI_MED-HI	303	6.0	102.1%	1.1%	5.850	6.665
	RTI-QC-HIGH	300	12.0	102.2%	1.0%	11.721	12.809
	RTI-QC-LOW	584	1.2	99.1%	1.5%	1.120	1.311
	RTI-QC-MED	711	3.0	100.4%	1.1%	2.835	3.236
Sodium	GFS 0.4 PPM QA	598	0.4	101.6%	2.2%	0.374	0.446
	GFS 4.0 PPM QA	569	4.0	100.1%	1.0%	3.846	4.160
	RTI 2.0 PPM QC Reg Std	402	2.0	100.8%	1.1%	1.954	2.107
	RTI 5.0 PPM QC	362	5.0	101.2%	1.0%	4.847	5.239
Ammonium	GFS 0.4 PPM QA	598	0.4	100.1%	4.0%	0.342	0.438
	GFS 4.0 PPM QA	569	4.0	100.1%	1.7%	3.521	4.339
	RTI 2.0 PPM QC Reg Std	402	2.0	100.6%	1.6%	1.827	2.144
	RTI 5.0 PPM QC	362	5.0	101.5%	2.0%	4.416	5.518
Potassium	GFS 0.4 PPM QA	598	0.4	102.5%	2.0%	0.378	0.449
	GFS 4.0 PPM QA	569	4.0	101.7%	0.9%	3.978	4.244
	RTI 2.0 PPM QC Reg Std	402	2.0	101.0%	1.0%	1.971	2.125
	RTI 5.0 PPM QC	362	5.0	101.0%	0.9%	4.917	5.240

* Acceptance criteria for average percent recovery is ± 10%.

Average recoveries for the QC samples ranged from 97.8 to 101.9% for the year. Average recoveries for the QA samples ranged from 98.9 to 102.5% for the year.

Table 3-8 shows percent recovery for all analyte spikes for the year. Average recoveries for the spikes ranged from 100.8 to 101.4%.

Table 3-8. Average Percent Recovery for Spikes

Analyte	Avg Recovery *	StDev	Count	Min	Max
Nitrate	101.3%	2.0%	670	95.2%	108.9%
Sulfate	101.4%	1.8%	670	85.5%	108.3%
Sodium	100.8%	1.5%	656	94.4%	109.6%
Ammonium	101.4%	2.0%	656	93.2%	109.3%
Potassium	100.9%	1.7%	656	94.7%	109.3%

* Acceptance criteria for average percent recovery is ± 10%

Table 3-9 presents filter blank (N BLANK) and reagent blank values for all analytes over the 12-month period.

Table 3-9. Filter Blank (N) and Reagent Blank Values (ppm) for all Analytes

Analyte	Type	Count	Avg	StDev	Min	Max
Nitrate	Eluent	20	0.013	0.011	0.000	0.031
	DI H2O	992	0.009	0.010	-0.025	0.040
Sulfate	Eluent	20	0.010	0.011	0.000	0.033
	DI H2O	992	0.004	0.007	-0.012	0.040
Sodium	DI H2O	643	0.003	0.006	0.000	0.039
Ammonium	DI H2O	643	0.000	0.000	0.000	0.000
Potassium	DI H2O	643	0.000	0.000	0.000	0.007

* N QC is a blank filter extract analyzed to test the acceptability of the cleaned nylon filter batches. One nylon filter is tested from each bottle used for filter cleaning. If the ion loading for any ion is >1 µg, the filters from that bottle are rejected.

** REAG is a 25-ml aliquot of either deionized water or anion eluent that has been pipetted into an extraction tube and carried through the same extraction procedure as the filters.

3.2.4 Assessment of Between-instrument Comparability

Anion duplicates were analyzed on all anion instruments and cation duplicates were analyzed on all cation instruments. A comparison of the ranges reported between the two instruments indicates very close results.

Table 3-10 and **Table 3-11** compare QA and QC samples run on separate instruments on the same day. Each day, the anion instruments ran at least two QC and three QA samples. Similarly, the cation instruments ran at least two QC and two QA samples on each instrument each day. These tables show that the difference between two instruments analyzing the same QA or QC sample are very small. The calculated average difference and standard deviation indicate a high level of between-instrument comparability.

Table 3-10. Between-instrument Comparability: IC Systems A3 vs. A4 and C1 vs. C2

Analyte	QA/QC Type	Conc., µg/mL	Count	Average * Difference	Standard Deviation of Diff.	Minimum Diff.	Maximum Diff.
Nitrate	QA-CPI_LOW	1.2	41	-0.001	0.007	-0.030	0.017
	QA-CPI_MED-HI	6.0	30	-0.003	0.036	-0.146	0.059
	RTI-QC-HIGH	12.0	28	0.001	0.082	-0.184	0.271
	RTI-QC-LOW	1.2	105	0.003	0.033	-0.031	0.237
	RTI-QC-MED	3.0	152	-0.013	0.055	-0.339	0.098

(continued)

Table 3.10. (continued)

Analyte	QA/QC Type	Conc., µg/mL	Count	Average * Difference	Standard Deviation of Diff.	Minimum Diff.	Maximum Diff.
Sulfate	QA-CPI_LOW	1.2	41	0.000	0.012	-0.019	0.035
	QA-CPI_MED-HI	6.0	30	0.011	0.063	-0.076	0.253
	RTI-QC-HIGH	12.0	28	0.046	0.168	-0.205	0.599
	RTI-QC-LOW	1.2	105	-0.002	0.011	-0.033	0.031
	RTI-QC-MED	3.0	152	0.000	0.026	-0.067	0.103
Sodium	GFS 0.4 PPM QA	0.4	111	-0.002	0.011	-0.035	0.025
	GFS 4.0 PPM QA	4.0	104	-0.014	0.050	-0.130	0.134
	RTI 2.0 PPM QC	2.0	47	-0.018	0.031	-0.088	0.035
	RTI 5.0 PPM QC	5.0	44	-0.048	0.076	-0.242	0.108
Ammonium	GFS 0.4 PPM QA	0.4	111	-0.005	0.025	-0.069	0.031
	GFS 4.0 PPM QA	4.0	104	0.010	0.086	-0.241	0.284
	RTI 2.0 PPM QC	2.0	47	-0.022	0.048	-0.167	0.038
	RTI 5.0 PPM QC	5.0	44	-0.017	0.175	-0.556	0.261
Potassium	GFS 0.4 PPM QA	0.4	111	-0.009	0.013	-0.044	0.011
	GFS 4.0 PPM QA	4.0	104	0.006	0.045	-0.124	0.149
	RTI 2.0 PPM QC	2.0	47	-0.017	0.032	-0.101	0.035
	RTI 5.0 PPM QC	5.0	44	-0.013	0.061	-0.156	0.126

* Differences are calculated as Concentration of A3 – Concentration of A4 for Anions and Concentration of C1 – Concentration of C2 for Cations.

Table 3-11. Between-instrument Comparability: IC Systems A5 vs. A4 and C3 vs. C2

Analyte	QA/QC Type	Conc., µg/mL	Count	Average * Difference	Standard Deviation of Diff.	Minimum Diff.	Maximum Diff.
Nitrate	QA-CPI_LOW	1.2	38	0.002	0.020	-0.073	0.046
	QA-CPI_MED-HI	6.0	29	-0.027	0.068	-0.299	0.128
	RTI-QC-HIGH	12.0	29	-0.005	0.115	-0.275	0.432
	RTI-QC-LOW	1.2	113	0.000	0.015	-0.068	0.040
	RTI-QC-MED	3.0	145	-0.003	0.060	-0.128	0.347

(continued)

Table 3.11 (continued)

Analyte	QA/QC Type	Conc., µg/mL	Count	Average * Difference	Standard Deviation of Diff.	Minimum Diff.	Maximum Diff.
Sulfate	QA-CPI_LOW	1.2	38	-0.009	0.012	-0.037	0.027
	QA-CPI_MED-HI	6.0	29	-0.031	0.125	-0.539	0.280
	RTI-QC-HIGH	12.0	29	-0.095	0.157	-0.636	0.144
	RTI-QC-LOW	1.2	111	-0.014	0.021	-0.131	0.031
	RTI-QC-MED	3.0	145	-0.020	0.043	-0.217	0.038
Sodium	GFS 0.4 PPM QA	0.4	175	0.011	0.010	-0.007	0.048
	GFS 4.0 PPM QA	4.0	156	0.004	0.033	-0.064	0.208
	RTI 2.0 PPM QC	2.0	67	0.021	0.030	-0.043	0.129
	RTI 5.0 PPM QC	5.0	51	0.004	0.051	-0.152	0.184
Ammonium	GFS 0.4 PPM QA	0.4	175	0.016	0.026	-0.065	0.064
	GFS 4.0 PPM QA	4.0	156	0.022	0.099	-0.182	0.651
	RTI 2.0 PPM QC	2.0	67	0.017	0.061	-0.112	0.262
	RTI 5.0 PPM QC	5.0	51	0.074	0.162	-0.198	0.602
Potassium	GFS 0.4 PPM QA	0.4	175	0.006	0.009	-0.011	0.037
	GFS 4.0 PPM QA	4.0	156	-0.003	0.031	-0.083	0.093
	RTI 2.0 PPM QC	2.0	67	0.015	0.022	-0.054	0.087
	RTI 5.0 PPM QC	5.0	51	-0.003	0.042	-0.152	0.099

* Differences are calculated as Concentration of A4 – Concentration of A5 for Anions and Concentration of C2 – Concentration of C3 for Cations.

3.2.5 Determination of Uncertainties and MDLs

Detection limits are determined by analyzing the lowest calibration standard 7 times and the detection limit, in µg/mL (or ppm), is calculated as 3 times the standard deviation of the 7 measurements. This detection limit is multiplied by 25mL, which is the extraction volume for each filter, to determine the detection limits in µg/filter. These calculations are performed for each instrument so that the detection limits are reported by instrument. Since most samples are not analyzed in replicate, analytical uncertainties must be estimated based on historical data and scientific judgment. A simple formula of the form $U = a \cdot C + b$ is used, where U is the uncertainty and C is the concentration. The coefficients a and b vary by instrument and by analyte. The b coefficient is essentially MDL/3. The value for a is assumed to be 0.05 (5%). MDLs for the CSN Program are summarized in Appendix A.

3.2.6 Audits, Performance Evaluations, Training, and Accreditations

On September 1, 2009, EPA/NAREL conducted a Technical Systems Audit (TSA) at RTI International as a part of the quality assurance oversight of the PM2.5 Chemical Speciation Network. Anion and cation spike solutions that had been prepared by NAREL were given to an ion chromatography analyst the morning of the audit. The solutions were analyzed during the day of the audit and the analysis results were given to the auditors during their debriefing with RTI staff. The auditors also were given aliquots of anion and cation calibration standards used by the RTI IC lab, and the calibration standards were analyzed at NAREL the following week. RTI's results were in excellent agreement with NAREL's results for all comparisons.

The IC lab also participated in NAREL's most recent inter-laboratory comparison study in which several laboratories analyzed replicate sets of single-blind filter samples for ions. Results from the proficiency testing study indicated good performance by RTI's IC lab. The auditors reported that they found no deficiencies associated with the IC lab and that the lab appeared to be well-managed with good laboratory practices, including good documentation.

3.3 Organic Carbon/Elemental Carbon Laboratory

The RTI OC/EC Laboratory staff analyzed 6,853 quartz filter samples by the STN or CSN/TOT method during the period January 1, 2009, through December 31, 2009, and reported the results of those analyses to RTI's Speciation Program Information Management System (SPIMS). Four Sunset Laboratory Carbon Aerosol Analyzers (designated by the letters R, S, T, and F) were used for CSN/TOT analyses for the entire year. Analyzer T was upgraded from a single-mode (TOT) to a dual-mode (TOT and TOR) analyzer effective March 27, 2009. Since the calculation software was also upgraded, analyzer T before the upgrade is designated Ta, and analyzer T after the upgrade is designated Tb.

3.3.1 Quality Issues and Corrective Actions

No issues that affected the quality of reported data arose during the reporting period.

3.3.2 Description of QC Checks Applied

Quality control (QC) checks, acceptance criteria, and corrective actions for the OC/EC Laboratory are summarized in **Table 3-12**.

Table 3-13 contains a list of all data flags assigned to carbon analysis data and the number of filter analysis results assigned each flag in the OC/EC Laboratory during the reporting period. Only flags assigned in OC/EC Laboratory data reports to RTI's SPIMS are included in the table. The Sample Handling and Archiving Laboratory (SHAL) or the QA Officer may have assigned additional flags to the quartz filter samples based on field data or additional data validation checks.

Table 3-12. OC/EC Laboratory QC Checks, Acceptance Criteria, and Corrective Actions

QC Element	Frequency	Acceptance Criteria	Response When Outside Criteria
Method Detection Limit	After oven replacement or annually, whichever comes first	MDL 0.5 µg C/cm^2	Investigate the source of the problem and initiate corrective action, if necessary, to correct the problem before analyzing samples.
Calibration Peak Area	Every analysis	Within 95% to 105% of average calibration peak area for that day	Discard the results of that analysis and, if necessary, repeat the analysis with a second punch from the same filter.
Instrument Blank	Daily and after about 30 samples	(1) Blank 0.3 µg/cm^2, and (2) calibration peak area 90% to 110% of average for the weekly three-point calibration.	Determine if the problem is with the filter or the instrument and, if necessary, initiate corrective action to identify and solve any instrument problem, and run an acceptable instrument blank before analyzing samples.
Three-Point Calibration	Weekly	(1) Correlation Coefficient (R^2) 0.998 [with force-fit through 0,0], (2) 93% to 107% recovery for all three standards, and (3) FID response factor is 90% to 110% of the average response factor for all three standards.	Determine the cause of the nonlinearity, and initiate actions that will identify and solve any problem that may have arisen. Then repeat the three-point calibration, which must yield satisfactory results before samples are analyzed.
Calibration Check	Daily	(1) 93% to 107% recovery, (2) calibration peak area 90% to 110% of average for the weekly three-point calibration, and (3) FID response factor is 90% to 110% of average response factor for last three-point calibration.	Initiate corrective action, if necessary, to solve the problem before analyzing samples.
Duplicate Analyses	10% of all samples	(1) TC Values greater than 10 µg C/cm^2-- Less than 10% RPD, (2) TC Values 5 - 10 µg C/cm^2-- Less than 15% RPD, (3) TC Values less than 5 □g C/cm^2-- Within 0.75 µg C/cm^2.	Flag analysis results for that filter with non-uniform filter deposit (LFU) flag.

Table 3-13. OC/EC Laboratory-Assigned Data Flags

Flag	Description	Number of Filters
LFU	Filter inspection flag - non-uniformity (Duplicate analysis failed applicable duplicate criterion.)	33
	Total Number of Analyses Flagged by OC/EC Analysts	33
	Total Number of OC/EC Analyses Reported to SPIMS	6,853
	Percent of OC/EC Analyses Flagged by Analysts	0.482%

3.3.3 Summary of QC Results

3.3.3.1 Instrument Blanks

Table 3-14 contains the number of instrument blanks run during the reporting period and the average, minimum, and maximum measured blank values for each of the carbon aerosol analyzers used in the program. For all reported data, the last instrument blank run before reported samples were analyzed met the blank criterion for TC, and the internal standard peak area (IS) was within 90% to 110% of the average IS area for the most recent full FID calibration for that analyzer.

Table 3-14. OC/EC Instrument Blank Statistics

Blank Statistic	CSN/TOT Analyzer				
	R	S	Ta	Tb	F
Number of Instrument Blanks	228	225	53	107	119
Mean Response (µg C/cm^2)	0.013	0.053	0.018	-0.007	0.025
Standard Deviation	0.016	0.030	0.018	0.060	0.054
Minimum Response (µg C/cm^2)	0.000	0.004	0.000	-0.214	-0.177
Maximum Response (µg C/cm^2)	0.129	0.194	0.065	0.257	0.191
IS/Cal IS (%): Mean	100.34%	100.36%	101.68%	100.90%	100.98%
IS/Cal IS (%): St. Dev.	2.32%	1.71%	2.76%	2.37%	3.06%
IS/Cal IS (%): Minimum	91.09%	94.01%	95.70%	94.23%	94.10%
IS/Cal IS (%): Maximum	107.10%	106.12%	108.06%	109.94%	109.62%

3.3.3.2 Calibrations

Table 3-15 provides summary statistics for full 3-point calibrations by analyzer. In addition to number of 3-point calibrations run, the table includes average, minimum, and maximum values for slope and linearity (expressed as correlation coefficient, R^2) for the calibrations and for the three percentages used as QC checks on analysis results for each individual calibration standard. The three percentages separately calculated for the low-, mid-, and high-level calibration standards include:

1. FID response to the internal standard (expressed as a percentage of the average FID response to the internal standard for the 3-point calibration),

2. Recovery (mass of carbon measured expressed as a percentage of the mass of carbon in the spiked volume of standard used), and

3. FID response factor (expressed as a percentage of the average FID response factor for the 3-point calibration).

Table 3-15. OC/EC Three-Point Calibration Statistics

Variable/Statistic			CSN/TOT Analyzer				
			R	S	Ta	Tb	F
Number of Full Calibrations Passing All Criteria			52	54	10	30	30
Number of Full Calibrations Failing Any Criterion			0	0	0	0	0
Slope (counts/µgC), forced through origin (0,0)		Average	7,594	5,945	6,390	13,645	10,017
		Minimum	6,950	5,352	6,178	12,680	8,651
		Maximum	8,141	6,602	6,734	14,333	10,685
Correlation Coefficient (R^2) (Criterion: ≥0.998)		Average	0.9996	0.9993	0.9995	0.9996	0.9997
		Minimum	0.9981	0.9980	0.9984	0.9983	0.9987
		Maximum	1.0000	1.0000	1.0000	1.0000	1.0000
FID Response to Internal Standard as a Percent of Average Internal Standard FID Response for 3-Point Cal (Criterion: 90% to 110%)	Low Cal	Average	100.05%	100.02%	100.12%	101.00%	101.48%
		Minimum	97.28%	98.30%	99.25%	96.60%	96.44%
		Maximum	101.37%	101.71%	100.85%	104.39%	104.66%
	Mid Cal	Average	100.04%	99.93%	99.77%	100.06%	99.55%
		Minimum	98.47%	98.22%	98.26%	95.56%	95.38%
		Maximum	103.17%	102.50%	100.88%	103.49%	102.59%
	High Cal	Average	99.91%	100.05%	100.11%	98.96%	98.80%
		Minimum	98.66%	98.48%	99.12%	95.98%	95.51%
		Maximum	101.55%	102.49%	101.58%	101.43%	102.49%
Recovery: Mass of Carbon Measured as a Percent of Mass of Carbon Spiked (Criterion: 93% to 107%)	Low Cal	Average	101.02%	101.64%	99.79%	101.00%	101.48%
		Minimum	95.97%	96.75%	96.01%	96.60%	96.44%
		Maximum	104.90%	104.80%	103.27%	104.39%	104.66%
	Mid Cal	Average	100.43%	100.61%	101.11%	100.06%	99.55%
		Minimum	97.60%	97.31%	99.28%	95.56%	95.38%
		Maximum	104.49%	104.89%	104.28%	103.49%	102.59%
	High Cal	Average	98.54%	97.74%	99.12%	98.96%	98.80%
		Minimum	96.23%	95.41%	97.44%	95.98%	95.51%
		Maximum	102.45%	103.74%	100.74%	101.43%	102.49%
	All 3 Cals	Average	100.00%	100.00%	100.00%	100.01%	99.94%
		Minimum	99.98%	99.97%	99.98%	99.97%	98.50%
		Maximum	100.02%	100.03%	100.02%	100.35%	100.02%
FID Response Factor as a Percent of Average FID Response Factor for 3-Point Cal (Criterion: 90% to 110%)	Low Cal	Average	100.27%	101.66%	99.91%	101.11%	101.72%
		Minimum	96.30%	96.68%	95.83%	94.74%	96.88%
		Maximum	104.03%	105.02%	104.15%	104.83%	105.91%
	Mid Cal	Average	100.47%	102.85%	101.70%	101.55%	101.38%
		Minimum	97.69%	94.95%	97.98%	95.54%	95.65%
		Maximum	104.20%	106.21%	105.70%	105.69%	105.15%
	High Cal	Average	98.46%	97.79%	99.21%	98.69%	98.46%
		Minimum	96.11%	95.26%	96.93%	95.43%	96.37%
		Maximum	102.35%	102.17%	101.04%	101.59%	101.49%

Table 3-16 provides summary statistics for daily calibration checks by analyzer. The table gives the number of calibration checks run on each analyzer and the average, minimum, and maximum values of the three percentages used as QC checks to determine if a calibration check is acceptable. The three percentages used to evaluate the validity of each calibration check analysis include:

1. Internal standard area (as a percentage of the average internal standard area for the last 3-point calibration),

2. Recovery (mass of carbon measured expressed as a percentage of the mass of carbon in the spiked volume of standard used), and

3. FID response factor (as a percentage of the average response factor for the last 3-point calibration).

A calibration check is acceptable only if it meets all three criteria, and an acceptable daily calibration check was run on each analyzer before any filter samples were analyzed on that analyzer.

Table 3-16. OC/EC Daily Calibration Check Statistics

Variable/Statistic		R	S	Ta	Tb	F
Number of Cal Checks Passing All Criteria		170	162	41	68	87
Number of Cal Checks Failing Any Criterion		0	0	0	0	0
Internal Standard (IS) Area as a Percent of Average IS Area for 3-Point Cal (Criterion: 90% to 110%)	Average	100.14%	100.32%	99.79%	99.87%	101.19%
	Minimum	91.34%	94.68%	94.88%	90.16%	95.91%
	Maximum	105.71%	104.36%	106.38%	104.32%	108.52%
Recovery: Mass of Carbon Measured as a Percent of Mass of Carbon Spiked (Criterion: 95% to 105%)	Average	99.87%	100.88%	100.79%	99.37%	99.17%
	Minimum	95.37%	95.06%	95.10%	95.07%	95.15%
	Maximum	104.80%	104.96%	104.98%	104.99%	104.74%
FID Response Factor as a Percent of Average Response Factor for 3-Point Cal (Criterion: 90% to 110%)	Average	100.02%	101.21%	100.57%	99.22%	100.37%
	Minimum	90.45%	93.43%	93.37%	90.83%	93.71%
	Maximum	109.49%	107.86%	107.49%	105.33%	109.82%

3.3.3.3 Duplicate Analyses

Table 3-17 gives summary statistics for all duplicate CSN/TOT OC/EC analyses run on all analyzers during the reporting period. A duplicate analysis was run on the same analyzer on about every 10th filter. A total of 987 duplicate CSN/TOT analyses were run in 2009. OC/EC analysis results for 35 (or 3.55%) of those duplicates failed the applicable duplicate criterion and were flagged as coming from a filter with a non-uniform deposit.

Table 3-17. Duplicate OC/EC Analysis Statistics

Variable/Statistic		Analyzer				
		R	S	Ta	Tb	F
Total Number of Duplicate Analyses		321	317	101	123	125
Number of Analyses Flagged as Failing Duplicate Criteria		11	15	4	5	0
Percentage of Duplicate Analyses Failing Duplicate Criteria		3.43%	4.73%	3.96%	4.07%	0.00%
OC Sample vs. Dup Plot	Slope	0.993	1.015	0.988	1.009	1.002
	Intercept	0.025	-0.076	0.033	-0.022	0.020
	R^2	0.999	0.996	0.990	0.945	0.988
EC Sample vs. Dup Plot	Slope	0.957	0.854	0.915	0.869	1.018
	Intercept	0.023	0.061	0.024	0.084	-0.010
	R^2	0.976	0.921	0.946	0.886	0.996
TC Sample vs. Dup Plot	Slope	0.993	1.011	0.985	0.990	1.004
	Intercept	0.034	-0.068	0.028	0.069	0.004
	R^2	0.999	0.994	0.989	0.944	0.990
Pk1C Sample vs. Dup Plot	Slope	1.001	0.945	1.004	1.013	1.015
	Intercept	-0.011	0.020	0.001	-0.049	-0.016
	R^2	1.000	0.990	0.995	0.976	0.992
Pk2C Sample vs. Dup Plot	Slope	0.988	0.970	0.972	0.949	0.986
	Intercept	0.005	0.029	0.024	0.104	0.027
	R^2	0.999	0.998	0.979	0.881	0.980
Pk3C Sample vs. Dup Plot	Slope	0.989	1.018	0.914	0.972	0.996
	Intercept	0.022	-0.015	0.044	0.045	0.021
	R^2	0.965	0.986	0.955	0.946	0.977
Pk4C Sample vs. Dup Plot	Slope	1.034	1.019	0.993	1.005	1.001
	Intercept	-0.015	-0.021	0.011	0.009	0.001
	R^2	0.989	0.961	0.986	0.959	0.994
PyrolC Sample vs. Dup Plot	Slope	0.979	1.041	0.145	0.842	1.030
	Intercept	-0.002	-0.006	0.005	-0.082	0.009
	R^2	0.999	0.999	0.022	0.895	0.985

3.3.3.4 Assessment of Between-Instrument Comparability

While duplicate analysis results (two punches from the same filter run on the same analyzer) agree fairly well, replicate analysis results (two or more punches from the same filter run on different analyzers) for the OC Peaks do not always agree as well, especially for Pyrol C. The level of oxygen contamination present in the analyzer ovens during the non-oxidizing heat ramps seems to be the primary cause of the differences in OC Peak measurements between analyzers.[1] Whether the oxygen comes from diffusion through seals inside the analyzer, by back-diffusion from the oxidizer oven (immediately downstream from the sample oven), or from some type of carry-over from the preceding analysis is not known.

[1] The helium supply line for each RTI OC/EC analyzer is fitted with two oxygen traps: a high-capacity trap followed by an indicating trap. Only ultra-high purity (UHP) helium is used for OC/EC analysis. All OC/EC analyzers, regardless of manufacturer or model, have this problem.

Trace amounts of contaminating oxygen cause some of the carbon in thermally unstable organic species to be evolved rather than forming char during the non-oxidizing heating ramps. This early evolution of organic carbon reduces the amount of organic char formed and shifts the OC/EC split time to an earlier time in the analysis. It appears that the presence of oxygen does not significantly change the OC:EC mass ratio. However, the presence of oxygen shifts the evolution of OC from the later OC Peaks (especially Pyrol C) to the earlier OC Peaks.

To assess between-analyzer comparability of OC, EC, TC, and the individual OC Peaks, RTI's OC/EC Laboratory analyzed a total 294 filters by the STN/TOT method on three Sunset Laboratory Carbon Aerosol Analyzers over a 3-year period. Because carbon fractions are defined by the conditions (temperature, oxygen concentration, and time) under which they evolve from the sample during analysis, carbon fractions (except for TC) are not independent analytes, and the usual statistical approaches to measurement uncertainty are not adequate and may be misleading. As a result, RTI's OC/EC Laboratory developed an empirical procedure to estimate reasonable uncertainties for all of the reported carbon fractions based on replicate (across-analyzers) analysis data. The results are presented in Section 3.3.5.

3.3.4 Determination of Uncertainties and MDLs

Table 3-18 gives estimated constant and proportional components of uncertainty for OC, EC, TC, and the five OC Peaks measured on multiple analyzers in RTI's OC/EC Laboratory.[4,5,6] The constant component of uncertainty appears to be essentially independent of filter loading and can be easily estimated in plots of absolute difference (y-axis) vs. average value (x-axis) for sample-duplicate pairs of analyses run on the same analyzer. The proportional component of uncertainty is most evident in plots of individual measurements of replicate analyses of filter samples across multiple analyzers (y-axis) vs. the average measured values across analyzers for those filter samples (x-axis).

From the table, it is obvious that Pyrol C has by far the largest proportional component of uncertainty. Pyrol C is a measure of the pyrolyzed organic carbon remaining on the filter punch after oxygen is added at the end of the four non-oxidizing heating ramps. If the sample contains little pyrolyzable organic carbon, the trace amounts of contaminating oxygen may prevent the formation of any Pyrol C. If the sample contains sufficient pyrolyzable organic carbon to exceed the reaction capacity of the trace amounts of contaminating oxygen, then at least some PyrolC will be measured. Because the trace amounts of contaminating oxygen differ slightly between analyzers, the distribution of OC among the OC Peaks differs more between analyzers than it does within duplicates run on the same analyzer. Because PyrolC is formed primarily during the evolution of Pk3 C and Pk4 C, these last-evolved OC Peaks typically have the largest between-analyzer variability and, therefore, larger measurement uncertainties.

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[4] Peterson, M.R., and M.H. Richards. 2006. *Estimation of Uncertainties for Organic Carbon Peaks Data in Thermal-Optical-Transmittance Analysis of PM2.5 by the Speciation Trends Network Method*. Presented at the A&WMA Symposium on Air Quality Measurement Methods and Technology, May 9-11, 2006, Durham, NC.
[5] Peterson, M.R., J.B. Flanagan, and M.H. Richards. 2008. *Estimating Uncertainties for Non-Independent Analytes--Thermal-Optical Analysis of Carbon in PM2.5*. Presented at Air & Waste Management Association (A&WMA) 101st Annual Conference & Exhibition, Portland, OR, June 23-27.
[6] Peterson, M.R., and M.H. Richards. 2008. *Evaluating Nonuniformity of Carbon Fractions in PM2.5 Collected on Quartz Fiber Filters*. Presented at Air & Waste Management Association (A&WMA) Symposium on Air Quality Measurement Methods and Technology, Chapel Hill, NC, November 3-6.

Table 3-18. Estimated Uncertainties for CSN/TOT Carbon Fractions

Fraction	"Best Fit" Uncertainty (μgC/cm²)
OC	(0.20 + 0.05*OC)
EC	(0.20 + 0.05*EC)
TC	(0.30 + 0.05*TC)
Pk1 C	(0.20 + 0.05*Pk1 C)
Pk2 C	(0.20 + 0.05*Pk2 C)
Pk3 C	(0.30 + 0.05*Pk3 C)
Pk4 C	(0.30 + 0.10*Pk4 C)
Pyrol C	(0.20 + 1.40*Pyrol C)

Table 3-19 gives target MDL's for all reported carbon fractions. MDL values for the five OC Peaks were taken from the constant components of uncertainty in Table 3-17. This same approach was used to determine reasonable target MDL's for OC, EC, and TC, all of which have proven to be attainable when an analyzer is functioning properly and all operating conditions are under control.

Table 3-19. Target MDLs for OC/EC Carbon Fractions

Carbon Fraction	Target MDL (μgC/cm²)
OC	0.20
EC	0.20
TC	0.30
Pk1 C	0.20
Pk2 C	0.20
Pk3 C	0.30
Pk4 C	0.30
Pyrol C	0.20

3.3.5 Audits, PEs, Training, and Accreditations

3.3.5.1 System Audits

RTI's chemical speciation laboratories were audited on September 1, 2009. The audit report section for RTI's OC/EC Laboratory concluded: "Good laboratory practices, good QC practices, and good record keeping are performed in the Carbon laboratory. No deficiencies were observed for the Carbon laboratory during the TSA."

3.3.5.2 Performance Evaluations

RTI's OC/EC Laboratory was one of four laboratories participating in the December 2008 EPA/NAREL interlaboratory comparison study. Both CSN/TOT and IMPROVE_A analysis results for the PE samples were reported to EPA/NAREL in February 2009. The TSA report included the following statement concerning the PE samples: "Carbon results from NAREL's 2008 PT study were discussed during the interview with Max [Peterson]. The study compared CSN and IMPROVE_A analysis results from five laboratories analyzing quartz fiber test filters. RTI analyzed filters on both Sunset Labs and DRI Model 2001 instruments using both the CSN method as well as the IMPROVE_A method. The study showed overall good agreement between NAREL, RTI, and DRI for carbon analyses by both methods."

3.3.5.3 Training

No new analysts were trained for the CSN/TOT method; however, one additional CSN/TOT-trained analyst was instructed in running the IMPROVE_A method on both Sunset Laboratory and DRI Model 2001 analyzers and in performing a full IMPROVE_A FID calibration on both analyzers.

3.3.5.4 Accreditations

There are no accreditation programs for OC/EC analysis.

3.4 DRI Carbon Analysis Laboratory

The DRI Carbon Analysis Laboratory, as a subcontractor to RTI for EPA's Chemical Speciation Network (CSN), received 11,744 quartz-fiber filters in batches 61 through 91 during the period January 1, 2009 through December 31, 2009. (Batch numbers refer to sets of quartz filters sent from RTI to DRI approximately twice per month.) DRI analyzed 11,406 quartz-fiber filter samples in the batches using the IMPROVE_A method (Chow et al. 2007) and reported the results of those analyses to RTI. Some of the filters in batch 91 were not analyzed until January 2010 and the results for the entire batch 91 were not reported until 2010. The statistics included in this report cover only those samples analyzed in 2009. Eleven DRI Model 2001 Thermal/Optical Carbon Analyzers (designated as units # 6 – 13, 16, 18, and 19) were used for the CSN IMPROVE_A analyses.

3.4.1 Quality Issues and Corrective Actions

Oxygen tests were performed in April 2008. Subsequent tests were delayed due to the need to repair a component used in the oxygen measurements and scheduling around annual GC/MS calibrations. Additional oxygen tests were completed as soon as possible (January 2009) after repairs and calibrations were completed.

3.4.2 Description of QC Checks Applied

Samples received at the DRI Carbon Laboratory follow the chain-of-custody procedure specified in DRI SOP #2-111.4. Samples are analyzed following DRI SOP # 2-216r2, revised in July 2008. Quality control (QC) measures for the DRI carbon analysis are summarized in **Table**

3-20. It specifies the frequency and standards required for the specified checks, along with the acceptance criteria and corrective actions.

Table 3-20. DRI Carbon Analysis QC Measures

Requirement	Frequency	Calibration Standard	Performed By	Acceptance Criteria	Corrective Action
Temperature Calibration	1/6 months or after major instrument repair	6 Tempilaq G temperature-indicating liquids	Analyst	Slope within 5% of 1; intercept <15, and r^2 >0.98	Troubleshoot instrument, especially position of thermocouple, and repeat calibration until results are satisfactory
Multipoint Calibrations	1/6 months or after major instrument repair	CH_4/He, CO_2/He, sucrose, and KHP QC standards	Analyst	All slopes ± 5% of average	Troubleshoot instrument and repeat calibration until results are satisfactory
Oxygen Test	1/6 months or after major instrument repair	N/A	GC/MS Analyst	<100 ppm O_2	Troubleshoot instrument and repeat test until results are satisfactory
Minimum Detection Limit (MDL)	Initially, then annually or after major instrument change	Lab blanks	Carbon Lab Supervisor, Project Mgr, QA Mgr	Within ± 10% of previous limits	Troubleshoot instrument and repeat calibration until results are satisfactory
Lower Quantifiable Limit (LQL)	Annually	Field blanks	Carbon Lab Supervisor, Project Mgr, QA Mgr	Within ± 10% of previous limits	Troubleshoot instrument and check samples
System Blank Check	Beginning of analysis day	N/A	Analyst	≤ 0.2 µg C/cm^2	Check instrument and filter lots; bake oven
Leak Check	Beginning of analysis day	N/A	Analyst	Oven pressure drops <0.01 psi per sec.	Locate leaks and fix
Laser Performance Check	Beginning of analysis day	Clean blank filter	Analyst	Reflectance 1400-2000 mv; Transmittance 800-1300 mv; both consistent with previous days values	Check laser and filter holder position; adjust potentiometer
Auto-Calibration Check	Beginning of analysis day	NIST 5% CH_4/He gas standard	Analyst	Three calibration peak areas should compare and be >20,000	Troubleshoot and correct system before analyzing samples
Calibration Peak Area Check	Every sample	NIST 5% CH_4/He gas standard	Analyst	Counts > 20,000 and 95-100% of average calibration peak area for the day	Discard analysis result and repeat analysis with second filter punch

Table 3-21 contains a list of quality-related data flags assigned to carbon analysis data and the number of filter analysis results assigned each flag by the DRI Carbon Laboratory during the reporting period. Out of 13,972 runs, there were 1140 runs flagged as invalid and 3,984 runs with blank flags. Only 10 were flagged based on notes on the sample Petri dish; the rest were modified for this report based on data in a spreadsheet later submitted to DRI by RTI. Actual sample blank information is not included in the data files RTI sends to DRI at the time the filters are to be analyzed. It was provided to DRI prior to completion of this report for MDL and LQL

analysis. In 2009 there were four categories of blanks – 24-hour field blank, trip blank, backup filter, and trip blank backup filter. In addition, there were 1425 runs with replicate (and duplicate) flags. In many cases, there was more than one flag for a sample run. The flag categories "s" and "v" will generally result in additional runs. Only flags assigned in DRI Carbon Laboratory data reports to RTI are included in the table. RTI interprets the DRI Carbon Laboratory validation flags and assigns AQS null value codes or validity status codes when reporting the data to AQS.

Table 3-21. DRI Carbon Laboratory-Assigned Data Flags

Validation Flag Category	Validation Flag Subcategory	Description	No. of Sample Runs
n		Foreign substance on sample	6
s		Suspect analysis result	6
v		Void (invalid) analysis result	1140
	v2	Replicate analysis failed acceptable limit	337
	v3	Potential contamination	14
	v5	Analytical instrument error	689
	v6	Analyst error	73
	v7	Software malfunction	27
		Total no. of sample runs (incl. blank and replicate flags)	13973

3.4.3 Summary of QC Results

3.4.3.1 Blanks

Tables 3-22 and **3-23** contain the number of instrument system blanks run during the reporting period and the average, standard deviation, maximum, minimum, and median measured blank values for the eleven carbon aerosol analyzers used in the program. Specifically, **Table 3-22** gives the system blank values by month for all eleven analyzers and **Table 3-23** gives the system blank values for each of the eleven carbon analyzers used during this reporting period.

System blanks are run at the beginning of each analysis day for each operating analyzer. They may be rerun until the analyzer gives readings lower than 0.20 µg C/cm^2 of TC. However, they are also run to check instrument performance after repairs and adjustments. In addition, system blanks are assigned to the instrument and not to the project. The data in **Tables 3-22** and **3-23** include all reported system blank data that met the blank criterion for TC before reported samples were analyzed using the IMPROVE_A method for this and other projects.

In addition, **Tables 3-24** through **3-26** give the analysis results by analyzer for the 24-hour (field), backup filter, and trip blanks, respectively, based upon the blank list provided to DRI by RTI. There were only 9 trip blank backup filters, so there is no table showing their analysis results by analyzer. However, **Table 3-27** summarizes the results for all analyzers for each type of blank, including trip blank backup filters. Average TC concentration for the 1609 field blanks was 1.5 ± 2.3 µg/cm^2, while it was 3.4 ± 1.7 µg/cm^2 for the 1579 backup filters, 1.4

Table 3-22. DRI Carbon Laboratory System Blank Statistics for All Analyzers by Month for the Period 1/1/09 through 12/31/09

			IMPROVE_A Parameter (units are µg C/cm²)													
Month	No.	Statistic	O1TC	O2TC	O3TC	O4TC	OPTRC	OPTTC	OCTRC	OCTTC	E1TC	E2TC	E3TC	ECTRC	ECTTC	TCTC
Jan	229	Mean	0.002	0.009	0.022	0.001	0.001	0.001	0.036	0.036	0.001	0.001	0.004	0.005	0.005	0.041
		StdDev	0.010	0.016	0.024	0.008	0.007	0.007	0.040	0.040	0.006	0.006	0.019	0.020	0.020	0.048
		Max	0.108	0.097	0.138	0.080	0.102	0.102	0.176	0.176	0.077	0.063	0.156	0.156	0.156	0.198
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.017	0.000	0.000	0.000	0.023	0.023	0.000	0.000	0.000	0.000	0.000	0.024
Feb	216	Mean	0.002	0.010	0.020	0.001	0.000	0.000	0.034	0.034	0.000	0.001	0.002	0.003	0.003	0.037
		StdDev	0.009	0.021	0.023	0.004	0.000	0.000	0.041	0.041	0.001	0.007	0.011	0.014	0.014	0.046
		Max	0.075	0.141	0.109	0.030	0.000	0.000	0.186	0.186	0.008	0.074	0.111	0.125	0.125	0.200
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.015	0.000	0.000	0.000	0.019	0.019	0.000	0.000	0.000	0.000	0.000	0.022
Mar	170	Mean	0.002	0.006	0.017	0.000	0.000	0.000	0.025	0.025	0.000	0.000	0.001	0.002	0.002	0.027
		StdDev	0.009	0.014	0.021	0.004	0.000	0.000	0.034	0.034	0.001	0.002	0.007	0.008	0.008	0.036
		Max	0.063	0.114	0.107	0.043	0.000	0.000	0.179	0.179	0.007	0.025	0.076	0.078	0.078	0.179
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.009	0.000	0.000	0.000	0.013	0.013	0.000	0.000	0.000	0.000	0.000	0.014
Apr	167	Mean	0.002	0.004	0.013	0.000	0.000	0.000	0.020	0.020	0.000	0.001	0.003	0.004	0.003	0.023
		StdDev	0.011	0.011	0.023	0.002	0.000	0.004	0.032	0.033	0.002	0.003	0.016	0.019	0.019	0.039
		Max	0.120	0.062	0.144	0.025	0.000	0.041	0.177	0.177	0.028	0.027	0.170	0.197	0.197	0.197
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.004
May	160	Mean	0.002	0.005	0.014	0.001	0.000	0.001	0.022	0.022	0.000	0.001	0.001	0.002	0.002	0.024
		StdDev	0.007	0.011	0.019	0.006	0.000	0.005	0.030	0.032	0.003	0.005	0.006	0.008	0.007	0.034
		Max	0.047	0.058	0.092	0.059	0.000	0.048	0.190	0.190	0.037	0.039	0.063	0.064	0.064	0.193
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.001	0.000
		Median	0.000	0.000	0.007	0.000	0.000	0.000	0.010	0.010	0.000	0.000	0.000	0.000	0.000	0.010
Jun	218	Mean	0.002	0.007	0.021	0.001	0.000	0.000	0.030	0.030	0.000	0.000	0.001	0.002	0.002	0.033
		StdDev	0.007	0.017	0.025	0.004	0.000	0.001	0.040	0.040	0.002	0.002	0.008	0.009	0.009	0.042
		Max	0.049	0.095	0.113	0.031	0.000	0.018	0.194	0.194	0.023	0.026	0.095	0.095	0.095	0.196
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.013	0.000	0.000	0.000	0.018	0.018	0.000	0.000	0.000	0.000	0.000	0.019
Jul	198	Mean	0.001	0.003	0.016	0.001	0.000	0.000	0.021	0.021	0.000	0.001	0.001	0.001	0.001	0.023
		StdDev	0.006	0.010	0.024	0.006	0.001	0.001	0.033	0.033	0.002	0.003	0.003	0.005	0.005	0.035
		Max	0.064	0.065	0.129	0.071	0.018	0.017	0.175	0.175	0.018	0.035	0.019	0.035	0.035	0.175
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.003	0.000	0.000	0.000	0.009	0.010	0.000	0.000	0.000	0.000	0.000	0.010
Aug	209	Mean	0.001	0.005	0.023	0.001	0.000	0.000	0.031	0.031	0.000	0.002	0.001	0.003	0.003	0.034
		StdDev	0.009	0.012	0.030	0.007	0.002	0.003	0.042	0.043	0.001	0.008	0.006	0.012	0.011	0.048
		Max	0.094	0.082	0.198	0.069	0.028	0.030	0.198	0.198	0.006	0.083	0.039	0.089	0.089	0.200
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.005	0.000
		Median	0.000	0.000	0.016	0.000	0.000	0.000	0.017	0.017	0.000	0.000	0.000	0.000	0.000	0.017
Sep	203	Mean	0.002	0.004	0.021	0.000	0.000	0.000	0.027	0.028	0.000	0.000	0.001	0.001	0.001	0.029
		StdDev	0.006	0.009	0.021	0.003	0.000	0.001	0.028	0.028	0.001	0.002	0.003	0.005	0.004	0.030
		Max	0.036	0.055	0.131	0.031	0.000	0.012	0.146	0.146	0.010	0.020	0.026	0.030	0.030	0.167
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.020	0.000	0.000	0.000	0.022	0.022	0.000	0.000	0.000	0.000	0.000	0.022
Oct	140	Mean	0.002	0.004	0.027	0.001	0.001	0.000	0.035	0.035	0.000	0.001	0.003	0.003	0.003	0.038
		StdDev	0.008	0.011	0.034	0.006	0.005	0.003	0.048	0.047	0.001	0.004	0.011	0.011	0.012	0.049
		Max	0.071	0.062	0.178	0.039	0.057	0.039	0.199	0.199	0.015	0.049	0.099	0.099	0.099	0.199
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.020	0.000	0.000	0.000	0.021	0.021	0.000	0.000	0.000	0.000	0.000	0.022
Nov	233	Mean	0.001	0.006	0.029	0.001	0.000	0.000	0.036	0.037	0.000	0.001	0.003	0.003	0.003	0.040
		StdDev	0.002	0.012	0.027	0.003	0.003	0.003	0.035	0.035	0.002	0.004	0.014	0.015	0.015	0.039
		Max	0.019	0.064	0.195	0.047	0.053	0.045	0.195	0.195	0.023	0.045	0.146	0.146	0.146	0.198
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.024	0.000	0.000	0.000	0.028	0.028	0.000	0.000	0.000	0.000	0.000	0.030
Dec	204	Mean	0.001	0.008	0.034	0.001	0.000	0.001	0.044	0.044	0.000	0.000	0.001	0.001	0.001	0.046
		StdDev	0.008	0.015	0.026	0.003	0.003	0.004	0.040	0.040	0.001	0.002	0.006	0.007	0.006	0.041
		Max	0.085	0.072	0.128	0.037	0.024	0.047	0.196	0.196	0.009	0.014	0.048	0.052	0.052	0.196
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.031	0.000	0.000	0.000	0.033	0.033	0.000	0.000	0.000	0.000	0.000	0.035
2009	2347	Mean	0.002	0.006	0.022	0.001	0.000	0.000	0.031	0.031	0.000	0.001	0.002	0.003	0.003	0.033
		StdDev	0.008	0.014	0.026	0.005	0.003	0.004	0.038	0.038	0.002	0.005	0.011	0.012	0.012	0.042
		Max	0.120	0.141	0.198	0.080	0.102	0.102	0.199	0.199	0.077	0.083	0.170	0.197	0.197	0.200
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.005	0.000
		Median	0.000	0.000	0.016	0.000	0.000	0.000	0.019	0.019	0.000	0.000	0.000	0.000	0.000	0.020

Table 3-23. DRI Carbon Laboratory System Blank Statistics for Each Analyzer (1/1/09 through 12/31/09)

Analyzer			IMPROVE_A Parameter (units are µg C/cm^2)													
No.	No.	Statistic	O1TC	O2TC	O3TC	O4TC	OPTRC	OPTTC	OCTRC	OCTTC	E1TC	E2TC	E3TC	ECTRC	ECTTC	TCTC
6	132	Mean	0.001	0.003	0.019	0.001	0.000	0.000	0.024	0.024	0.000	0.001	0.003	0.004	0.004	0.028
		StdDev	0.006	0.008	0.017	0.005	0.000	0.000	0.027	0.026	0.001	0.002	0.017	0.018	0.018	0.034
		Max	0.068	0.063	0.110	0.047	0.000	0.000	0.162	0.162	0.005	0.021	0.146	0.146	0.146	0.181
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.018	0.000	0.000	0.000	0.020	0.020	0.000	0.000	0.000	0.000	0.000	0.021
7	334	Mean	0.001	0.006	0.017	0.001	0.001	0.001	0.024	0.025	0.000	0.001	0.002	0.003	0.002	0.027
		StdDev	0.004	0.014	0.021	0.006	0.004	0.004	0.032	0.033	0.002	0.004	0.008	0.010	0.009	0.036
		Max	0.038	0.102	0.099	0.071	0.045	0.045	0.190	0.190	0.028	0.045	0.100	0.101	0.101	0.193
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.009	0.000	0.000	0.000	0.013	0.013	0.000	0.000	0.000	0.000	0.000	0.014
8	362	Mean	0.001	0.005	0.018	0.000	0.000	0.000	0.024	0.024	0.000	0.000	0.001	0.002	0.002	0.026
		StdDev	0.006	0.012	0.023	0.001	0.001	0.001	0.033	0.033	0.000	0.003	0.009	0.010	0.010	0.036
		Max	0.085	0.072	0.198	0.014	0.011	0.011	0.198	0.198	0.005	0.049	0.111	0.125	0.125	0.200
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.013	0.000	0.000	0.000	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.016
9	160	Mean	0.001	0.005	0.025	0.001	0.001	0.001	0.032	0.032	0.000	0.003	0.007	0.009	0.009	0.041
		StdDev	0.004	0.010	0.028	0.003	0.005	0.005	0.037	0.037	0.001	0.010	0.021	0.025	0.025	0.047
		Max	0.031	0.047	0.138	0.031	0.047	0.047	0.165	0.165	0.009	0.074	0.170	0.197	0.197	0.198
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.015	0.000	0.000	0.000	0.016	0.016	0.000	0.000	0.000	0.000	0.000	0.022
10	168	Mean	0.003	0.006	0.023	0.000	0.000	0.000	0.032	0.032	0.000	0.000	0.001	0.001	0.001	0.033
		StdDev	0.011	0.014	0.027	0.002	0.002	0.002	0.042	0.042	0.001	0.002	0.004	0.005	0.005	0.043
		Max	0.094	0.082	0.110	0.017	0.019	0.019	0.184	0.184	0.009	0.017	0.039	0.044	0.044	0.184
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.010	0.000	0.000	0.000	0.016	0.016	0.000	0.000	0.000	0.000	0.000	0.016
11	222	Mean	0.001	0.006	0.022	0.001	0.001	0.001	0.031	0.030	0.000	0.001	0.002	0.001	0.002	0.032
		StdDev	0.004	0.016	0.029	0.004	0.007	0.007	0.043	0.042	0.000	0.006	0.013	0.012	0.013	0.045
		Max	0.047	0.114	0.142	0.039	0.102	0.102	0.199	0.199	0.005	0.083	0.156	0.156	0.156	0.199
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.014	0.000	0.000	0.000	0.017	0.017	0.000	0.000	0.000	0.000	0.000	0.017
12	315	Mean	0.003	0.004	0.021	0.001	0.000	0.000	0.029	0.029	0.001	0.001	0.001	0.003	0.003	0.032
		StdDev	0.012	0.009	0.028	0.005	0.000	0.000	0.037	0.037	0.003	0.005	0.010	0.012	0.012	0.041
		Max	0.120	0.051	0.195	0.080	0.007	0.007	0.195	0.195	0.023	0.052	0.146	0.146	0.146	0.198
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.015	0.000	0.000	0.000	0.018	0.018	0.000	0.000	0.000	0.000	0.000	0.019
13	197	Mean	0.001	0.008	0.019	0.002	0.001	0.001	0.030	0.031	0.000	0.001	0.001	0.002	0.002	0.033
		StdDev	0.004	0.015	0.026	0.007	0.004	0.004	0.039	0.039	0.003	0.004	0.005	0.007	0.007	0.041
		Max	0.028	0.070	0.132	0.048	0.048	0.048	0.168	0.181	0.025	0.039	0.038	0.048	0.043	0.176
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.005	0.000
		Median	0.000	0.000	0.009	0.000	0.000	0.000	0.017	0.017	0.000	0.000	0.000	0.000	0.000	0.018
16	273	Mean	0.003	0.010	0.032	0.002	0.000	0.000	0.047	0.047	0.000	0.001	0.001	0.002	0.002	0.049
		StdDev	0.011	0.020	0.028	0.007	0.002	0.002	0.046	0.046	0.005	0.005	0.003	0.009	0.008	0.049
		Max	0.108	0.141	0.144	0.069	0.018	0.018	0.194	0.194	0.077	0.042	0.030	0.085	0.085	0.200
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.025	0.000	0.000	0.000	0.031	0.032	0.000	0.000	0.000	0.000	0.000	0.032
18	102	Mean	0.003	0.010	0.031	0.001	0.001	0.001	0.045	0.045	0.001	0.000	0.000	0.002	0.001	0.046
		StdDev	0.008	0.019	0.024	0.004	0.003	0.003	0.041	0.041	0.004	0.003	0.002	0.005	0.004	0.042
		Max	0.049	0.093	0.107	0.023	0.024	0.024	0.185	0.185	0.037	0.024	0.017	0.037	0.037	0.196
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Median	0.000	0.000	0.031	0.000	0.000	0.000	0.034	0.035	0.000	0.000	0.000	0.000	0.000	0.035
19	82	Mean	0.002	0.005	0.019	0.000	0.000	0.000	0.025	0.026	0.000	0.001	0.003	0.003	0.003	0.029
		StdDev	0.008	0.008	0.018	0.001	0.003	0.003	0.025	0.025	0.000	0.004	0.014	0.014	0.014	0.029
		Max	0.060	0.040	0.073	0.005	0.032	0.032	0.110	0.110	0.000	0.030	0.095	0.095	0.095	0.110
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.001	0.000
		Median	0.000	0.000	0.017	0.000	0.000	0.000	0.019	0.019	0.000	0.000	0.000	0.000	0.000	0.021
All	2347	Mean	0.002	0.006	0.022	0.001	0.000	0.000	0.031	0.031	0.000	0.001	0.002	0.003	0.003	0.033
		StdDev	0.008	0.014	0.026	0.005	0.004	0.004	0.038	0.038	0.002	0.005	0.011	0.012	0.012	0.042
		Max	0.120	0.141	0.198	0.080	0.102	0.102	0.199	0.199	0.077	0.083	0.170	0.197	0.197	0.200
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.005	0.000
		Median	0.000	0.000	0.016	0.000	0.000	0.000	0.019	0.019	0.000	0.000	0.000	0.000	0.000	0.020

Table 3-24. DRI Carbon Analysis Statistics for 24-Hour Field Blanks

Analyzer			IMPROVE_A Parameter (units are µg C/cm^2)													
No.	No.*	Statistic*	O1TC	O2TC	O3TC	O4TC	OPTRC	OPTTC	OCTRC	OCTTC	E1TC	E2TC	E3TC	ECTRC	ECTTC	TCTC
6	205	Mean	0.188	0.392	0.551	0.059	0.025	0.025	1.216	1.222	0.034	0.010	0.001	0.019	0.013	1.235
		StdDev	0.166	0.265	0.464	0.149	0.238	0.238	1.046	1.102	0.241	0.102	0.004	0.115	0.056	1.143
		Max	1.181	3.123	4.576	1.367	3.183	3.183	12.011	12.987	3.210	1.458	0.050	1.503	0.526	13.513
		Min	0.000	0.000	0.166	0.000	0.000	0.000	0.218	0.218	0.000	0.000	0.000	0.000	0.000	0.218
		Median	0.159	0.349	0.449	0.013	0.000	0.000	0.984	0.984	0.000	0.000	0.000	0.000	0.000	1.001
7	212	Mean	0.206	0.509	0.706	0.135	0.078	0.078	1.635	1.681	0.143	0.006	0.001	0.072	0.025	1.706
		StdDev	0.475	0.693	1.213	0.587	1.011	1.011	3.623	3.989	1.631	0.026	0.007	0.642	0.265	4.233
		Max	6.823	9.694	10.237	7.794	14.697	14.697	49.245	54.675	23.718	0.259	0.075	9.280	3.850	58.525
		Min	0.000	0.097	0.186	0.000	0.000	0.000	0.388	0.388	0.000	0.000	0.000	0.000	0.000	0.388
		Median	0.161	0.395	0.436	0.030	0.000	0.000	1.068	1.077	0.000	0.000	0.000	0.000	0.000	1.077
8	222	Mean	0.265	0.459	0.619	0.109	0.031	0.031	1.483	1.538	0.100	0.008	0.001	0.077	0.022	1.560
		StdDev	0.301	0.618	0.601	0.648	0.358	0.358	2.302	2.757	1.062	0.064	0.004	0.767	0.294	3.033
		Max	3.445	8.831	5.759	9.429	5.160	5.160	32.624	39.617	15.735	0.781	0.037	11.375	4.383	43.999
		Min	0.000	0.029	0.178	0.000	0.000	0.000	0.217	0.217	0.000	0.000	0.000	0.000	0.000	0.217
		Median	0.205	0.384	0.469	0.012	0.000	0.000	1.156	1.170	0.000	0.000	0.000	0.000	0.000	1.170
9	59	Mean	0.163	0.567	0.874	0.119	0.018	0.018	1.741	1.771	0.059	0.012	0.008	0.061	0.031	1.802
		StdDev	0.105	0.790	1.648	0.334	0.111	0.111	2.631	2.671	0.156	0.032	0.019	0.110	0.067	2.679
		Max	0.597	5.527	12.800	2.387	0.826	0.826	19.203	19.334	1.016	0.164	0.078	0.508	0.318	19.394
		Min	0.000	0.084	0.212	0.000	0.000	0.000	0.418	0.418	0.000	0.000	0.000	0.000	0.000	0.418
		Median	0.149	0.398	0.531	0.038	0.000	0.000	1.139	1.216	0.000	0.000	0.000	0.008	0.001	1.216
10	205	Mean	0.235	0.441	0.674	0.100	0.002	0.002	1.451	1.469	0.033	0.004	0.000	0.036	0.018	1.488
		StdDev	0.208	0.252	0.569	0.173	0.016	0.016	0.966	1.006	0.183	0.020	0.002	0.186	0.154	1.060
		Max	1.857	1.879	4.722	1.299	0.184	0.184	6.987	7.297	2.496	0.203	0.023	2.515	2.156	7.297
		Min	0.000	0.126	0.147	0.000	0.000	0.000	0.473	0.473	0.000	0.000	0.000	0.000	0.000	0.473
		Median	0.201	0.383	0.512	0.046	0.000	0.000	1.200	1.200	0.000	0.000	0.000	0.000	0.000	1.200
11	116	Mean	0.131	0.435	0.602	0.063	0.048	0.048	1.281	1.300	0.088	0.001	0.000	0.041	0.021	1.321
		StdDev	0.164	0.495	0.826	0.394	0.522	0.522	2.284	2.469	0.895	0.006	0.000	0.379	0.187	2.653
		Max	1.487	5.352	8.023	4.084	5.621	5.621	24.566	26.644	9.641	0.064	0.000	4.084	2.006	28.650
		Min	0.000	0.113	0.086	0.000	0.000	0.000	0.348	0.348	0.000	0.000	0.000	0.000	0.000	0.348
		Median	0.098	0.355	0.453	0.000	0.000	0.000	0.956	0.956	0.000	0.000	0.000	0.000	0.000	0.956
12	221	Mean	0.168	0.445	0.648	0.074	0.018	0.018	1.353	1.353	0.044	0.007	0.001	0.035	0.035	1.388
		StdDev	0.132	0.308	0.558	0.177	0.171	0.171	1.125	1.157	0.374	0.035	0.008	0.239	0.196	1.302
		Max	0.822	2.938	5.491	1.773	2.507	2.507	11.845	12.503	5.528	0.473	0.083	3.494	2.835	15.339
		Min	0.000	0.000	0.013	0.000	0.000	0.000	0.125	0.125	0.000	0.000	0.000	-0.001	0.000	0.125
		Median	0.147	0.393	0.506	0.011	0.000	0.000	1.099	1.099	0.000	0.000	0.000	0.000	0.000	1.110
13	102	Mean	0.173	0.514	0.608	0.066	0.000	0.000	1.361	1.376	0.026	0.004	0.001	0.031	0.016	1.392
		StdDev	0.115	0.297	0.422	0.125	0.000	0.000	0.715	0.746	0.062	0.015	0.006	0.071	0.044	0.763
		Max	0.725	2.794	2.526	0.918	0.000	0.000	4.918	5.290	0.375	0.093	0.043	0.375	0.261	5.292
		Min	0.000	0.130	0.142	0.000	0.000	0.000	0.395	0.395	0.000	0.000	0.000	0.000	0.000	0.395
		Median	0.178	0.450	0.493	0.022	0.000	0.000	1.189	1.189	0.000	0.000	0.000	0.000	0.000	1.196
16	126	Mean	0.387	0.331	0.792	0.107	0.006	0.006	1.623	1.639	0.037	0.009	0.004	0.044	0.027	1.666
		StdDev	0.228	0.211	0.468	0.168	0.064	0.064	0.856	0.874	0.085	0.028	0.015	0.078	0.062	0.900
		Max	1.504	1.033	4.316	1.416	0.717	0.717	7.437	7.426	0.709	0.187	0.088	0.446	0.446	7.556
		Min	0.000	0.000	0.252	0.000	0.000	0.000	0.406	0.406	0.000	0.000	0.000	0.000	0.000	0.406
		Median	0.376	0.286	0.699	0.047	0.000	0.000	1.492	1.492	0.000	0.000	0.000	0.000	0.000	1.494
18	86	Mean	0.199	0.516	0.664	0.118	0.002	0.002	1.499	1.519	0.025	0.006	0.002	0.031	0.011	1.530
		StdDev	0.154	0.243	0.306	0.139	0.015	0.015	0.711	0.737	0.048	0.020	0.011	0.059	0.034	0.742
		Max	0.633	1.308	1.706	0.671	0.142	0.142	4.183	4.385	0.273	0.109	0.096	0.383	0.203	4.385
		Min	0.000	0.187	0.265	0.000	0.000	0.000	0.523	0.523	0.000	0.000	0.000	0.000	0.000	0.523
		Median	0.179	0.457	0.598	0.079	0.000	0.000	1.343	1.354	0.000	0.000	0.000	0.003	0.000	1.354
19	55	Mean	0.249	0.565	0.988	0.180	0.012	0.012	1.994	2.026	0.065	0.006	0.001	0.061	0.028	2.054
		StdDev	0.395	0.472	1.047	0.309	0.057	0.057	1.839	1.923	0.139	0.028	0.006	0.118	0.047	1.937
		Max	2.612	2.529	6.081	1.515	0.398	0.398	9.064	9.513	0.725	0.169	0.033	0.458	0.253	9.513
		Min	0.000	0.119	0.300	0.000	0.000	0.000	0.544	0.544	0.000	0.000	0.000	0.000	0.000	0.544
		Median	0.177	0.440	0.658	0.064	0.000	0.000	1.350	1.350	0.002	0.000	0.000	0.010	0.000	1.372
All	1609	Mean	0.216	0.455	0.669	0.097	0.026	0.026	1.463	1.487	0.064	0.007	0.001	0.046	0.023	1.510
		StdDev	0.267	0.457	0.761	0.371	0.429	0.429	1.940	2.138	0.772	0.049	0.008	0.402	0.182	2.282
		Max	6.823	9.694	12.800	9.429	14.697	14.697	49.245	54.675	23.718	1.458	0.096	11.375	4.383	58.525
		Min	0.000	0.000	0.013	0.000	0.000	0.000	0.125	0.125	0.000	0.000	0.000	-0.001	0.000	0.125
		Median	0.178	0.385	0.499	0.024	0.000	0.000	1.139	1.145	0.000	0.000	0.000	0.000	0.000	1.147

* Excludes replicates

Table 3-25. DRI Carbon Analysis Statistics for Backup Filters

Analyzer No.	No.*	Statistic*	IMPROVE_A Parameter (units are µg C/cm²) O1TC	O2TC	O3TC	O4TC	OPTRC	OPTTC	OCTRC	OCTTC	E1TC	E2TC	E3TC	ECTRC	ECTTC	TCTC
6	174	Mean	0.482	1.038	1.295	0.351	0.044	0.088	3.210	3.254	0.097	0.030	0.001	0.083	0.039	3.293
		StdDev	0.354	0.446	0.710	0.238	0.133	0.161	1.305	1.333	0.149	0.047	0.003	0.114	0.092	1.368
		Max	2.933	3.640	4.999	1.120	1.375	1.537	8.392	8.392	1.485	0.241	0.025	0.572	0.566	8.697
		Min	0.000	0.279	0.368	0.000	0.000	0.000	0.749	0.749	0.000	0.000	0.000	0.000	-0.003	0.749
		Median	0.426	0.967	1.100	0.278	0.000	0.040	3.064	3.097	0.061	0.000	0.000	0.036	0.000	3.160
7	245	Mean	0.541	1.011	1.168	0.381	0.030	0.130	3.132	3.232	0.116	0.028	0.000	0.114	0.013	3.246
		StdDev	0.401	0.425	0.654	0.260	0.105	0.156	1.302	1.359	0.131	0.042	0.002	0.125	0.039	1.366
		Max	2.983	2.712	5.485	1.640	1.087	1.267	8.231	8.305	1.131	0.199	0.013	0.667	0.300	8.305
		Min	0.000	0.000	0.217	0.000	0.000	0.000	0.309	0.309	0.000	0.000	0.000	0.000	0.000	0.356
		Median	0.449	0.956	1.054	0.343	0.000	0.085	3.038	3.094	0.090	0.002	0.000	0.084	0.000	3.114
8	213	Mean	0.673	0.875	1.153	0.307	0.019	0.095	3.027	3.103	0.086	0.017	0.001	0.084	0.008	3.111
		StdDev	0.425	0.338	0.837	0.311	0.100	0.206	1.473	1.592	0.195	0.044	0.004	0.197	0.038	1.610
		Max	2.491	2.007	6.805	2.579	1.070	1.947	10.869	12.815	2.122	0.333	0.035	2.455	0.509	13.324
		Min	0.000	0.000	0.127	0.000	0.000	0.000	0.272	0.309	0.000	0.000	0.000	0.000	0.000	0.309
		Median	0.571	0.836	0.994	0.239	0.000	0.035	2.751	2.761	0.039	0.000	0.000	0.042	0.000	2.761
9	59	Mean	1.144	1.208	1.363	0.455	0.083	0.232	4.252	4.402	0.263	0.099	0.014	0.293	0.143	4.545
		StdDev	1.053	0.656	0.721	0.325	0.261	0.345	2.368	2.483	0.333	0.110	0.027	0.287	0.168	2.553
		Max	5.315	3.995	3.781	1.493	1.818	2.115	13.373	13.785	2.117	0.398	0.128	0.974	0.561	14.198
		Min	0.000	0.298	0.471	0.000	0.000	0.000	1.011	1.011	0.000	0.000	0.000	0.000	0.000	1.011
		Median	0.760	0.990	1.179	0.416	0.000	0.101	3.752	3.989	0.189	0.064	0.000	0.187	0.067	4.056
10	214	Mean	0.638	0.963	1.166	0.361	0.012	0.086	3.139	3.213	0.085	0.014	0.000	0.088	0.013	3.227
		StdDev	0.509	0.456	0.695	0.261	0.068	0.135	1.460	1.528	0.115	0.037	0.002	0.112	0.040	1.538
		Max	3.574	2.649	5.063	1.533	0.647	0.908	9.548	9.651	0.647	0.318	0.021	0.608	0.354	9.651
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.009	0.000	0.000	0.000	0.000	-0.002	0.009
		Median	0.561	0.896	1.016	0.319	0.000	0.030	2.944	3.023	0.044	0.000	0.000	0.047	0.000	3.023
11	114	Mean	0.561	1.030	1.222	0.273	0.060	0.123	3.146	3.209	0.101	0.022	0.002	0.066	0.003	3.212
		StdDev	0.562	0.581	1.318	0.337	0.276	0.625	2.372	2.740	0.520	0.106	0.019	0.424	0.016	2.741
		Max	2.713	4.992	13.628	2.946	2.331	6.141	23.560	28.051	5.125	0.996	0.199	4.491	0.150	28.051
		Min	0.000	0.266	0.236	0.000	0.000	0.000	0.635	0.635	0.000	0.000	0.000	0.000	0.000	0.635
		Median	0.372	0.918	1.044	0.217	0.000	0.000	2.906	2.906	0.000	0.000	0.000	0.000	0.000	2.906
12	193	Mean	0.517	1.057	1.246	0.325	0.038	0.065	3.184	3.210	0.083	0.031	0.002	0.077	0.051	3.261
		StdDev	0.453	0.521	0.781	0.276	0.105	0.156	1.560	1.600	0.192	0.081	0.011	0.197	0.143	1.696
		Max	2.288	3.185	7.590	1.971	0.765	1.396	13.537	14.176	2.265	0.925	0.091	2.433	1.795	15.970
		Min	0.000	0.225	0.359	0.000	0.000	0.000	0.718	0.718	0.000	0.000	0.000	0.000	-0.003	0.718
		Median	0.401	0.993	1.117	0.264	0.000	0.000	3.010	3.010	0.035	0.000	0.000	0.019	0.006	3.048
13	87	Mean	0.572	1.131	1.453	0.380	0.045	0.137	3.582	3.674	0.133	0.031	0.002	0.121	0.028	3.702
		StdDev	0.430	0.431	0.903	0.268	0.236	0.193	1.561	1.603	0.249	0.045	0.009	0.135	0.095	1.635
		Max	2.291	2.697	6.216	1.234	2.140	1.368	9.160	9.436	2.140	0.190	0.062	0.587	0.772	9.542
		Min	0.000	0.230	0.260	0.000	0.000	0.000	0.658	0.658	0.000	0.000	0.000	0.000	0.000	0.658
		Median	0.505	1.122	1.283	0.371	0.000	0.088	3.569	3.710	0.076	0.006	0.000	0.080	0.000	3.740
16	132	Mean	0.844	0.769	1.676	0.429	0.044	0.151	3.761	3.869	0.144	0.043	0.002	0.145	0.038	3.907
		StdDev	0.367	0.412	0.912	0.273	0.149	0.225	1.430	1.499	0.196	0.065	0.012	0.191	0.072	1.511
		Max	1.926	2.724	6.898	1.680	1.052	1.460	10.868	10.908	1.543	0.358	0.119	1.642	0.470	10.908
		Min	0.079	0.131	0.329	0.000	0.000	0.000	0.780	0.780	0.000	0.000	0.000	0.000	0.000	0.780
		Median	0.826	0.699	1.458	0.388	0.000	0.081	3.485	3.568	0.097	0.020	0.000	0.095	0.000	3.596
18	80	Mean	0.566	1.328	1.380	0.475	0.042	0.185	3.790	3.932	0.152	0.070	0.004	0.184	0.042	3.974
		StdDev	0.324	0.576	0.634	0.289	0.140	0.270	1.426	1.539	0.175	0.106	0.010	0.186	0.089	1.567
		Max	1.569	4.160	3.591	1.426	0.809	1.445	7.928	8.607	0.731	0.690	0.066	0.785	0.377	8.607
		Min	0.000	0.319	0.223	0.000	0.000	0.000	0.738	0.738	0.000	0.000	0.000	0.000	0.000	0.757
		Median	0.545	1.231	1.247	0.403	0.000	0.082	3.588	3.707	0.087	0.043	0.000	0.124	0.000	3.736
19	68	Mean	0.832	1.069	1.309	0.408	0.009	0.102	3.628	3.721	0.162	0.047	0.009	0.209	0.115	3.837
		StdDev	0.687	0.517	0.716	0.287	0.029	0.180	1.727	1.855	0.270	0.104	0.035	0.356	0.240	1.984
		Max	3.988	3.173	4.687	1.325	0.131	1.000	9.994	10.710	1.995	0.605	0.244	2.348	1.415	12.058
		Min	0.036	0.305	0.339	0.000	0.000	0.000	0.850	0.850	0.000	0.000	0.000	0.000	0.000	0.850
		Median	0.706	0.998	1.195	0.348	0.000	0.000	3.474	3.569	0.105	0.000	0.000	0.109	0.061	3.626
All	1579	Mean	0.627	1.008	1.275	0.363	0.034	0.114	3.309	3.388	0.113	0.032	0.002	0.112	0.033	3.421
		StdDev	0.504	0.484	0.822	0.284	0.145	0.251	1.600	1.706	0.230	0.070	0.012	0.212	0.100	1.743
		Max	5.315	4.992	13.628	2.946	2.331	6.141	23.560	28.051	5.125	0.996	0.244	4.491	1.795	28.051
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.009	0.000	0.000	0.000	0.000	-0.003	0.009
		Median	0.505	0.941	1.110	0.309	0.000	0.040	3.115	3.175	0.056	0.000	0.000	0.054	0.000	3.196

* Excludes replicates

Table 3-26. DRI Carbon Analysis Statistics for Trip Blanks

Analyzer No.	No.*	Statistic*	IMPROVE_A Parameter (units are µg C/cm^2)													
			O1TC	O2TC	O3TC	O4TC	OPTRC	OPTTC	OCTRC	OCTTC	E1TC	E2TC	E3TC	ECTRC	ECTTC	TCTC
6	38	Mean	0.264	0.371	0.660	0.081	0.000	0.011	1.377	1.388	0.014	0.001	0.006	0.021	0.010	1.398
		StdDev	0.109	0.193	0.769	0.193	0.000	0.046	1.084	1.125	0.046	0.002	0.027	0.052	0.028	1.125
		Max	0.537	1.029	5.098	1.212	0.003	0.272	7.426	7.697	0.272	0.010	0.147	0.272	0.147	7.697
		Min	0.052	0.107	0.202	0.000	0.000	0.000	0.396	0.396	0.000	0.000	0.000	0.000	0.000	0.396
		Median	0.284	0.322	0.527	0.044	0.000	0.000	1.167	1.167	0.000	0.000	0.000	0.000	0.000	1.175
7	41	Mean	0.278	0.385	0.435	0.036	0.000	0.012	1.134	1.146	0.007	0.006	0.002	0.015	0.003	1.149
		StdDev	0.122	0.169	0.207	0.076	0.000	0.057	0.447	0.465	0.030	0.025	0.008	0.058	0.011	0.470
		Max	0.591	0.880	1.248	0.315	0.000	0.357	2.326	2.344	0.167	0.140	0.050	0.357	0.066	2.410
		Min	0.086	0.106	0.178	0.000	0.000	0.000	0.459	0.459	0.000	0.000	0.000	0.000	0.000	0.459
		Median	0.258	0.324	0.374	0.000	0.000	0.000	1.069	1.069	0.000	0.000	0.000	0.000	0.000	1.069
8	52	Mean	0.273	0.289	0.537	0.069	0.005	0.010	1.172	1.177	0.011	0.001	0.000	0.007	0.002	1.179
		StdDev	0.119	0.158	0.573	0.186	0.035	0.061	0.898	0.920	0.060	0.002	0.000	0.029	0.010	0.923
		Max	0.547	0.927	3.557	1.111	0.253	0.436	5.848	6.030	0.427	0.014	0.000	0.188	0.070	6.036
		Min	0.000	0.109	0.194	0.000	0.000	0.000	0.505	0.505	0.000	0.000	0.000	0.000	0.000	0.505
		Median	0.245	0.247	0.353	0.000	0.000	0.000	0.914	0.914	0.000	0.000	0.000	0.000	0.000	0.914
9	15	Mean	0.169	0.377	0.831	0.146	0.000	0.026	1.523	1.549	0.022	0.003	0.002	0.027	0.001	1.550
		StdDev	0.093	0.297	1.015	0.324	0.000	0.059	1.585	1.634	0.059	0.007	0.008	0.058	0.003	1.634
		Max	0.379	1.089	3.409	1.073	0.000	0.225	5.571	5.796	0.225	0.021	0.033	0.225	0.011	5.796
		Min	0.000	0.106	0.193	0.000	0.000	0.000	0.416	0.416	0.000	0.000	0.000	0.000	0.000	0.416
		Median	0.171	0.243	0.457	0.021	0.000	0.000	0.926	0.934	0.000	0.000	0.000	0.000	0.000	0.934
10	51	Mean	0.309	0.347	0.585	0.101	0.000	0.020	1.342	1.362	0.028	0.016	0.000	0.044	0.024	1.386
		StdDev	0.159	0.189	0.463	0.167	0.000	0.055	0.811	0.844	0.076	0.067	0.000	0.121	0.105	0.892
		Max	0.759	1.045	3.255	1.005	0.000	0.266	5.389	5.655	0.363	0.420	0.002	0.575	0.575	5.783
		Min	0.000	0.051	0.180	0.000	0.000	0.000	0.451	0.451	0.000	0.000	0.000	0.000	0.000	0.451
		Median	0.280	0.326	0.434	0.050	0.000	0.000	1.138	1.138	0.000	0.000	0.000	0.000	0.000	1.138
11	18	Mean	0.295	0.373	0.423	0.017	0.000	0.000	1.107	1.107	0.000	0.001	0.000	0.001	0.001	1.108
		StdDev	0.121	0.141	0.174	0.042	0.000	0.000	0.382	0.382	0.000	0.005	0.000	0.005	0.005	0.383
		Max	0.480	0.761	0.904	0.174	0.000	0.000	2.178	2.178	0.000	0.022	0.000	0.022	0.022	2.178
		Min	0.105	0.170	0.203	0.000	0.000	0.000	0.546	0.546	0.000	0.000	0.000	0.000	0.000	0.546
		Median	0.312	0.358	0.377	0.000	0.000	0.000	1.040	1.040	0.000	0.000	0.000	0.000	0.000	1.040
12	43	Mean	0.232	0.458	0.868	0.112	0.005	0.023	1.674	1.692	0.031	0.007	0.004	0.037	0.019	1.712
		StdDev	0.124	0.533	2.336	0.352	0.031	0.118	3.134	3.240	0.121	0.019	0.015	0.121	0.057	3.246
		Max	0.480	3.261	15.718	2.269	0.203	0.734	21.261	21.995	0.734	0.096	0.087	0.734	0.326	21.995
		Min	0.000	0.077	0.240	0.000	0.000	0.000	0.457	0.457	0.000	0.000	0.000	0.000	0.000	0.457
		Median	0.203	0.316	0.466	0.017	0.000	0.000	1.100	1.100	0.000	0.000	0.000	0.000	0.000	1.100
13	15	Mean	0.228	0.450	0.636	0.073	0.000	0.015	1.387	1.402	0.013	0.003	0.000	0.017	0.002	1.404
		StdDev	0.136	0.233	0.571	0.203	0.000	0.039	1.036	1.070	0.031	0.012	0.001	0.041	0.007	1.069
		Max	0.478	0.985	2.498	0.798	0.000	0.149	4.760	4.908	0.103	0.045	0.003	0.149	0.027	4.908
		Min	0.000	0.019	0.093	0.000	0.000	0.000	0.112	0.112	0.000	0.000	0.000	0.000	0.000	0.112
		Median	0.240	0.389	0.446	0.006	0.000	0.000	1.187	1.187	0.000	0.000	0.000	0.000	0.000	1.187
16	6	Mean	0.365	0.348	0.991	0.148	0.000	0.013	1.853	1.866	0.033	0.001	0.000	0.034	0.021	1.887
		StdDev	0.154	0.246	0.824	0.261	0.000	0.032	1.407	1.438	0.038	0.003	0.000	0.040	0.032	1.437
		Max	0.642	0.734	2.625	0.679	0.000	0.078	4.680	4.757	0.078	0.008	0.000	0.086	0.078	4.766
		Min	0.236	0.095	0.414	0.000	0.000	0.000	0.971	0.971	0.000	0.000	0.000	0.000	0.000	0.971
		Median	0.306	0.305	0.697	0.048	0.000	0.000	1.362	1.362	0.020	0.000	0.000	0.020	0.004	1.382
18	17	Mean	0.302	0.441	0.666	0.100	0.000	0.016	1.510	1.525	0.009	0.005	0.002	0.016	0.000	1.526
		StdDev	0.158	0.213	0.449	0.136	0.000	0.024	0.820	0.829	0.017	0.014	0.006	0.024	0.001	0.829
		Max	0.553	0.865	1.786	0.434	0.000	0.066	3.553	3.609	0.058	0.056	0.021	0.066	0.003	3.609
		Min	0.000	0.132	0.118	0.000	0.000	0.000	0.365	0.365	0.000	0.000	0.000	0.000	0.000	0.365
		Median	0.261	0.392	0.477	0.050	0.000	0.000	1.433	1.460	0.000	0.000	0.000	0.000	0.000	1.460
19	23	Mean	0.180	0.306	0.596	0.076	0.007	0.000	1.165	1.158	0.028	0.003	0.000	0.024	0.031	1.189
		StdDev	0.077	0.179	0.429	0.133	0.029	0.000	0.769	0.746	0.062	0.011	0.000	0.067	0.071	0.799
		Max	0.344	0.906	2.219	0.555	0.137	0.000	4.031	3.893	0.256	0.052	0.000	0.308	0.308	4.031
		Min	0.042	0.146	0.262	0.000	0.000	0.000	0.634	0.634	0.000	0.000	0.000	0.000	0.000	0.634
		Median	0.176	0.260	0.457	0.034	0.000	0.000	0.901	0.901	0.000	0.000	0.000	0.000	0.000	0.901
All	319	Mean	0.264	0.370	0.622	0.082	0.002	0.014	1.340	1.352	0.018	0.005	0.002	0.023	0.011	1.363
		StdDev	0.132	0.266	0.999	0.205	0.020	0.062	1.415	1.460	0.066	0.030	0.012	0.077	0.053	1.469
		Max	0.759	3.261	15.718	2.269	0.253	0.734	21.261	21.995	0.734	0.420	0.147	0.734	0.575	21.995
		Min	0.000	0.019	0.093	0.000	0.000	0.000	0.112	0.112	0.000	0.000	0.000	0.000	0.000	0.112
		Median	0.248	0.315	0.440	0.016	0.000	0.000	1.061	1.069	0.000	0.000	0.000	0.000	0.000	1.074

* Excludes replicates

Table 3-27. DRI Carbon Analysis Annual Statistics for CSN Blank Categories

Type of Blank	No.*	Statistic*	IMPROVE_A Parameter (units are µg C/cm²)													
			O1TC	O2TC	O3TC	O4TC	OPTRC	OPTTC	OCTRC	OCTTC	E1TC	E2TC	E3TC	ECTRC	ECTTC	TCTC
24-Hour Field	1609	Mean	0.216	0.455	0.669	0.097	0.026	0.049	1.463	1.487	0.064	0.007	0.001	0.046	0.023	1.510
		StdDev	0.267	0.457	0.761	0.371	0.429	0.636	1.940	2.138	0.772	0.049	0.008	0.402	0.182	2.282
		Max	6.823	9.694	12.800	9.429	14.697	20.128	49.245	54.675	23.718	1.458	0.096	11.375	4.383	58.525
		Min	0.000	0.000	0.013	0.000	0.000	0.000	0.125	0.125	0.000	0.000	0.000	-0.001	0.000	0.125
		Median	0.178	0.385	0.499	0.024	0.000	0.000	1.139	1.145	0.000	0.000	0.000	0.000	0.000	1.147
		LQL	0.800	1.370	2.284	1.112	1.287	1.909	5.821	6.415	2.316	0.146	0.023	1.205	0.545	6.847
Backup	1579	Mean	0.627	1.008	1.275	0.363	0.034	0.114	3.309	3.388	0.113	0.032	0.002	0.112	0.033	3.421
		StdDev	0.504	0.484	0.822	0.284	0.145	0.251	1.600	1.706	0.230	0.070	0.012	0.212	0.100	1.743
		Max	5.315	4.992	13.628	2.946	2.331	6.141	23.560	28.051	5.125	0.996	0.244	4.491	1.795	28.051
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.009	0.000	0.000	0.000	0.000	-0.003	0.009
		Median	0.505	0.941	1.110	0.309	0.000	0.040	3.115	3.175	0.056	0.000	0.000	0.054	0.000	3.196
		LQL	1.513	1.451	2.466	0.851	0.436	0.752	4.799	5.119	0.689	0.209	0.037	0.636	0.299	5.230
Trip	319	Mean	0.264	0.370	0.622	0.082	0.002	0.014	1.340	1.352	0.018	0.005	0.002	0.023	0.011	1.363
		StdDev	0.132	0.266	0.999	0.205	0.020	0.062	1.415	1.460	0.066	0.030	0.012	0.077	0.053	1.469
		Max	0.759	3.261	15.718	2.269	0.253	0.734	21.261	21.995	0.734	0.420	0.147	0.734	0.575	21.995
		Min	0.000	0.019	0.093	0.000	0.000	0.000	0.112	0.112	0.000	0.000	0.000	0.000	0.000	0.112
		Median	0.248	0.315	0.440	0.016	0.000	0.000	1.061	1.069	0.000	0.000	0.000	0.000	0.000	1.074
		LQL	0.396	0.799	2.996	0.616	0.059	0.187	4.245	4.379	0.199	0.089	0.035	0.230	0.158	4.407
Trip Backup	9	Mean	0.154	0.243	0.465	0.021	0.000	0.006	0.882	0.889	0.006	0.004	0.000	0.010	0.004	0.892
		StdDev	0.051	0.110	0.236	0.031	0.000	0.019	0.365	0.372	0.019	0.008	0.000	0.027	0.008	0.378
		Max	0.239	0.398	0.944	0.081	0.000	0.057	1.660	1.660	0.057	0.024	0.000	0.081	0.024	1.669
		Min	0.057	0.087	0.215	0.000	0.000	0.000	0.522	0.522	0.000	0.000	0.000	0.000	0.000	0.522
		Median	0.160	0.213	0.394	0.000	0.000	0.000	0.769	0.769	0.000	0.000	0.000	0.000	0.000	0.769
		LQL	0.153	0.329	0.707	0.094	0.000	0.057	1.096	1.117	0.057	0.025	0.000	0.081	0.025	1.135

* Excludes replicates

± 1.5 µg/cm² for the 319 trip blanks, and 0.9 ± 0.4 µg/cm² for the nine trip blank backup filters. There is little instrument to instrument variation among the 24-hour (field), backup filters, or trip blanks. Differences were typically within one standard deviation. Some differences may be due to samples incorrectly labeled as blanks. Nearly all the TC was in OC, with negligible quantities of EC.

3.4.3.2 Calibrations

Table 3-28 provides summary statistics for full multi-point calibrations by analyzer for the period during which the project samples were analyzed. The next scheduled multi-point calibrations are due in January 2010. The multipoint calibrations are performed semi-annually or whenever major repairs or changes are made to the instruments. Separate calibrations are performed using four different sources of carbon: methane (CH_4), carbon dioxide (CO_2), sucrose ($C_{12}H_{22}O_{11}$), and potassium hydrogen phthalate (KHP). The average of the regression slopes through zero is obtained and used for converting counts to µg C. The slope represents the response of the entire analyzer to generic carbon compounds and includes the efficiencies of the oxidation and methanator zones and sensitivity of the FID.

Table 3-29 provides summary statistics for the multi-point temperature calibrations of each carbon analyzer. The temperature calibrations are performed every six months or after a major instrument repair. Criteria for an acceptable calibration include a slope within 5% of 1, an absolute value of the intercept <15, and an r^2 >0.98. As shown in **Table 3-29**, performance for the calibrated analyzers was well within the specified criteria.

Table 3-28. DRI Multi-Point Calibration Statistics

Analyzer No.	Date	Slope	Scatter	Correlation
6	12/23/08	20.71	0.63	0.9919
	06/23/09	20.87	0.62	0.9936
	07/19/09	21.49	0.96	0.9896
7	11/11/08	21.46	0.34	0.9971
	02/24/09	20.99	0.55	0.9921
	09/14/09	21.88	0.74	0.9931
8	12/23/08	20.66	0.61	0.9884
	05/22/09	24.76	0.46	0.9974
	07/10/09	20.95	1.17	0.9861
9	09/23/08	21.50	0.30	0.9974
	03/23/09	21.06	0.30	0.9974
	04/22/09	21.62	0.43	0.9975
	05/22/09	21.51	0.58	0.9920
	10/26/09	20.78	0.29	0.9976
10	06/04/08	21.14	0.47	0.9949
	01/28/09	21.59	0.41	0.9949
	07/20/09	21.43	1.07	0.9897
11	08/12/08	21.06	0.56	0.9908
	02/24/09	20.59	0.60	0.9952
	03/20/09	20.40	0.48	0.9939
	06/30/09	20.19	0.33	0.9946
	10/08/09	21.98	1.13	0.9770
12	09/10/08	22.73	0.27	0.9991
	01/13/09	22.26	0.69	0.9872
	06/01/09	22.37	0.49	0.9969
	07/31/09	21.79	1.15	0.9911
13	11/03/08	21.70	0.34	0.9965
	02/23/09	21.21	0.45	0.9963
	05/01/09	21.49	0.62	0.9933
	05/28/09	20.97	1.10	0.9849
	08/17/09	20.77	1.07	0.9917
	10/28/09	20.65	0.75	0.9945
16	10/20/08	21.88	0.69	0.9929
	03/31/09	21.93	0.53	0.9960
	09/24/09	22.26	0.54	0.9964
	10/06/09	20.71	0.59	0.9915
18	04/30/09	22.55	0.59	0.9939
	05/11/09	21.77	0.57	0.9913
	10/08/09	21.97	0.37	0.9976
19	04/29/09	22.84	0.53	0.9956
	05/14/09	20.61	0.48	0.9929
	10/08/09	20.37	0.38	0.9978

Table 3-29. DRI Temperature Calibration Statistics

Cal No.	Param.	Units	6	7	8	9	10*	11	12	13	16	18**	19**
1	Slope		1.019	1.013	1.019	1.010	1.024	1.016	1.019	1.007	1.007	1.027	1.028
	Intercept	° C	11.143	6.181	11.312	6.350	9.147	3.244	3.613	11.536	14.201	4.525	3.009
	r^2		0.9995	0.9995	0.9989	0.9997	0.9991	0.9997	0.9996	0.9977	0.9989	0.9994	0.9941
	Date		Mar-08	Aug-08	Dec-08	Sep-08	Jan-09	Jul-08	Sep-08	Oct-08	Oct-08	Apr-09	Apr-09
2	Slope		1.025	1.044	1.044	1.009	1.022	1.025	1.009	1.007	1.006	1.039	1.021
	Intercept	° C	9.078	2.597	-0.569	-0.029	4.185	2.021	4.407	8.266	5.229	4.514	-0.617
	r^2		0.9965	0.9998	0.9982	0.9997	0.9990	0.9993	0.9996	0.9992	0.9994	0.9994	0.9994
	Date		Jan-09	Feb-09	May-09	Mar-09	Jul-09	Feb-09	Jan-09	Feb-09	Mar-09	Oct-09	Oct-09
3	Slope		1.032	1.030	1.014	1.013	0.998	1.009	1.009	1.022	1.016		
	Intercept	° C	7.739	2.884	5.740	-0.197	3.163	4.471	7.261	2.704	3.705		
	r^2		0.9995	0.9999	0.9995	0.9994	0.9993	0.9994	0.9995	0.9993	0.9998		
	Date		Jun-09	Sep-09	Jan-10	Oct-09	Jan-10	Oct-09	Jul-09	Jul-09	Oct-09		
4	Slope		1.017						1.024	1.012			
	Intercept	° C	4.506						3.224	8.316			
	r^2		0.9996						0.9995	0.9997			
	Date		Nov-09						Jan-10	Jan-10			

Columns 6 through 19** are Analyzer No.

* Returned to CSN analysis 2/09
** New analyzer began CSN analysis 5/09

Table 3-30 provides a summary of the oxygen leak tests that are performed every six months or after major instrument repairs. The results are considered acceptable if the O_2 concentration is < 100 ppm. The O_2 contents were well below 100 ppm, in the range of 5-30 ppm. Measurements were not taken semi-annually due to the failure of components used in the test and the subsequent need to perform the annual calibration on the GC/MS before the tests could be done. The tests were completed in January 2009 and again in August 2009.

Table 3-30. DRI Oxygen Test Statistics

	Date		Apr 2008		Jan 2009*		Aug 2009	
Analyzer No.	Temp	(°C)	140	580	140	580	140	580
6	Mean O_2	(ppm)	20.4	21	14.5	12.0	20.2	19.9
	Std Dev	(ppm)	n/a	n/a	0.4	0.5	0.3	0.2
7	Mean O_2	(ppm)	20.3	21	14.3	15.5	22.5	22.7
	Std Dev	(ppm)	n/a	n/a	0.1	0.4	0.3	0.3
8	Mean O_2	(ppm)	30	31.3	6.5	6.7	14.7	14.6
	Std Dev	(ppm)	n/a	n/a	0.2	0.3	0.4	0.4
9	Mean O_2	(ppm)	23	28.7	10.5	10.7	20.5	19.6
	Std Dev	(ppm)	n/a	n/a	0.3	0.3	0.6	0.3
10	Mean O_2	(ppm)	21	21.8	16.0	10.2	13.0	9.9
	Std Dev	(ppm)	n/a	n/a	0.7	0.2	0.3	0.3
11	Mean O_2	(ppm)	21.4	20.4	5.1	5.6	14.5	13.8
	Std Dev	(ppm)	n/a	n/a	0.4	0.3	0.2	0.2
12	Mean O_2	(ppm)	23.1	23.6	8.9	4.5	17.5	16.6
	Std Dev	(ppm)	n/a	n/a	0.6	0.1	0.4	0.2
13	Mean O_2	(ppm)	17.6	18.2	21.6	12.4	18.7	15.6
	Std Dev	(ppm)	n/a	n/a	0.4	0.2	0.2	0.2
16	Mean O_2	(ppm)	Brought into		6.4	5.7	12.6	12.7
	Std Dev	(ppm)	service 10/08		0.2	0.1	0.3	0.3
18	Mean O_2	(ppm)			Brought into		14.0	14.6
	Std Dev	(ppm)			service 5/09		0.2	0.3
19	Mean O_2	(ppm)			Brought into		14.5	0.2
	Std Dev	(ppm)			service 5/09		14.4	0.3

* Measurements not made until January 2009 due to measurement component failure and the need to calibrate the GC/MS.

Figure 3-1 shows the daily autocalibration response during the reporting period for each analyzer. Using the Carle valve, the methane standard is injected once in a He-only atmosphere, once in a He/O_2 atmosphere, and finally the normal calibration peak at the end. The three peaks should have similar peak areas if the catalysts are in good condition and the calibration factor holds. Thermogram peaks are compared and the calibration peak area is examined. Counts that fall below 20,000 result in instrument maintenance. Details of instrument maintenance performed during the reporting period as a result of the autocalibration check are included in **Table 3-31**.

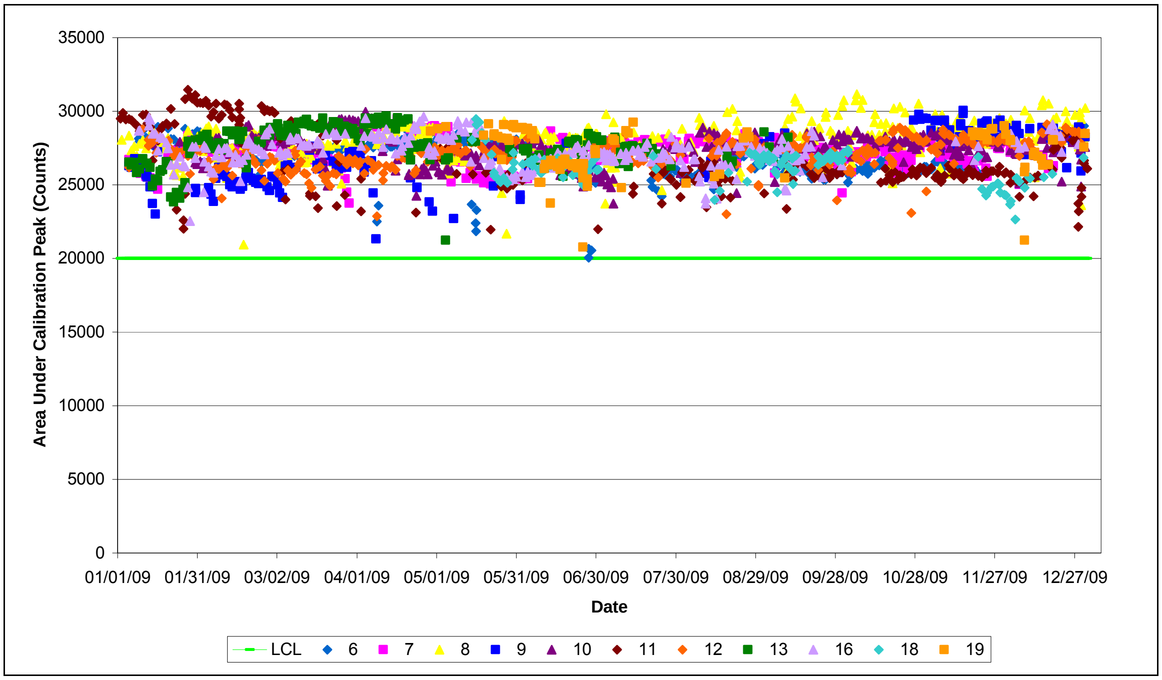

Figure 3-1. DRI Carbon Analyzer Daily Autocalibration Response for the Period 1/1/09 – 12/31/09

Table 3-31. Summary of Instrument Maintenance Performed as a Result of Autocalibration Peak Response

Analyzer No.	Date	Resolution
7	04/02/09	Repired/replaced methanator
8	07/13/09 08/19/09	Repired/replaced methanator Repaired/replaced Ni catalyst
9	01/17/09 02/03/09	Repaired/replaced Ni catalyst Repired/replaced oven, catylist, and heater element
10	03/22/09 05/28/09	Repaired/replaced Ni catalyst Leak check - removed piece of filter on breach o-ring
11	03/05/09 04/03/09 09/09/09	Repaired/replaced Ni catalyst Repired/replaced methanator Repaired/replaced Ni catalyst
16	02/02/09 05/24/09	Repaired/replaced Ni catalyst Repaired/replaced Ni catalyst

3.4.3.3 Replicate and Duplicate Analyses

Replicate analysis results are from two or more punches from the same sample run on different analyzers. Duplicate analysis results are from two punches from the same sample run on the same analyzer. **Table 3-33** gives the criteria and summary statistics for replicate and duplicate IMPROVE_A carbon analyses run on all analyzers for the CSN filter samples during the reporting period. A replicate or duplicate analysis was selected randomly from every group of 10 samples. A total of 1414 replicate or duplicate analyses were analyzed during the reporting period. Of the 1414 replicates or duplicates, 13 contained f, g, h, or i analysis flags. These were not included in the replicate and duplicate statistical summary. Of the 1401 remaining, 53 were duplicate analyses and 1348 were replicate analyses.

Table 3-33. DRI Replicate Analysis Criteria and Statistics

			Replicates				Duplicates				
Range	Criteria	Statistic	No.	TC	OC	EC	No.	TC	OC	EC	Units
All		Count	1348				53				
TC, OC, & EC < 10 µg C/cm^2	< ±1.0 µg C/cm^2	Count		280	351	1068		9	10	47	
		No. Fail		9	10	1		1	1	1	
		%Fail		3.2	2.8	0.1		11.1	10.0	2.1	%
		Mean		0.343	0.334	0.341		0.461	0.350	0.227	µg C/cm^2
		StdDev		0.296	0.279	0.354		0.403	0.347	0.216	µg C/cm^2
		Max		1.592	1.484	2.180		1.047	1.015	1.110	µg C/cm^2
		Min		0.003	0.004	0.000		0.014	0.013	0.000	µg C/cm^2
		Median		0.273	0.275	0.238		0.410	0.185	0.172	µg C/cm^2
TC, OC, & EC ≥ 10 µg C/cm^2	TC, OC %RPD < 10%	Count		1068	997	280		44	43	6	
	EC %RPD < 20%	No. Fail		8	46	10		0	0	0	
		%Fail		0.7	4.6	3.6		0.0	0.0	0.0	%
		Mean		3.68	4.35	7.23		3.66	4.25	7.01	%RPD
		StdDev		2.51	3.16	6.32		2.20	2.40	4.80	%RPD
		Max		15.01	22.91	33.08		9.05	9.86	12.19	%RPD
		Min		0.00	0.01	0.01		0.07	0.14	0.86	%RPD
		Median		3.33	3.80	5.67		3.40	4.25	8.20	%RPD

3.4.4 Assessment of Duplicate and Replicate Analyses

Duplicate and replicate analysis results for TC, OC, and EC agree well, with higher relative percent differences (RPD) at loading levels below 10.0 µg C/cm^2. Replicate analyses results are more variable than duplicate analyses, but remain within acceptable limits. The small size (25 mm) of the filter used in the IMPROVE_A carbon analysis method does not permit more than three punches (each ~0.5 cm^2) to be taken from the filter. Samples not meeting replicate criteria (TC and OC < 10% and EC < 20% RPD) are re-analyzed or examined for inhomogeneities. Instrument performance is also verified to eliminate instrument issues as a source of replicate or duplicate variation. Higher percent errors in OC and TC may be due to inhomogeneous sample deposit and organic artifact. Higher percent error in EC may be due to the low EC loadings on the samples.

3.4.5 Determination of MDLs and LQLs

Table 3-33 gives estimated minimum detection limits (MDLs) for IMPROVE_A parameters for 2009. The MDLs are determined as three times the standard deviation of laboratory blanks. **Table 3-33** also gives estimated lower quantifiable limits (LQLs) for the

IMPROVE_A parameters. These LQLs are determined as three times the standard deviation of the 24-hour (field) blanks, backup filters, and trip blanks, based on information provided to DRI after the analyses were completed.

Table 3-33. Estimated MDLs and LQLs for IMPROVE_A Parameters for 2009

Type of Blank	No.*	Statistic*	IMPROVE_A Parameter (units are µg C/cm^2)													
			O1TC	O2TC	O3TC	O4TC	OPTRC	OPTTC	OCTRC	OCTTC	E1TC	E2TC	E3TC	ECTRC	ECTTC	TCTC
Lab	557	Mean	0.015	0.077	0.282	0.018	0.000	0.010	0.392	0.401	0.016	0.005	0.003	0.023	0.014	0.415
		StdDev	0.050	0.124	0.343	0.065	0.004	0.070	0.485	0.527	0.072	0.037	0.019	0.098	0.069	0.553
		Max	0.661	1.058	2.850	0.625	0.087	1.077	3.876	4.845	0.927	0.693	0.327	1.077	1.050	4.846
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.009	0.000
		Median	0.000	0.033	0.175	0.000	0.000	0.000	0.249	0.250	0.000	0.000	0.000	0.000	0.000	0.251
		MDL	0.149	0.371	1.030	0.196	0.011	0.209	1.455	1.582	0.215	0.110	0.057	0.294	0.208	1.658
24-Hour Field	1609	Mean	0.216	0.455	0.669	0.097	0.026	0.049	1.463	1.487	0.064	0.007	0.001	0.046	0.023	1.510
		StdDev	0.267	0.457	0.761	0.371	0.429	0.636	1.940	2.138	0.772	0.049	0.008	0.402	0.182	2.282
		Max	6.823	9.694	12.800	9.429	14.697	20.128	49.245	54.675	23.718	1.458	0.096	11.375	4.383	58.525
		Min	0.000	0.000	0.013	0.000	0.000	0.000	0.125	0.125	0.000	0.000	0.000	-0.001	0.000	0.125
		Median	0.178	0.385	0.499	0.024	0.000	0.000	1.139	1.145	0.000	0.000	0.000	0.000	0.000	1.147
		LQL	0.800	1.370	2.284	1.112	1.287	1.909	5.821	6.415	2.316	0.146	0.023	1.205	0.545	6.847
Backup	1579	Mean	0.627	1.008	1.275	0.363	0.034	0.114	3.309	3.388	0.113	0.032	0.002	0.112	0.033	3.421
		StdDev	0.504	0.484	0.822	0.284	0.145	0.251	1.600	1.706	0.230	0.070	0.012	0.212	0.100	1.743
		Max	5.315	4.992	13.628	2.946	2.331	6.141	23.560	28.051	5.125	0.996	0.244	4.491	1.795	28.051
		Min	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.009	0.000	0.000	0.000	0.000	-0.003	0.009
		Median	0.505	0.941	1.110	0.309	0.000	0.040	3.115	3.175	0.056	0.000	0.000	0.054	0.000	3.196
		LQL	1.513	1.451	2.466	0.851	0.436	0.752	4.799	5.119	0.689	0.209	0.037	0.636	0.299	5.230
Trip	319	Mean	0.264	0.370	0.622	0.082	0.002	0.014	1.340	1.352	0.018	0.005	0.002	0.023	0.011	1.363
		StdDev	0.132	0.266	0.999	0.205	0.020	0.062	1.415	1.460	0.066	0.030	0.012	0.077	0.053	1.469
		Max	0.759	3.261	15.718	2.269	0.253	0.734	21.261	21.995	0.734	0.420	0.147	0.734	0.575	21.995
		Min	0.000	0.019	0.093	0.000	0.000	0.000	0.112	0.112	0.000	0.000	0.000	0.000	0.000	0.112
		Median	0.248	0.315	0.440	0.016	0.000	0.000	1.061	1.069	0.000	0.000	0.000	0.000	0.000	1.074
		LQL	0.396	0.799	2.996	0.616	0.059	0.187	4.245	4.379	0.199	0.089	0.035	0.230	0.158	4.407
Trip Backup	9	Mean	0.154	0.243	0.465	0.021	0.000	0.006	0.882	0.889	0.006	0.004	0.000	0.010	0.004	0.892
		StdDev	0.051	0.110	0.236	0.031	0.000	0.019	0.365	0.372	0.019	0.008	0.000	0.027	0.008	0.378
		Max	0.239	0.398	0.944	0.081	0.000	0.057	1.660	1.660	0.057	0.024	0.000	0.081	0.024	1.669
		Min	0.057	0.087	0.215	0.000	0.000	0.000	0.522	0.522	0.000	0.000	0.000	0.000	0.000	0.522
		Median	0.160	0.213	0.394	0.000	0.000	0.000	0.769	0.769	0.000	0.000	0.000	0.000	0.000	0.769
		LQL	0.153	0.329	0.707	0.094	0.000	0.057	1.096	1.117	0.057	0.025	0.000	0.081	0.025	1.135

* Excludes replicates

3.4.6 Audits, PEs, Training, and Accreditations

3.4.6.1 System Audits

EPA/NAREL conducts a Technical System Audit (TSA) approximately once every two to three years. EPA/NAREL last conducted a TSA of DRI's Environmental Analysis Facility (EAF), including its Carbon Laboratory, on May 15, 2007. Its audit report, dated August 21, 2007, found that DRI's Carbon laboratory was a modern facility with state-of-the art instrumentation, good documentation, and well-qualified staff and that it met or exceeded compliance with good laboratory practices and SOPs. Another TSA is anticipated in 2010.

3.4.6.2 Performance Evaluations

DRI's Environmental Analysis Facility (EAF), including its Carbon Laboratory, was one of several laboratories participating in the 2008-2009 EPA/NAREL inter-laboratory comparison study. The final results of the Performance Evaluation (PE) were released July 22, 2009. The 2009-2010 PE study was begun December 2009 through February 2010 and the results were recently submitted to EPA/NAREL.

3.4.6.3 Training

DRI's carbon analysis laboratory currently operates 24 hours a day, 7 days a week. Two full-time technicians, five students from the University of Nevada, Reno, two hourly technicians, and one maintenance technician are fully trained in carbon analysis. All new technicians undergo a rigorous two-week training program which includes a complete review of SOPs, filter analysis training and documentation, filter shipping and receiving, and basic equipment maintenance and operation.

3.4.6.4 Accreditations

There are no accreditation programs for thermal/optical carbon analysis.

3.5.6.4 References

Chow, J.C.; Watson, J.G.; Chen, L.W.; Chang, M.C..; Robinson, N.F..; Dana Trimble; Steven Kohl. (2007). The IMPROVE_A Temperature Protocol for Thermal/Optical Carbon Analysis: Maintaining Consistency with a Long-Term Database. *J. Air Waste Manage. Assoc.*, **57**:1014-1023.

3.5 X-ray Fluorescence Laboratories

The two XRF laboratories, RTI and CLN used 3 and 1 XRF instruments, respectively, to analyze an estimated 16,269 filters for 48 elements during the period of January 1 through March 15, 2009 and for 33 elements during the period of March 16, through December 31, 2009.

Beginning March 16, 2009, under the new PM2.5 contract the RTI XRF Laboratory and CLN decreased the amount of elements analyzed by XRF from 48 to 33. In addition to the drop in elements analyzed by XRF, RTI incorporated mass attenuation correction for filters analyzed by RTI, as required in the new contract.

3.5.1 RTI International XRF Laboratory

3.5.1.1 Quality Issues and Instrument Maintenance and Repairs

The following repairs and maintenance were performed for XRF 1:

- 05/05/09 – Replaced detector, preamp filter, and Q-box cooling fan (calibration required)
- 05/27/09 – Replaced tube and calibrated detector (calibration required)

- 08/31/09 – Replaced vacuum pump
- 11/03/09 – PM performed, checked voltages, resolution, and stability
- 11/20/09 – Replaced EDS board, PS1, and patch cable (calibration verified)

The following repairs and maintenance were performed for XRF 2:

- 02/10/09 – Replaced vacuum pump
- 03/06/09 – Replaced CPU board and re-loaded software (calibration verified)
- 11/03/09 – PM performed, checked voltages, resolution, and stability
- 11/12/09 – Replaced vacuum pump and 10 position sample tray

The following repair and maintenance was performed for XRF 3:

- 01/16/09 – Replaced EDS board and calibrated detector (calibration verified)
- 04/03/09 – Replaced HVPS (calibration verified)
- 11/03/09 – PM performed, checked voltages, resolution, and stability

3.5.1.2 Description of QC Checks Applied

QC activities for the analysis of elements by EDXRF for the RTI XRF Laboratory, their frequency of application and control limits, comments, and corrective actions are shown in **Table 3-34**.

Table 3-34. QC Procedures Performed in RTI XRF Elemental Analysis Laboratory

QC Check	QC Frequency	Control Limits	Comments/ Corrective Action
Calibration	as needed	—	—
Calibration verification[1]	monthly	90–110% recovery	check calibration
Instrument precision[2]	analyzed with each tray of samples (10 tray autosampler)	within 5% CV	check calibration and reanalysis of tray
Energy calibration	daily	—	—
Sample replicate precision	5%	+/- 50 RPD	Reanalysis

[1] Using NIST SRM
[2] Micromatter QC

3.5.1.3 Summary of QC Results

Precision was monitored by the reproducibility of the measurements of the multi-element Micromatter QC sample. The QC sample has six selected elements and is analyzed with each tray of samples. Comparison of the element's replicate values gives the measure of reproducibility or precision. The data used to monitor precision are presented in **Tables 3-35**

through 3-39. The percent coefficient of variation (%CV) for the average of all data for each of the six elements ranged between 0.15 and 0.39% for XRF 1, between 0.25 and 0.66% for XRF 2, and between 0.30 and 1.11% for XRF 3.

In 2009, it was observed that the Micromatter QC for XRF 3 had begun to deteriorate and developed a tear near the center of the sample. The QC sample was changed out for a new multi-element Micromatter QC sample on March 19, 2009.

Table 3-35. Summary of RTI XRF 1 Laboratory QC Precision Data, μg/cm^2, 3/17/2009 through 4/8/2009

Element	n	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Si	64	5.00	5.04	5.02	0.01	0.19	-0.19
Ti	64	6.70	6.77	6.74	0.02	0.23	0.25
Fe	64	6.70	6.78	6.73	0.02	0.27	0.40
Cd	64	5.60	5.68	5.64	0.02	0.33	0.37
Se	64	3.94	4.01	3.98	0.01	0.35	-0.07
Pb	64	9.02	9.09	9.06	0.01	0.15	-0.20

Table 3-36. Summary of RTI XRF 1 Laboratory QC Precision Data, μg/cm^2, 7/29/2009 through 12/30/2009

Element	n	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Si	258	5.01	5.09	5.05	0.02	0.35	-0.01
Ti	258	6.75	6.85	6.80	0.02	0.26	0.01
Fe	258	6.86	6.96	6.89	0.02	0.26	0.06
Cd	258	5.59	5.69	5.64	0.02	0.38	0.04
Se	258	3.91	3.97	3.94	0.02	0.39	-0.01
Pb	258	9.04	9.20	9.15	0.02	0.21	-0.01

Table 3-37. Summary of RTI XRF 2 Laboratory QC Precision Data, μg/cm^2, 1/1/2009 through 12/30/2009

Element	n	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Si	801	5.06	5.34	5.25	0.03	0.61	-0.17
Ti	801	6.60	6.73	6.64	0.02	0.31	-0.01
Fe	801	6.85	6.97	6.91	0.02	0.25	-0.03
Cd	801	5.69	5.98	5.91	0.02	0.38	-0.03
Se	801	3.94	4.05	4.00	0.02	0.44	0.02
Pb	801	9.25	9.48	9.33	0.06	0.66	-0.21

Table 3-38. Summary of RTI XRF 3 Laboratory QC Precision Data, μg/cm^2, 1/1/2009 through 3/18/2009

Element	n	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Si	152	9.83	10.2	10.1	0.07	0.69	-5.50
Ti	152	9.10	9.28	9.15	0.03	0.36	2.86
Fe	152	10.4	10.7	10.6	0.05	0.49	-2.92
Cd	152	5.68	5.88	5.83	0.03	0.60	-3.12
Se	152	4.05	4.15	4.10	0.02	0.37	-0.56
Pb	152	10.2	10.7	10.6	0.12	1.09	-8.19

Table 3-39. Summary of RTI XRF 3 Laboratory QC Precision Data, μg/cm^2, 3/19/2009 through 12/30/2009

Element	n	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Si	553	4.66	4.83	4.71	0.03	0.61	-1.02
Ti	553	5.60	5.93	5.66	0.06	1.11	-2.05
Fe	553	6.20	6.35	6.23	0.02	0.30	0.03
Cd	553	5.59	5.88	5.66	0.05	0.94	-1.58
Se	553	3.95	4.09	4.00	0.02	0.42	0.01
Pb	553	8.68	8.95	8.89	0.05	0.54	0.89

n = number of observations
Min = minimum value observed
Max = maximum value observed
Std Dev = standard deviation
%CV = percent coefficient variation ((Std Dev/Average)*100)

Recovery or system accuracy was determined by the analysis of a NIST Standard Reference Material (SRM) filter. Recovery is calculated by comparisons of measured and expected values. **Tables 3-40 through 3-42** show recovery for 7 elements of the 33 elements normally measured. The recovery values for all the elements ranged between 96 and 105% for XRF 1; between 96 and 103% for XRF 2; and between 94 and 102% for XRF 3. Note that every month, 33 elements of the Micromatter calibration standards are analyzed as unknowns to verify calibration.

Table 3-40. Recovery Determined from Analysis of NIST SRM 1832 for RTI XRF 1, 3/17/2009 through 12/30/2009

Element	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Al	96	102	99	0.32	2.15	-0.87
Si	97	98	97	0.11	0.31	0.21
Ca	96	98	97	0.18	0.92	-0.50
V	97	101	99	0.07	1.52	-0.21
Mn	101	105	103	0.05	1.08	-0.16
Co	97	100	99	0.01	1.33	-0.04
Cu	96	98	97	0.02	0.89	0.04

Table 3-41. Recovery Determined from Analysis of NIST SRM 1832 for RTI XRF 2, 1/1/2009 through 12/30/2009

Element	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Al	99	101	99	0.07	0.49	0.05
Si	96	97	96	0.09	0.27	-0.17
Ca	99	101	100	0.14	0.68	0.31
V	101	103	102	0.03	0.59	0.07
Mn	97	99	98	0.02	0.44	0.02
Co	97	99	98	0.01	0.61	-0.01
Cu	97	99	98	0.01	0.31	-0.01

Table 3-42. Recovery Determined from Analysis of NIST SRM 1832 for RTI XRF 3, 1/1/2009 through 12/30/2009

Element	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Al	95	100	98	0.20	1.38	0.25
Si	94	99	97	0.67	1.94	2.26
Ca	96	99	98	0.22	1.10	0.72
V	98	102	100	0.05	1.04	0.09
Mn	97	102	100	0.06	1.37	0.11
Co	95	99	98	0.01	1.39	0.03
Cu	96	99	98	0.02	0.82	0.04

Replicates were analyzed at a frequency of 5% of the number of filters analyzed in the RTI XRF Laboratory. Six elements were selected for comparison through regression analysis. **Table 3-43** shows the correlation coefficient and average RPDs for the replicate analysis. The correlation coefficients for XRF 1 range from 0.9983 to 0.9999, the correlation coefficients for XRF 2 range from 0.9982 to 0.9999, and the correlation coefficients for XRF 3 range from 0.9994 to 0.9999, indicating acceptable replication with all three instruments. Also, for the six elements, the average RPD on XRF 1 was less than 3%, the average RPD for the six elements on XRF 2 was less than 2%, and the average RPD for the six elements on XRF 3 was less than 2%.

Table 3-43. Replicates for XRF 1, XRF 2, and XRF 3

XRF 1				XRF 2			
Element	n	Correlation Coefficient	Average RPD	Element	n	Correlation Coefficient	Average RPD
Si	168	0.9983	-1.76	Si	408	0.9982	0.04
S	168	0.9999	0.31	S	408	0.9999	-0.17
K	168	0.9993	0.05	K	408	0.9999	1.00
Ca	168	0.9989	-2.88	Ca	408	0.9999	0.60
Fe	168	0.9997	-0.21	Fe	408	0.9998	1.08
Zn	168	0.9944	-3.07	Zn	408	0.9999	-1.23

XRF 3			
Element	n	Correlation Coefficient	Average RPD
Si	369	0.9997	-0.15
S	369	0.9999	-0.56
K	369	0.9994	0.51
Ca	369	0.9999	-0.67
Fe	369	0.9999	-0.50
Zn	369	0.9997	1.81

Assessment of Between-Instrument Comparability

Overview of Round-Robin Samples Run During 2009

In addition to passing internal QC samples as described in the sections above, the RTI laboratories and CLN participated in a “round-robin” filter program coordinated by the RTI XRF Laboratory. It should be emphasized that the round-robin program is only used to collect descriptive statistics about network performance; the results are not currently being used for QC purposes. The lag time between successive analyses and the potential for filter contamination and damage in transit make it impractical to use these filters for laboratory QC.

In the round-robin program, previously analyzed CSN filters are recycled through all the instruments in the two laboratories. **Table 3-44** summarizes the number of round-robin filters analyzed during 2009.

Table 3-44. Numbers of Round-Robin Filter Analyses Performed during 2008

Laboratory	Instrument	Filters
CLN	Kevex 770	24
CLN	Kevex 771	0
RTI	XRF 1	20
RTI	XRF 2	20
RTI	XRF 3	14

The Kevex 771 XRF instrument of the CLN Laboratory did not analyze any CSN filters during 2009; therefore no round robin filter results are reported for this instrument. XRF 3 of the RTI Laboratory reported a limited amount of round robin filter results due to the instrument being inoperable at the end of 2009.

The majority of elements reported by XRF are present in quantities at or below the detection capabilities of the instruments; therefore, it was necessary to restrict the statistical analysis of the round-robin results to 11 elements that were found in sufficient quantity on a majority of the filters. The statistics to follow in this section are restricted to latter filters.

Assessment of Bias and Precision

The primary purpose of the round-robin program is to assess bias between instruments for the various elements. Interlaboratory precision, a component of overall network error, can also be estimated based on these statistics.

One simple way to assess potential differences in performance of the different instruments is to perform linear regression in which the individual observations for each instrument are regressed against a reference value. **Tables 3-45 and 3-46** show linear regression results for which the data for the filters are regressed versus the median for the four instruments for each filter. The median value is used as the reference value, since the "true" value is unknown for these filters. Each instrument in the program reported zeros or low-level detections in some of the elements. This was especially noticeable for Mn, Ni, and Se, which affected the calculation for slope and correlation coefficient for these three elements. Note that the calculated uncertainty of these results for each instrument was not taken into account when doing the regression (i.e., no weighting factors were used).

Note: Three instruments from RTI and one from CLN were used in the calculations for the regression results.

Table 3-45. Regression Results for 11 Elements
RTI XRF Instrument XRF #1 and XRF #2

Element	RTI #1				RTI #2			
	n	Correlation Coefficient	Slope	Intercept	n	Correlation Coefficient	Slope	Intercept
Si	20	0.9991	0.9916	0.0120	20	0.9984	0.9924	0.0369
S	20	0.9999	0.9967	0.0490	20	0.9999	0.9933	0.0195
K	20	0.9997	0.9955	0.0054	20	0.9992	1.0520	-0.0064
Ca	20	0.9995	0.9782	0.0001	20	0.9996	0.9751	-0.0214
Mn	20	0.9139	0.9834	0.0019	20	0.9422	1.0722	0.0066
Fe	20	0.9996	1.0017	0.0306	20	0.9995	0.9798	0.0280
Ni	20	0.9989	1.0147	0.0016	20	0.9975	0.9435	0.0014
Cu	20	0.9748	0.9574	0.0017	20	0.9905	1.0053	0.0000
Zn	20	0.9931	0.9694	0.0087	20	0.9968	1.0123	0.0069
Se	20	0.9511	1.0498	-0.0015	20	0.8549	0.6233	0.0011
Pb	20	0.9863	0.9904	0.0016	20	0.9760	1.0091	-0.0016

Note: Units for intercept are µg/filter; correlation coefficient and slope are dimensionless.

Table 3-46. Regression Results for 11 Elements
RTI XRF Instrument #3 and CLN XRF Instrument 770

Element	RTI #3				CLN 770			
	n	Correlation Coefficient	Slope	Intercept	N	Correlation Coefficient	Slope	Intercept
Si	14	0.9995	1.0084	-0.0457	20	0.9900	0.9781	0.0000
S	14	0.9997	1.0177	-0.1245	20	0.9985	1.0089	-0.1987
K	14	0.9994	0.9827	-0.0217	20	0.9981	0.9826	-0.0029
Ca	14	0.9994	1.0177	0.0031	20	0.9993	1.0310	0.0429
Mn	14	0.9834	1.0826	-0.0058	20	0.8178	0.7376	-0.0010
Fe	14	0.9985	1.0357	-0.0315	20	0.9952	0.9809	-0.0794
Ni	14	0.9982	0.9808	0.0024	20	0.9728	0.9663	-0.0066
Cu	14	0.9947	1.0759	-0.0008	20	0.9716	0.9418	0.0007
Zn	14	0.9968	1.0472	-0.0120	20	0.9936	0.9217	0.0009
Se	14	0.8188	0.8529	0.0022	20	0.9192	0.9343	0.0066
Pb	14	0.9808	0.9752	0.0022	20	0.9714	0.9210	0.0032

Note: Units for intercept are µg/filter; correlation coefficient and slope are dimensionless.

3.5.1.4 Determination of Uncertainties and MDLs

MDLs are determined periodically by obtaining data from the analysis of 10 laboratory blanks. The MDLs are calculated as three times the average counting uncertainty for each element. This is equivalent to a “3-sigma” MDL; data users should be careful to know what multiple has been used in establishing the MDL when comparing values reported by different environmental laboratories, since some laboratories may use 1-sigma, 2-sigma, or 2.5-sigma. The calculated MDLs based on XRF uncertainty from XRF 1, XRF 2, and XRF 3 is presented in **Table 3-47**.

Counting uncertainties for each analytical result are automatically calculated by the ThermoNoran software, except when the concentration value is zero; the software cannot calculate an uncertainty. Total uncertainty is calculated using a combination of the counting uncertainty, attenuation uncertainty (if applicable), laboratory calibration uncertainty (5%), and field sampling and handling uncertainty (5%). The ThermoNoran software returns a zero counting uncertainty whenever the calculated mass for an element is calculated to be zero or negative. To obtain an uncertainty value for when the concentration is zero, the following formula is used:

$$\text{Uncertainty} = \text{slope} * A * \text{sqrt}\,(3 * \text{sqrt}\,(B * t) + B * t) / t$$

Where

A = scaling factor
B = background counts (cps) is incorporated during the importing of the data into the RTI XRF database
t = livetime.

Table 3-47. Method Detection Limits – Interference-Free, 3-sigma, μg/filter

Element	RTI #1	RTI #2	RTI #3
Na	0.337	0.303	0.342
Mg	0.111	0.114	0.115
Al	0.273	0.129	0.267
Si	0.134	0.093	0.139
P	0.103	0.155	0.116
S	0.067	0.095	0.073
Cl	0.052	0.075	0.056
K	0.045	0.070	0.044
Ca	0.052	0.073	0.050
Ti	0.039	0.051	0.044
V	0.032	0.037	0.032
Cr	0.021	0.025	0.023
Mn	0.018	0.018	0.018
Fe	0.015	0.016	0.014
Co	0.013	0.013	0.013
Ni	0.013	0.012	0.012
Cu	0.040	0.016	0.014
Zn	0.026	0.017	0.017
As	0.019	0.009	0.018
Se	0.021	0.013	0.021
Br	0.020	0.013	0.024
Rb	0.020	0.019	0.015
Sr	0.024	0.023	0.028
Zr	0.329	0.032	0.036
Ag	0.216	0.126	0.135
Cd	0.308	0.166	0.141
In	0.295	0.154	0.219
Sn	0.264	0.196	0.342
Sb	0.371	0.377	0.401
Cs	0.113	0.110	0.110
Ba	0.094	0.105	0.103
Ce	0.076	0.094	0.075
Pb	0.046	0.045	0.056

3.5.1.5 Audits, PEs, Training, and Accreditations

On September 1, 2009, a Technical Systems Audit (TSA) was conducted by the EPA as part of the quality assurance oversight for the PM2.5 Chemical Speciation Network. The audit team consisted of personnel form the National Air and Radiation Environmental Laboratory (NAREL) and personnel from the Office of Air Quality Planning and Standards (OAQPS). NAREL provided the RTI XRF lab a sample previously analyzed by RTI, to be analyzed during the day of the audit and results provided during the exit interview. Results of the analysis performed the day of the audit compared well with previous analysis of the filter.

Prior to the onsite audit, the RTI XRF laboratory participated in a NAREL sponsored inter-laboratory comparison study. The study included the analysis of both 47mm and 25mm Teflon filters. RTI XRF laboratory served as the reference lab for the 47mm Teflon filters, in which they analyzed all 47mm filters used in the study before they were distributed blindly to the participating laboratories and re-analyzed the 47mm filters a second time once they returned form the participating laboratories. The 25mm filters were submitted to the RTI XRF lab blind, with UC-Davis serving as the reference lab.

The results of the NAREL sponsored inter-laboratory comparison study indicated good performance from the RTI XRF laboratory for the 47mm filters as well as the 25mm filters, which are not routinely analyzed by the RTI XRF lab.

3.5.2 Chester LabNet X-Ray Fluorescence Laboratory

During the period covered by this report, Chester Labnet (CLN) operated one Kevex 770 XRF instrument analyzing 300 samples for 48 elements, and 900 samples for 33 elements.

3.5.2.1 Quality Issues and Instrument Repair and Maintenance

The following repairs and maintenance were performed for XRF-770:

- 4/10/09 - replaced PC power supply.
- 6/29/09 – replaced coolant in X-ray tube heat exchanger.
- 9/29/09 – replaced X-ray tube heat exchanger with S/N 1402.
- 10/1/09 – replaced X-ray tube heat exchanger with S/N 1424.

3.5.2.2 Description of QC Checks Applied

QC activities for the analysis of elements by EDXRF for the CLN XRF laboratory, their frequency of application and control limits, comments and corrective actions are shown in **Table 3-48.**

Table 3-48. QC Procedures Performed in Support of XRF Elemental Analysis

QC Check	QC Frequency	Control Limits	Comments/Corrective Action
Calibration	As needed	± 5%	Calibration
Calibration verification[1]	Once per week	± 2 sigma	Recalibrate
Instrument precision[2]	Per 10 to 15 samples	± 10%	Re-analyze
Excitation condition check	Per 10 to 15 samples	± 10%	Re-analyze
Sample replicate precision	Per 10 samples	RPD < 2x uncertainty	Re-analyze if necessary

1 - Using NIST SRMs
2 – Micromatter QC

3.5.2.3 Summary of QC Results

Precision

Precision was monitored by the reproducibility of the multi-element Micromatter QC sample. The QC sample has six selected elements and is analyzed with each tray of samples. The comparison of the element's values gives the measure of reproducibility or precision. The data used to monitor precision are presented in **Table 3-49**. The percent coefficient of variation (%CV) for the average of all data for each of the six elements ranged between 1.56 and 4.06%.

Table 3-49. Summary of CLN XRF 770 Laboratory QC Precision Data 1/1/2009 through 12/31/2009

Element	n	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Si	103	89.8	106.5	96.8	3.93	4.06	-8.53
Ti	103	92.5	104.2	96.9	2.23	2.30	-4.31
Fe	103	93.2	104.1	97.5	1.93	1.98	-3.83
Cd	103	94.5	102.8	98.1	1.53	1.56	-2.85
Se	103	90.3	104.5	94.7	2.63	2.78	-5.54
Pb	103	90.4	103.9	94.7	2.67	2.82	-6.01

Accuracy

Accuracy determinations are performed with three NIST thin film SRMs, four vapor deposited Micromatter standards, and one NIST particle size standard. Recovery is calculated by dividing the measured result by the expected value. Table 3-21A show recovery for 12 elements spanning the atomic mass range of the 33 elements normally measured. The min and max recovery values for all the elements ranged between 86.5 and 116.5%. Analysis of NIST Particle Standard SRM 2783 yielded recoveries of 100.0% for Ca and 100.8% for Zn. Averages over the reporting period were within the recovery goal of twice the standard deviation; however individual measurements were sometimes outside this criterion. Corrective actions were taken whenever a recovery was outside specifications as follows:

- If <u>one</u> of the elements in **Table 3-50** fell outside of the 2-sigma limit, a single re-analysis of the standard was performed in that excitation condition. If re-analysis resulted in failure, then recalibration of that excitation condition was necessary.

- If recalibration demonstrated that the log of the inverse of the new calibration factor (log sensitivity) –vs- atomic number (Z) for the "failed element" did not conform to a smoothly varying curve defined by the log of the sensitivity factors –vs- atomic numbers for the remaining elements, then the calibration factor was "forced" to fit the curve, with the resulting calibration factor yielding "less than optimum" recovery values.

Table 3-50. Recovery Determined from Analysis of NIST SRMs 1832, 1833, 2708 and 2783 for CLN XRF 770 -- 1/1/2009 through 12/31/2009

Element	Min	Max	Average	Std Dev	%CV	Slope (%/year)
Al	96.7	107.2	102.5	2.53	2.47	1.63
Si	96.9	104.3	101.3	1.64	1.62	0.81
Si	94.5	100.9	98.0	1.40	1.42	-1.14
S	86.5	101.6	97.1	2.76	2.84	0.95
K	101.4	110.6	106.4	2.28	2.14	0.79
Ca	94.3	104.7	100.0	2.25	2.25	0.92
Ti	94.1	102.9	98.2	2.00	2.04	0.57
V	91.6	102.3	97.2	2.52	2.60	2.55
Mn	95.3	105.8	98.7	1.94	1.96	-1.58
Fe	95.3	102.3	99.6	1. 30	1.30	-0.65
Cu	92.3	116.5	101.5	4.18	4.11	-1.66
Zn	93.1	112.4	100.8	4.34	4.30	-7.89
Pb	95.5	106.7	100.1	2.34	2.33	-0.63

<u>Reproducibility</u>

Replicate analysis of field samples are used to assess reproducibility of the analytical system. Replicates were analyzed at a frequency of 10% of the filters analyzed. Six elements were selected for comparison through regression analysis. **Table 3-51** shows the correlation coefficient and average RPDs for the replicate analysis. The correlation coefficients range from 0.9862 to 0.9993.

Table 3-51. Replicate Data for CLN XRF 770

Kevex 770			
Element	n	Correlation Coefficient	Average RPD
Al	73	.9862	3.44
Si	115	.9970	-6.90
S	119	.9989	-1.79
K	119	.9953	-1.04
Ca	119	.9992	-2.86
Fe	119	.9993	-1.26
Zn	107	.9971	1.55

There are times when the distribution of a certain species across the filter is not uniform, and will not produce tight precision. This is important information for those who intend to use the data. It is CLN's position that re-analysis of particle deposits on filters received from the field represents the degree of confidence the client may expect more accurately than precision calculated from the uniformly distributed deposits from the Micromatter QC standard.

Failure of individual replicate analysis results to fall with 2x uncertainty can fall into several categories:

- The wrong sample can be re-analyzed, which is easily deduced and easily corrected by re-analyzing the correct sample.
- If one element in a sample lies outside the 2-sigma range, especially a volatile species such as Cl which can be an order of magnitude lower on subsequent analysis due to the low pressure atmosphere in the analysis chamber, no action is taken. However, if several elements in one excitation condition lie outside action levels, while other species in different excitation conditions demonstrate good precision, then the spectra for the excitation condition in question are examined for anomalies, and re-analysis of that excitation condition is performed.

3.5.2.4 Assessment of Between-instrument Comparability

For XRF, inter-instrument comparability is assessed by a round-robin filter exchange program coordinated by the RTI XRF laboratory. See Section 3.4.2.4 for comparative performance of both laboratories.

Since the inception of the PM2.5 Speciation project, CLN has performed numerous comparisons between instruments via replicate analysis of a number of clients, but much of this data is proprietary and cannot be shared in this report.

3.5.2.5 Uncertainties and MDLs

The methods for determining uncertainties and MDLs are described in SOPs XR-002.02 and XR-006.01. MDLs were determined for the 770 instrument on 12/26/05. The calculated MDLs are presented in presented in **Table 3-52**.

Table 3-52. Method Detection Limits – Interference-Free, 3-sigma, μg/filter

Element	CLN 770
Na	0.849
Mg	0.314
Al	0.160
Si	0.110
P	0.059
S	0.056
Cl	0.106
K	0.058
Ca	0.046
Ti	0.022
V	0.019
Cr	0.024
Mn	0.030
Fe	0.049
Co	0.036
Ni	0.029
Cu	0.022
Zn	0.022
As	0.042
Se	0.021
Br	0.020
Rb	0.022
Sr	0.026
Zr	0.042
Ag	0.149
Cd	0.160
In	0.179
Sn	0.212
Sb	0.254
Cs	0.052
Ba	0.082
Ce	0.043
Pb	0.064

3.5.2.6 Audits, PEs, Training, and Accreditations

CLN has not received any audit visits from EPA on the CSN program since the beginning of the speciation project, and would welcome any PE samples or other oversight, which the EPA might deem appropriate.

CLN began training Rachel Mori in mid-April of 2007. Her training has included sample log-in, sample preparation for XRF, XRF analysis, QA/QC of XRF spectral data, data entry, and sample shipping. Rachel came to CLN with approximately 2 years experience performing XRF analysis on Teflon filters for the IMPROVE network at UC Davis. In 2008, Rachel Mori was named technical director of Chester's Gravimetry Department. She now splits her time between XRF and Gravimetry.

Another Chester client provides quarterly PE samples in the form of Micromatter vapor deposited standards for elements: Cr, Cu, Zn, Ga, As, Se, Cd, Te, and Pb. However, these PE samples were analyzed using instrument XRF 772, which is not currently approved for use on the CSN program.

3.6 Denuder Refurbishment Laboratory

The Denuder Refurbishment Laboratory is located in RTI Building No. 3, Laboratory 219. The purpose of the laboratory is to clean and refurbish the coatings on acid-gas-removing denuders used in samplers of CSNs operated by EPA and various State, local, and tribal agencies, which utilize the RTI/EPA contract. The laboratory also prepares denuders for capture of either acidic or basic gases from the atmosphere and subsequent extraction and analysis to quantify the concentrations of these gases. The laboratory follows these SOPs, which are kept on file in the laboratory:

- Standard Operating Procedures for Coating [MetOne] Aluminum Honeycomb Denuders with Magnesium Oxide
- Standard Operating Procedure for Coating and Extracting Annular Denuders with Sodium Carbonate
- Procedures for Coating R & P Speciation Sampler "ChemComb" Denuders with Sodium Carbonate
- Standard Operating Procedure for Coating Annular Denuders with XAD-4 Resin
- Standard Operating Procedure for Coating and Extracting Denuders for Capture of Ammonia and Its Analysis [specific for use with glass honeycomb denuder].
- Standard Operating Procedure for Coating and Extracting Compact Parallel-Plate Denuders for Capture of Ammonia [specific for use with the parallel plate denuder for the MetOne SASS sampler]

The SOP, "Standard Operating Procedure for Coating and Extracting Denuders for Capture of Ammonia and Its Analysis" was prepared in 2008. This SOP was assembled in recognition of the need for collection of the basic gas, ammonia, using the denuder technique with the MetOne SASS system. This SOP is subject to significant revisions when the final edition of the quartz, parallel plate design denuder is accepted by EPA and put into use at field sites. In anticipation of this, RTI obtained and conducted intramural studies of the parallel plate denuder. These studies included a visit to Colorado State University where the denuder was characterized and tested in the laboratory and in ambient air. The studies also involved field tests at the RTI campus and the preparation of an SOP written specifically for use of the parallel plate denuder for the MetOne SASS PM2.5 chemical speciation sampler. The SOP title is "Standard Operating Procedure for Coating and Extracting Compact Parallel-Plate Denuders for Capture of Ammonia," prepared September 30, 2009.

3.6.1 Quality Issues and Corrective Actions

Ms. Constance Wall continues to coordinate the Denuder Refurbishment Laboratory. She reviews the denuder refurbishment SOPs to ensure procedures are clearly stated and all processes are up to date. Minor revisions were made as required. All SOPs were reviewed and signed by responsible personnel in early 2009. Revisions mainly concerned glassware use and volumes of slurry; no revisions affected the quality of the actual denuder-coating process.

Personnel have been cross-trained to be able to process denuders. At present, there are four persons trained to refurbish and coat denuders. RTI is also capable of coating denuders in a glove cabinet so that exposure of denuders to ambient air is minimized and the denuders can later be extracted to quantify the mass of acidic (e.g., HNO_3) or basic (e.g., NH_3) gases collected.

3.6.2 Operational Discussion

3.6.2.1 Numbers of Each Type of Denuder Serviced

Table 3-53 lists the type of denuders refurbished and the number of refurbishments completed in 2009.

Table 3-53. Denuder Refurbishments, January 1, 2009 through December 31, 2009

Denuder Type	Total Refurbished
Denuder	864

3.6.2.2 Scheduling of Replacements

MetOne speciation sampler aluminum honeycomb denuders are coated with magnesium oxide. Because the MetOne denuders are part of the sampling module and six sets of modules are in circulation to each site, these denuders are refurbished at 18-month intervals. RTI is able to remove MgO from denuders using a dilute hydrochloric acid solution. As needed, RTI orders uncoated aluminum honeycomb denuder substrates from MetOne, cleans them with solvent and deionized water, and then coats them with magnesium oxide. The change-out occurs whenever the MetOne denuder assembly has been in use for 18 months.

R & P ChemComb™ glass honeycomb denuders are cleaned and coated with sodium carbonate/glycerol. R & P denuders are replaced after each 24-hour sampling use. Very few R&P denuders were used in 2009.

No XAD-4 resin coated denuders (for removal of organic vapors) were ordered by EPA/OAQPS during the reporting interval. No SOP exists for the preparation and use of organic vapor denuders for the MetOne SASS $PM_{2.5}$ chemical speciation sampling system.

No requests for use of the quartz parallel plate denuder, specifically designed for use with the MetOne SASS sampler, followed by laboratory determination of ammonia (and/or acidic gases) were received in 2009.

3.6.3 Description of QC Checks Applied and Results

QC checks for coating weight are no longer done. Work in earlier years of the project(s) showed that coating weights on the same types of MgO-coated denuders were usually within 10% of one another and that the amount (number of moles) of MgO applied far exceeded the expected mass (number of moles) of acidic gases that would be drawn through the denuder during the cumulative sampling period. Now the newly-coated denuder surfaces are examined by holding the denuder up to a light and sighting along the interior to determine the coating is thoroughly applied and the annuli are not blocked.

3.7 Sample Handling and Archiving Laboratory

3.7.1 Quality Issues and Corrective Actions

There were no major quality issues in the SHAL during 2009.

3.7.2 Description of QC Checks Applied

The SHAL uses a customized database program written specifically for RTI's SHAL operation. This database has been refined over 9 years to incorporate many built-in QC checks. For example, RTI has assigned an inventory number to all filter modules in the network. The database will only accept allowable inventory numbers for filter modules. This avoids errors in data input for any filter module used for a sampling event. Another example is the unique number of the Teflon filters used by RTI. RTI purchases Teflon filters with a check sum digit in the numbering sequence. The database will only accept those filter numbers with the correct check sum. This prevents inadvertent entry of incorrect filter identification numbers.

Figure 3-2. SHAL Technician Loading the URG 3000N Cassette.

- Bar-code readers are used to input identification numbers from modules, containers, and data forms to eliminate data transcription errors.
- A SHAL technician other than the one who prepared an outgoing shipment checks the package of outgoing filters. A checklist is used by the technician to verify that the package contents are correct before it is shipped from RTI. This check is performed on all outgoing shipments from the SHAL.

- Blank filters are taken from the SHAL refrigerator and sent unopened to the analytical laboratories for analysis. The results of the analysis of these QC filters are used to improve the overall quality of the program.
- The field site operators are provided contact information for the SHAL laboratory so they may communicate directly with personnel at RTI if any problems are discovered upon receipt of the filter modules. RTI personnel will attempt to resolve issues promptly. For example, a Field Data Form may be faxed from RTI to the site operator if necessary.

3.7.3 Summary of QC Results

During calendar year 2009, the SHAL shipped out and received back more than 31,000 packages of filters. By employing the QC checks described in Section 3.7.2, the majority of the coolers shipped and received at RTI contained the correct filter modules and the required paperwork for completing the sampling event at the field site. The high number of correctly packaged shipments sent from RTI helped the field-sampling locations meet their completion goals.

3.7.4 Summary of Scheduling Problems

RTI prepares shipping schedules for the CSN and distributes these to all field sampling locations through the EPA DOPO's. The schedules indicate when each cooler will be sent from RTI, the scheduled sampling date for the filters, and the return ship date from the site back to RTI. The schedules are designed to allow RTI to send the sampling site clean filters, allowing time for field site operators to set up and retrieve filters from the samplers. Late-arriving shipments back to RTI may cause disruptions in the designated shipping schedule and could lead to missed sampling events. For instance, RTI may receive a shipment from the field sampling site, past the date that the filter modules were to be sent for a subsequent sampling event. When this happens, it may be impossible for RTI to send the filter modules to the sampling location for the next sampling event. This will mean a missed sampling event for that location. Late-arriving shipments at RTI may be due to delays in transit or late return shipments from the site. Late shipments received at RTI during 2009 are summarized in **Figures 3-3 and 3-4**. Sites may also deviate from the sampling schedule and run filters on a date other than the scheduled date. **Table 3-54** lists those sites with less than 95% of their filters run on the intended sampling date.

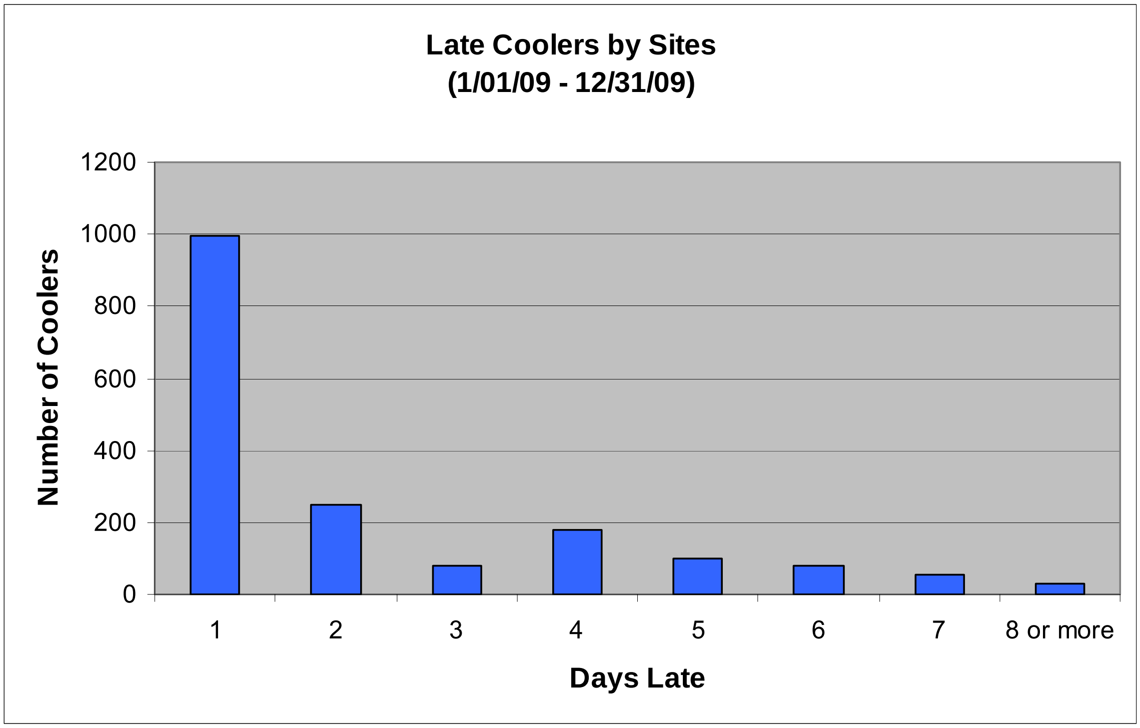

Figure 3-3. Late Coolers by Site.

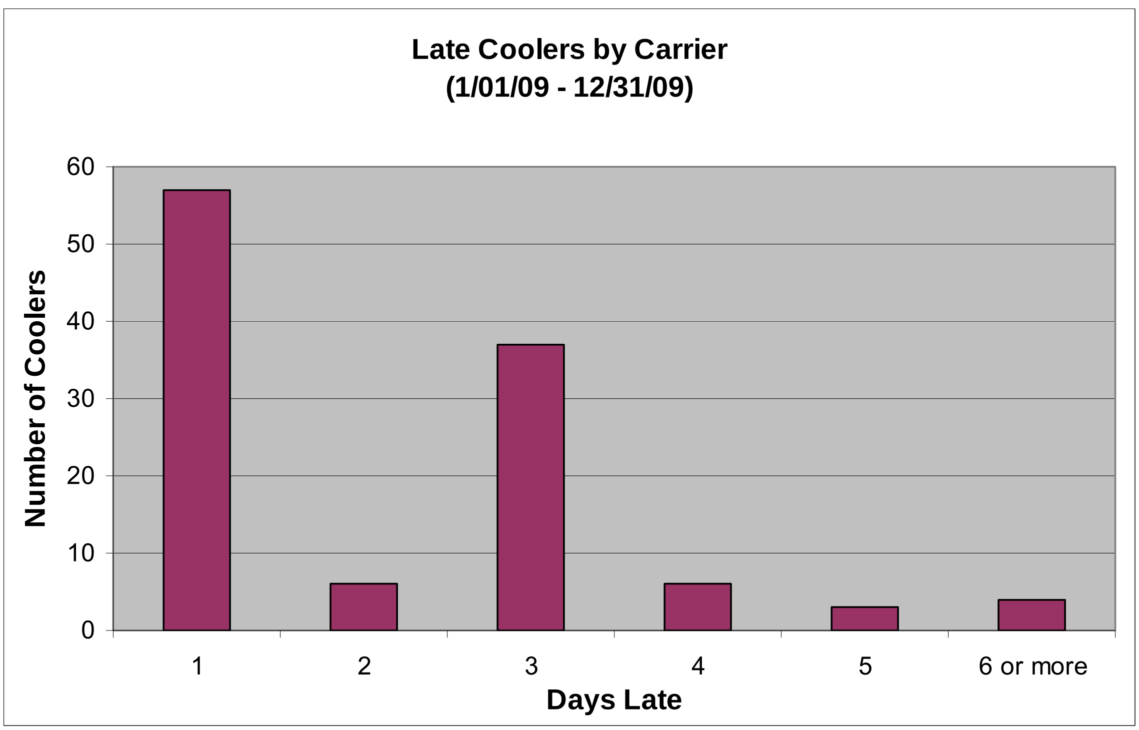

Figure 3-4. Late Coolers by Carrier.

Table 3-54. Sites with Less than 95% of Filters Run on Intended Sampling Date

AQS Site Code	POC	Location	Events[1]	On Date	Percent
191130037	5	Army Reserve Center	6	5	83.3
460990006	5	Kelo	15	13	86.7
471570024	5	Alabama (TN)	121	107	88.4
290470005	5	Liberty - Met One	130	116	89.2
280670002	5	Laurel	63	57	90.5
540390011	5	WV - Guthrie Agricultural Center	210	192	91.4
060190008	5	Fresno - First Street	186	173	93.0
060290014	6	Bakersfield-California Ave (Collocated)	66	62	93.9
060290014	5	Bakersfield-California Ave	108	102	94.4
220150008	5	Shreveport Airport - Met One	75	71	94.7
260810020	5	Grand Rapids	94	89	94.7
420210011	5	Johnstown	46	44	95.7
390870012	5	ODOT Garage	94	90	95.7
470931020	5	Spring Hill Elementary School	122	117	95.9
300630031	5	Missoula County Health Dept.	246	236	95.9

(1) For sites with both SASS and URG 3000 N, each sampler was counted separately.

3.7.5 Support Activities for Site Operators and Data Users

SHAL staff provided support to site operators and data users throughout 2009. A summary of email and phone communications with site operators and data users is presented in **Table 3-55**.

Table 3-55. Summary of SHAL Communications with Site Operators and Data Users

Description	Number of Communications
Site will send cooler late	75
Site needs schedule	43
Site did not receive cooler	42
Change of operator/site information	105
Sampler problems/questions	151
Field Blank/Trip Blank ran as routine sample	3
Request change of ship date from RTI	39
Site is stopping	88
Miscellaneous QA Issues	84
Data questions/reporting	146
Other	124

3.7.6 Audits, PEs, Training, and Accreditations

- All new SHAL technicians must undergo a formal training process before they handle any filters. This process includes a Safety and Occupational Health Orientation, the viewing of a training video detailing the SHAL procedures, a review of the SOP and instruction by senior staff in filter handling. A record of this training is kept on file.
- SHAL staff periodically review the SOP and a record of this review is added to their training file.
- All SHAL staff are trained in the handling of the 25mm quartz filters used in the URG 3000N sampler and the proper installation and removal of the quartz filter using the URG 3000N cassette.
- Throughout the year, senior SHAL staff will periodically observe the SHAL technicians processing the filter modules. A checklist of correct tasks has been prepared for each module type. The checklist is used during the observation of the technician. The SHAL supervisor keeps the completed checklists. Technicians are briefed following the review of any findings. A summary of the reviews for calendar year 2009 is shown in **Table 3-56**.
- In September of 2009, EPA QA Personnel performed an onsite Technical Systems Audit as part of the oversight for the Chemical Speciation Network. Their review of the SHAL operations concluded that “No deficiencies were noted for this area of laboratory operations.”

Table 3-56. Review of SHAL Technician Processing Filter Modules

Module Type	Number Observed	Findings	Findings Reviewed with Technician
MET ONE	105	5	5
URG 3000N	60	1	1

4.0 Data Processing

4.1 Quality Issues and Corrective Actions

No significant quality issues arose during the period of this report that affected reportable data.

4.2 Operational Summary

Routine data-processing activities have remained largely unchanged since the beginning of the program. These include the following:

- Accepting data entered from field forms
- Accepting data from the laboratories
- Backing up and maintaining the database
- Generating data monthly for validation and review
- Posting review data monthly to the Web site for external review
- Incorporating data change requested by the States
- Uploading finalized data to AQS
- Responding to user inquiries and data requests, including support to EPA and RTI personnel.

4.3 Operational Changes and Improvements

During RTI’s first laboratory support contract (1999-2003) for EPA’s Chemical Speciation Network (CSN), RTI’s Organic Carbon/Elemental Carbon (OC/EC) Laboratory used the original version of Sunset Laboratory's calculation software for all reported carbon fractions. With the new contract, RTI upgraded its analysis with new improved with new software that provided a better adjustment for aging laser chamber windows that enables a more accurate OC/EC switch over the useful lifetime of the analysis chamber and better signal filter routines that reduce noise at low levels of carbon. During the Carbon PM Monitoring Workshop at UC Davis in January 2008, the impact of the new software calculation software upgrade on analysis results for CSN trip and field blanks was quite obvious. Significantly lower background levels of EC were seen with the new software. The general consensus of the group was to try to bring the earlier OC/EC data into better alignment with OC/EC data for samples collected under the second contract. Under a separate work assignment, RTI used the new software to reprocess all OC/EC samples posted to AQS under the original contract. These samples were then reposted to AQS with the reprocessed results. As a result of this activity, all carbon analysis data in AQS for PM2.5 analyzed and posted by RTI using the CSN/TOT method should now be consistent across the entire period (2000 to 2009).

4.4 Monthly Data Postings to Web Site

Each month, RTI posts data for samples received on or before the 15th of the previous month. **Table 4-1** shows monthly totals for postings, and **Table 4-2** shows totals for events. Sample dates may overlap between different batches due to different shipping schedules for the

1-in-3 and 1-in-6 sampling schedules. In addition, the latest date may include samples received late (i.e., after the previous report's cutoff date). Note that the number of records reported per event varies with sampler type. Thus, the number of records per event will vary depending on how many of each sampler type was operating during that period. In addition, the totals in table 4-1 exclude backup filters (which are always run as part of another event) to prevent double counting of events.

Postings to AQS

After data have been posted to the external Web site, sites have 45 days to review data and send corrections to RTI. RTI then is required to post data to AQS within 15 days. RTI met all processing deadlines for this reporting year. **Table 4-3** contains totals of events posted to AQS. **Table 4-4** contains totals of records posted to AQS. Note that blanks involve fewer records per event, as temperature and barometric pressure for field and trip blanks are not posted to AQS. Some data, such as results for the collocated shipping study, were reported to the sites, but were not reported to AQS. In addition, the number of records posted per event varies with sampler type (with the URG posting volatile and total nitrate).

4.5 Data User Support Activities

RTI had continuing data-user support throughout the year. Most responses may be categorized into four categories; data change requests, requests for old data, support requests for the Speciation Data Validation and Analysis Tool (SDVAT), and requests from data users.

4.5.1 Data Change Requests

Sites are asked to review their data and submit any changes to RTI within 45 days. RTI then processes these changes before posting the data to AQS. Sites report changes via e-mail. Many sites do not report unless they have changes, whereas others send a report back indicating there are no changes to be made. **Table 4-5** shows a count of the number of change requests per batch. Note that many requests represent multiple sites (often an entire state).

Table 4-1. Events Posted to Web Site

Report		Sampling Date				Blanks			Backup Filters (3)	
Batch	Date	Earliest	Latest	Total(1)	Routine	Field	Trip	24 Hour(2)	Routine	Trip Blank
108	1/13/2009	11/8/2008	12/11/2008	1,476	1,088	178	61	75	74	
109	2/12/2009	12/8/2008	1/13/2009	1,411	1,260	1	36	56	58	
110	3/12/2009	12/11/2008	2/18/2009	1,424	1,196	65	12	76	75	
111	4/14/2009	2/6/2009	3/11/2009	1,338	1,017	4	175	71	71	
112	5/15/2009	3/8/2009	4/14/2009	1,811	1,302	171	4	168	166	
113	6/11/2009	4/13/2009	5/13/2009	1,195	1,074		3	58	59	1
114	7/14/2009	5/12/2009	6/13/2009	1,556	1,139	66	66	143	142	
115	8/13/2009	6/3/2009	7/12/2009	1,725	1,179	173	4	184	184	1
116	9/14/2009	7/6/2009	8/14/2009	1,475	1,182		1	148	144	
117	10/14/2009	8/11/2009	9/13/2009	1,860	1,267	1	179	207	206	
118	11/12/2009	9/10/2009	10/13/2009	1,629	1,127	65	7	215	210	5
119	12/15/2009	10/10/2009	11/12/2009	1,830	1,164	176	5	244	240	1
120	1/15/2010	11/9/2009	12/12/2009	1,739	1,193		69	238	238	1
			Total	20,469	15,188	900	622	1,883	1,867	9

1) Counts for Routine Events and Total Events do not include backup filters or 24-hour blanks.

2) 24 Hour blanks are only used with the URG 3000N samplers. Only results for OC/EC analysis by the IMPROVE_A method are reported for these samples.

3) Backup filters are only used for URG 3000N samplers. Only results for OC/EC analysis by the IMPROVE_A method are reported.

Table 4-2. Records Posted to Web Site

Report		Sampling Date				Blanks			Backup Filters (3)	
Batch	Date	Earliest	Latest	Total (1)	Routine	Field	Trip	24 Hour(2)	Routine	Trip Blank
108	1/13/2009	11/8/2008	12/11/2008	149,756	121,553	18,657	6,785	1,725	1,036	
109	2/12/2009	12/8/2008	1/13/2009	147,096	140,882	113	4,001	1,288	812	
110	3/12/2009	12/11/2008	2/18/2009	144,683	133,854	6,725	1,306	1,748	1,050	
111	4/14/2009	2/6/2009	3/11/2009	123,286	103,247	392	17,020	1,633	994	
112	5/15/2009	3/8/2009	4/14/2009	152,291	130,252	15,442	409	3,864	2,324	
113	6/11/2009	4/13/2009	5/13/2009	108,128	105,614		340	1,334	826	14
114	7/14/2009	5/12/2009	6/13/2009	130,096	112,467	5,693	6,659	3,289	1,988	
115	8/13/2009	6/3/2009	7/12/2009	138,441	116,612	14,573	434	4,232	2,576	14
116	9/14/2009	7/6/2009	8/14/2009	122,276	116,735		121	3,404	2,016	
117	10/14/2009	8/11/2009	9/13/2009	150,390	125,019	98	17,628	4,761	2,884	
118	11/12/2009	9/10/2009	10/13/2009	129,062	114,813	5,570	724	4,945	2,940	70
119	12/15/2009	10/10/2009	11/12/2009	138,009	115,318	13,173	532	5,612	3,360	14
120	1/15/2010	11/9/2009	12/12/2009	132,871	117,152		6,899	5,474	3,332	14
			Total	1,766,385	1,553,518	80,436	62,858	43,309	26,138	126

1) Counts for Routine Events and Total Events do not include backup filters or 24-hour blanks.

2) 24 Hour blanks are only used with the URG 3000N samplers. Only results for OC/EC analysis by the IMPROVE_A method are reported for these samples.

3) Backup filters are only used for URG 3000N samplers. Only results for OC/EC analysis by the IMPROVE_A method are reported.

Table 4-3. Events Posted to AQS

Report Batch	Routine(1)	Blanks			Backup Filters(2)
		24 Hour(2)	Field	Trip	
107	1,250	78		3	79
108	1,098	76	179	69	76
109	1,269	56	1	62	58
110	1,216	79	66	17	77
111	1,026	71	4	231	71
112	1,329	168	175	8	167
113	1,087	59		5	59
114	1,160	143	66	108	143
115	1,190	184	173	8	185
116	1,202	149		2	147
117	1,287	207	1	288	207
118	1,145	216	65	13	213
Total	14,259	1,486	730	814	1,482

1) A sampling event is defined as a sample taken at a single AQS site ID and Parameter Occurance Code (POC) on a single day. This would represent two physical samplers at sites that use URG 3000N samplers for carbon sampling.

2) URG 3000 N samplers only

Table 4-4. Records Posted to AQS

Report Batch	Routine	Blanks			Backup Filters(1)
		24 Hour(1)	Field	Trip	
107	85,972	1,014		140	1,027
108	75,651	988	11,627	4,143	988
109	87,545	728	67	2,572	754
110	83,587	1,027	4,274	838	1,001
111	59,503	923	208	9,528	923
112	73,649	2,184	8,736	239	2,171
113	60,610	767		182	767
114	64,772	1,859	3,215	3,761	1,859
115	66,918	2,392	8,331	246	2,405
116	67,198	1,937		65	1,911
117	71,826	2,691	52	10,092	2,691
118	66,001	2,808	3,156	414	2,769
Total	863,232	19,318	39,666	32,220	19,266

1) URG 3000 N only

Table 4-5. Change Requests per Report Batch(1)

Report Batch											
107	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**	**116**	**117**	**118**
9	9	5	6	2	8	5	5	5	3	6	8

1) Number of site data contact changes. Multiple data changes by one site contact are counted as one request.

5.0 Quality Assurance and Data Validation

5.1 QA Activities

5.1.1 QAPP Updates

RTI's QAPP was revised for the new CSN contract, and was submitted in February, 2009.

5.1.2 SOP Updates

RTI's SOPs were updated in preparation for the procurement of the CSN contract in July 2008. These were finalized in early 2009, after contract award. All SOPs are shown in Section 7 of this report.

5.1.3 Internal Surveillance Activities

Internal surveillance activities during 2009 included walkthroughs of all the laboratories to verify compliance with the SOPs. Outstanding quality issues are discussed at monthly project meetings, and any new changes required were implemented.

SHAL technicians also crosscheck each other's coolers before they are shipped to the sites.

5.1.4 Data User Support Activities

The Project Manager, QA Manager, SHAL Supervisors, Data Processing Supervisor and other project personnel responded to a number of questions and requests for data during 2009. These originated from both network participants (state agency personnel and EPA), as well as data users who were not affiliated with the CSN program.

5.2 Data Validation and Review

5.2.1 Review of Monthly Data Reports to the CSN Web Site

Each month, RTI reviews data completed during the previous month. These reviews include the following activities:

- Verification of data attribution to the correct site, POC, and date
- Visual review of report formats
- Investigation and corrective actions when discrepancies are found
- Automated range checks (e.g., barometric pressure, temperature)
- Level 1 checks (e.g., reconstructed mass balance, anion/cation balance, and sulfur/sulfate balance).

Tables 5-1 through 5-3 summarize the data flags attached to the data primarily through the data review process, although some of these were specified by either the field operator or one of the laboratories. Examining trends in flag percentages is a useful tool in diagnosing potential problems.

5.2.2 Review of Monthly Data Packages to AQS

Approximately 60 days after initial posting on the RTI Web site, the data are uploaded to the AQS database. Prior to uploading, the data processing staff prepares a QC summary report, which is reviewed by the QA Manager. This summary and review includes the following main areas:

- Verification that changes requested by the state agencies have been implemented. This includes checking data flags that are different between original reporting (Web site posting) and final AQS reporting.
- Verification that record counts match exactly the number of records previously reported on the CSN Web site, with allowance for all records that were added and deleted during processing. Record changes include such things as elimination of duplicates, generation of aggregated nitrate values for MASS samplers, and deletion of data for sites not reported to AQS (e.g., special studies).
- Scanning for unusual values such as start times other than midnight
- Scanning for formatting errors such as the following:
  - duplicate records
  - flags and other data in incorrect columns
  - previously delivered data (unless they are Modify records)
  - MDLs and uncertainties that do not agree between the original report and the AQS data file.

5.3 Analysis of Collocated Data

The CSN program operated six sites with collocated samplers during 2009, shown in **Table 5-4**. Two of these sites included the new URG 3000N IMPROVE-type sampler on both the primary and collocated sampler. The data from these sites afforded an opportunity to calculate total precision and compare the values with the uncertainty values that are currently being reported to AQS. Bias or accuracy cannot be assessed from this dataset because neither of the collocated samplers can be assumed to be more accurate than the other.

Table 5-1. Summary of Validity Status Codes by Delivery Batch Number (percent of data records reported)

Flag	Description	Delivery Batch Number												
		108	109	110	111	112	113	114	115	116	117	118	119	120
3	Possible field contamination	0.0%				0.0%		0.0%	0.0%		0.0%		0.0%	0.0%
4	Possible lab contamination													
5	Outlier-cause unknown	3.5%	4.4%	3.8%	3.9%	4.8%	5.1%	4.8%	3.1%	7.1%	3.4%	5.8%	6.0%	5.8%
J	Construction/Demolition													
W	Flow Rate Average out of specs		0.1%	0.1%	0.1%	0.1%				0.1%	0.5%		0.1%	0.1%
X	Filter Temperature Diff. out of spec	0.2%	0.3%	0.9%	0.7%	0.5%	0.9%	0.5%	0.5%	1.0%	0.9%	0.5%	0.5%	0.5%
Y	Elapsed Sample Time out of specs											0.0%	0.1%	
IA	African Dust													
IC	Chem. Spills and Industrial Accidents						0.3%	0.4%	0.4%	0.4%	0.3%	0.3%	0.3%	0.3%
ID	Cleanup After a Major Disaster						0.2%	0.4%	0.4%	0.4%	0.3%	0.3%	0.3%	0.3%
IE	Demolition	0.2%	0.2%											
IF	Fire - Canadian									0.2%				
IH	Fireworks							0.1%	0.2%		0.1%			
II	High Pollen Count									0.1%			0.1%	0.1%
IJ	High Winds	0.4%	0.2%	0.5%	0.1%	0.2%	0.4%	0.1%	0.5%	0.3%	0.4%	0.7%	0.4%	0.8%
IK	Infrequent Large Gatherings						0.1%	0.2%	0.1%	0.1%	0.1%			
IL	Other	0.1%	0.1%	0.5%	0.2%	1.0%	0.4%	0.6%	0.6%	0.6%	0.7%	0.2%	0.2%	0.2%
IM	Prescribed Fire				0.1%	0.1%					0.0%	0.2%	0.3%	0.1%
IN	Seismic Activity													
IO	Stratospheric Ozone Intrusion													
IP	Structural Fire					0.1%			0.1%		0.1%	0.1%		0.1%
IR	Unique Traffic Disruption										0.1%			
IT	Wildfire-U. S.	0.1%					0.2%	0.2%	0.1%	0.7%	1.2%	1.1%	0.3%	0.1%
IU	Wildland Fire Use Fire-U. S.													

Table 5-2. Summary of Null Value Codes by Delivery Batch Number (percent of data records reported)

Flag	Description	Delivery Batch Number												
		108	109	110	111	112	113	114	115	116	117	118	119	120
AB	Technician Unavailable	0.2%	0.1%	0.1%	0.1%	0.1%		0.2%	0.0%	0.2%	0.2%	0.3%	0.1%	0.2%
AC	Construction/Repairs in Area	0.2%	0.2%	0.1%	0.3%		0.0%		0.1%	0.2%	0.1%		0.0%	
AD	Shelter Storm Damage													
AF	Scheduled but not Collected	0.8%	1.2%	0.5%	0.7%	1.3%	0.3%	0.4%	0.5%	0.6%	0.5%	1.1%	0.7%	0.5%
AG	Sample Time out of Limits	0.3%	0.9%	0.5%	0.6%	0.6%	0.5%	0.7%	0.8%	1.0%	0.2%	0.6%	1.3%	0.7%
AH	Sample Flow Rate out of Limits	0.5%	0.8%	0.9%	0.6%	0.6%	0.4%	0.2%	0.6%	0.8%	0.5%	0.5%	0.6%	0.3%
AI	Insufficient Data (Can't Calculate)	0.1%	0.2%	0.3%	0.1%	0.3%	0.2%	0.2%	0.1%	0.4%	0.1%	0.1%	0.2%	0.0%
AJ	Filter Damage	0.2%	0.2%	0.1%	0.1%	0.3%	0.1%	0.1%	0.1%	0.2%	0.1%	0.1%	0.1%	0.1%
AK	Filter Leak					0.0%							0.0%	
AL	Voided by Operator	0.5%	0.2%	0.4%	0.4%	0.2%	0.1%	0.3%	0.2%	0.0%	0.1%	0.1%	0.1%	0.1%
AM	Miscellaneous Void	0.3%	0.2%	0.1%	0.3%	0.3%	0.0%			0.1%	0.0%	0.0%	0.0%	0.0%
AN	Machine Malfunction	0.7%	1.8%	2.2%	1.6%	1.8%	0.7%	0.6%	0.7%	1.2%	0.8%	1.3%	1.2%	0.6%
AO	Bad Weather		0.1%	0.2%	0.1%	0.1%	0.1%					0.1%		0.1%
AP	Vandalism	0.1%	0.1%			0.0%								
AQ	Collection Error	0.1%	0.4%	0.3%	0.3%	0.2%	0.2%	0.3%	0.1%	0.1%	0.2%	0.1%	0.1%	0.1%
AR	Lab Error	0.1%	0.0%	0.1%	0.1%	0.0%	0.0%	0.2%	0.0%	0.0%	0.1%	0.1%	0.2%	0.2%
AS	Poor Quality Assurance Results							0.1%						
AU	Monitoring Waived	0.2%		0.1%		0.0%	0.2%	0.1%		0.1%			0.0%	
AV	Power Failure	0.2%	0.7%	0.4%	0.7%	0.5%	0.4%	0.8%	0.5%	0.5%	0.1%	0.3%	0.7%	0.4%
AW	Wildlife Damage								0.0%				0.1%	
BA	Maintenance/Routine Repairs			0.2%	0.2%	0.1%	0.2%		0.2%	0.1%	0.0%		0.1%	0.1%
BB	Unable to Reach Site	0.0%	0.4%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.1%	0.0%	0.4%	0.2%
BE	Building/Site Repairs				0.2%	0.0%	0.1%	0.2%	0.1%		0.1%	0.1%		
BI	Lost or Damaged in Transit		0.1%											
BJ	Operator Error													

Table 5-3. RTI-assigned Flags (not reported to AQS) by Delivery Batch Number (percent of data records reported)

Flag	Description	Delivery Batch Number												
		108	109	110	111	112	113	114	115	116	117	118	119	120
ANB	Analysis not billable	0.2%	0.1%	0.0%	0.1%	0.2%	0.0%	0.3%	0.1%	0.1%	0.1%	0.3%	0.2%	0.4%
APB	Analysis partially billable	1.2%	2.0%	1.7%	2.0%	1.8%	1.6%	1.5%	1.5%	2.4%	1.5%	2.1%	3.2%	1.7%
DFM	Filter missing					0.0%						0.1%	0.0%	0.1%
DSI	Shipment invalid													
DST	Received Temperature > 4C	10.8%	9.7%	7.6%	9.5%	20.9%	30.0%	40.3%	54.4%	61.3%	48.1%	34.2%	17.4%	24.5%
FBS	Field or Trip Blank appears sampled	0.1%											0.1%	
FCE	Corrected - operator data entry error	1.3%	1.9%	2.3%	1.4%	1.9%	2.6%	2.4%	2.0%	1.3%	2.2%	2.3%	2.4%	4.0%
FES	Field Environmental Data Substituted	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%	0.1%	0.0%	0.1%	0.1%
FHT	Pickup holding time exceeded	20.4%	15.7%	16.9%	4.9%	13.1%	16.6%	9.5%	9.6%	15.2%	11.6%	11.2%	14.3%	13.9%
FSB	Sample is blank											0.1%		
FSL	Sample lost or damaged in shipmen													0.1%
LEQ	Lab environ. criteria out of limits													
LFA	Filter inspection - Filter wet	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%			0.0%	0.0%	0.1%	0.0%	0.1%
LFH	Filter inspection - Holes in filter			0.0%					0.0%	0.0%	0.0%			
LFL	Filter inspection - Loose Material								0.0%			0.1%		
LFO	Filter inspection - Other						0.0%	0.0%						
LFT	Filter inspection - Tear										0.0%			0.0%
QAC	Cation/Anion Ratio out of limits	0.3%	0.4%	0.3%	0.3%	0.4%	0.3%	0.3%	0.2%	0.3%	0.2%	0.2%	0.3%	0.3%
QL1	Invalidated by Level 1 Check	0.0%	0.1%	0.0%	0.1%	0.1%	0.1%	0.1%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%
QMB	Reconst. mass balance outside limits	3.2%	4.1%	3.6%	3.7%	4.3%	4.6%	4.6%	2.9%	6.8%	3.2%	5.6%	5.7%	5.4%
SNB	Sample not billable	0.1%	0.2%	0.2%		0.4%	0.1%	0.1%				0.2%	0.0%	0.0%
SPB	Sample partially billable	1.9%	3.6%	3.4%	3.3%	2.8%	1.0%	1.7%	1.4%	1.6%	1.3%	1.8%	1.7%	1.2%

Table 5-4. Collocated Sites in the CSN During 2009.

Location Name	State	AQS Code	Sampler Type
Bakersfield-California Ave	California	60290014	MetOne SASS
Deer Park	Texas	482011039	URG MASS
G.T. Craig	Ohio	390350060	MetOne SASS
New Brunswick	New Jersey	340230006	MetOne SASS
Riverside-Rubidoux	California	60658001	MetOne SASS
Roxbury (Boston)	Massachusetts	250250042	MetOne SASS

As indicated in the table, five of the sites use MetOne SASS samplers and one uses a URG MASS sampler. None of the collocated sites used either the Andersen RAAS sampler or the R&P speciation sampler during 2009.

In general, the collocation data shows good or excellent agreement for the major analytes. The figures that follow (**Figure 5-1**) show examples of the comparisons for organic and elemental carbon, $PM_{2.5}$ mass, nitrate, sulfate, and sulfur. Events for which one or both concentration values are invalid are not plotted, but data with Airs Validity Status codes set are included in the figures. The oblique line on each chart indicates perfect agreement (slope=1.000). In addition to Organic and Elemental Carbon results from the original CSN method (sampled with MetOne SASS or URG MASS) results from the IMPROVE_A TOR method (sampled with URG 3000N) are included. The scatter for the IMPROVE_A results is noticeably better than for the CSN method results because of the large difference in deposit density on the 3000N filters. Higher concentrations of analyte tend to reduce relative analytical variability.

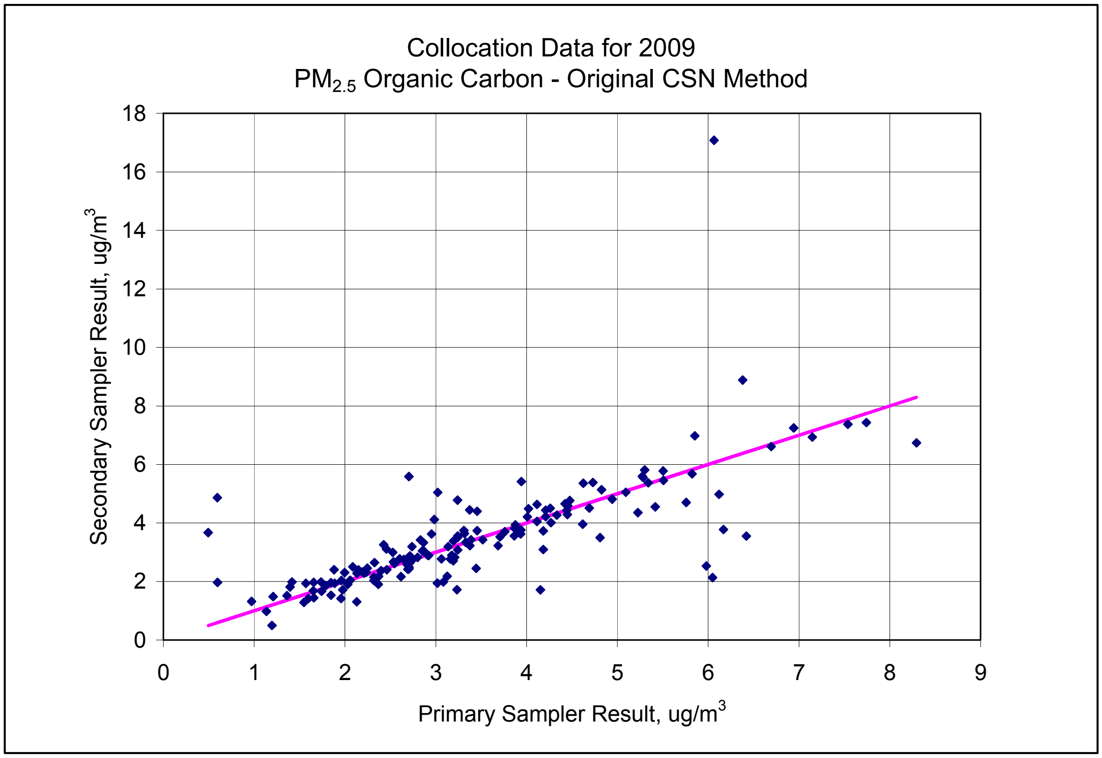

Figure 5-1. Examples of the Comparisons for CSN Organic Carbon, CSN Elemental Carbon, IMPROVE_A Organic Carbon, IMPROVE_A Elemental Carbon, Mass, Nitrate, Sulfate, and Sulfur.

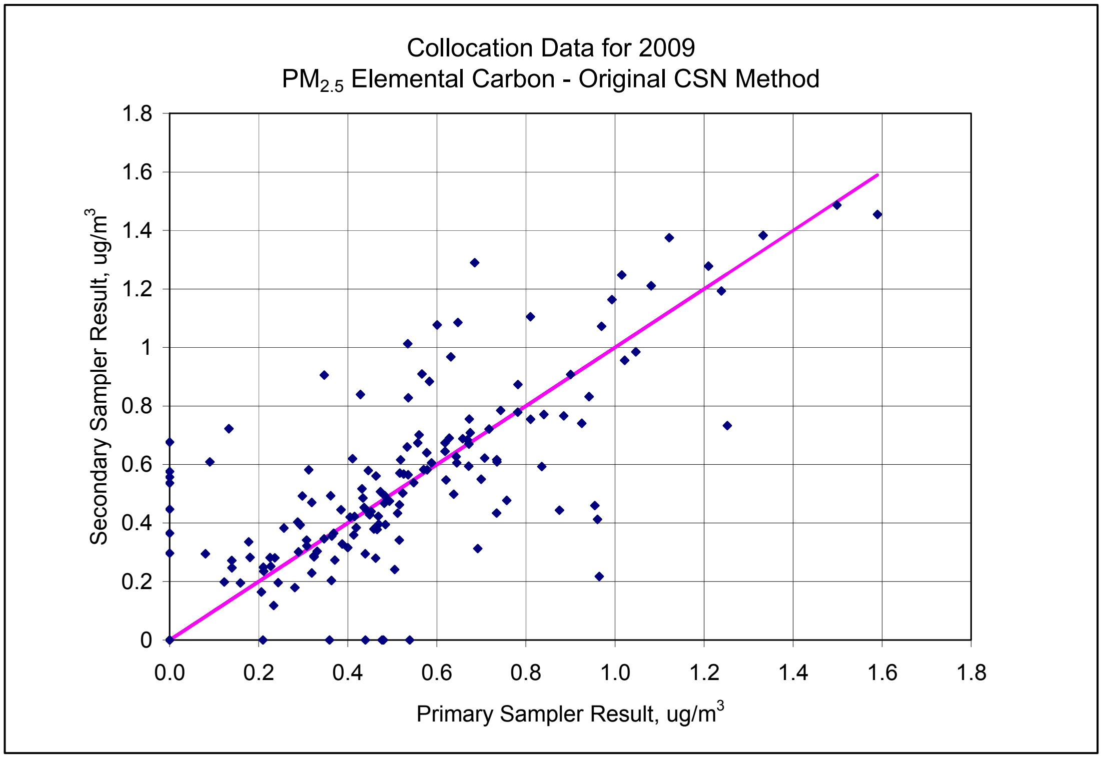

Figure 5-1. (continued).

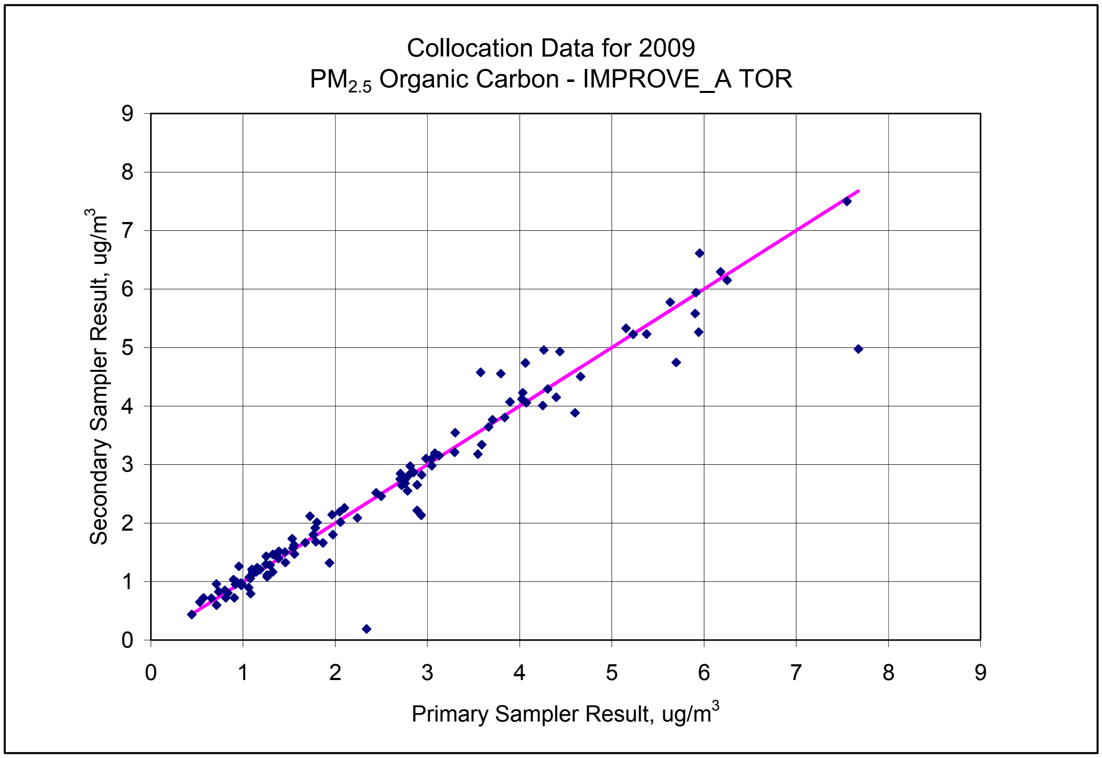

Figure 5-1. (continued).

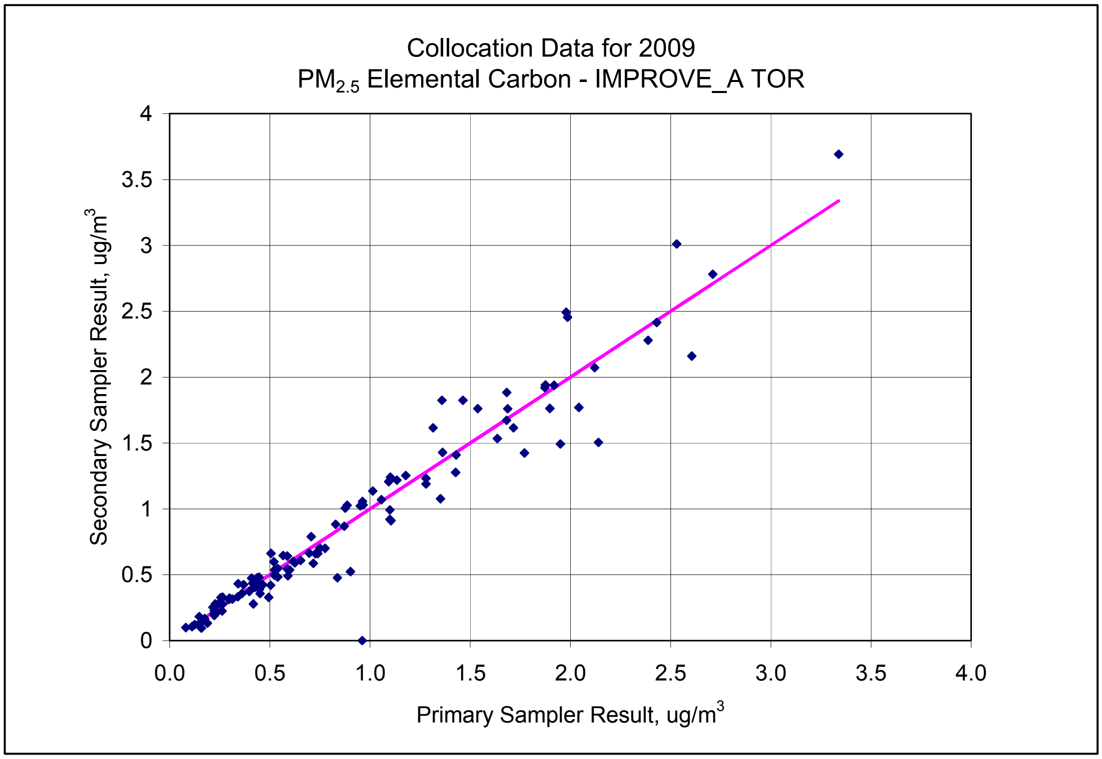

Figure 5-1. (continued).

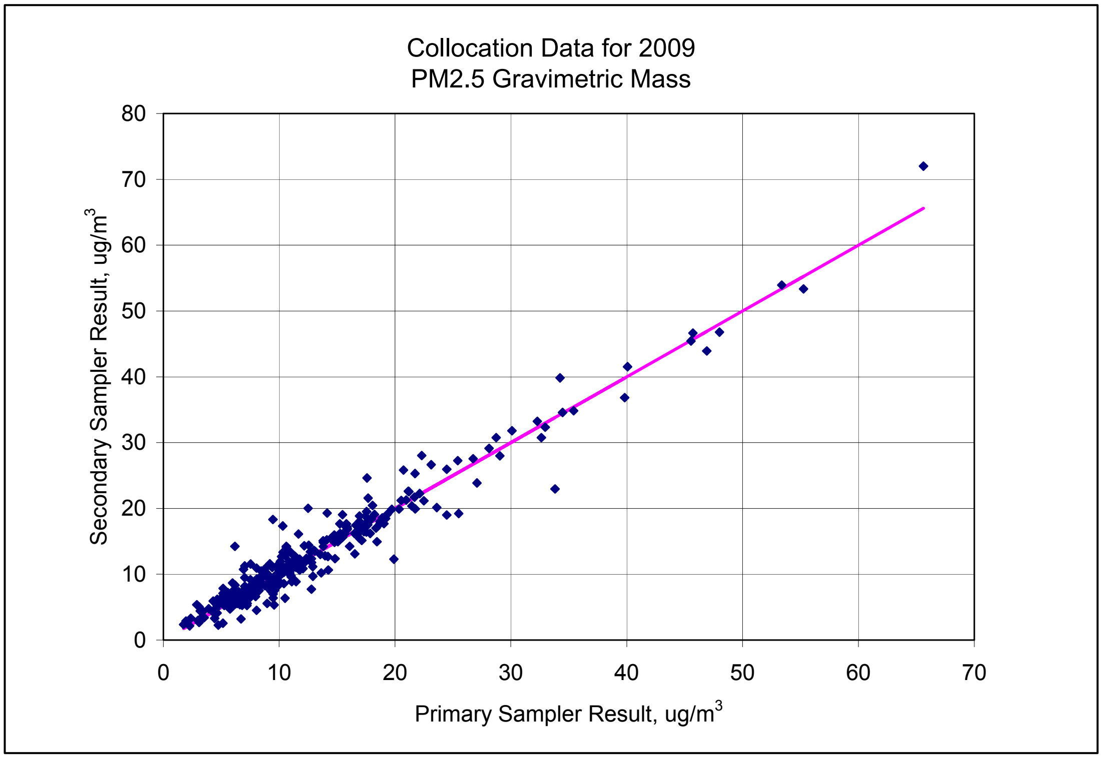

Figure 5-1. (continued).

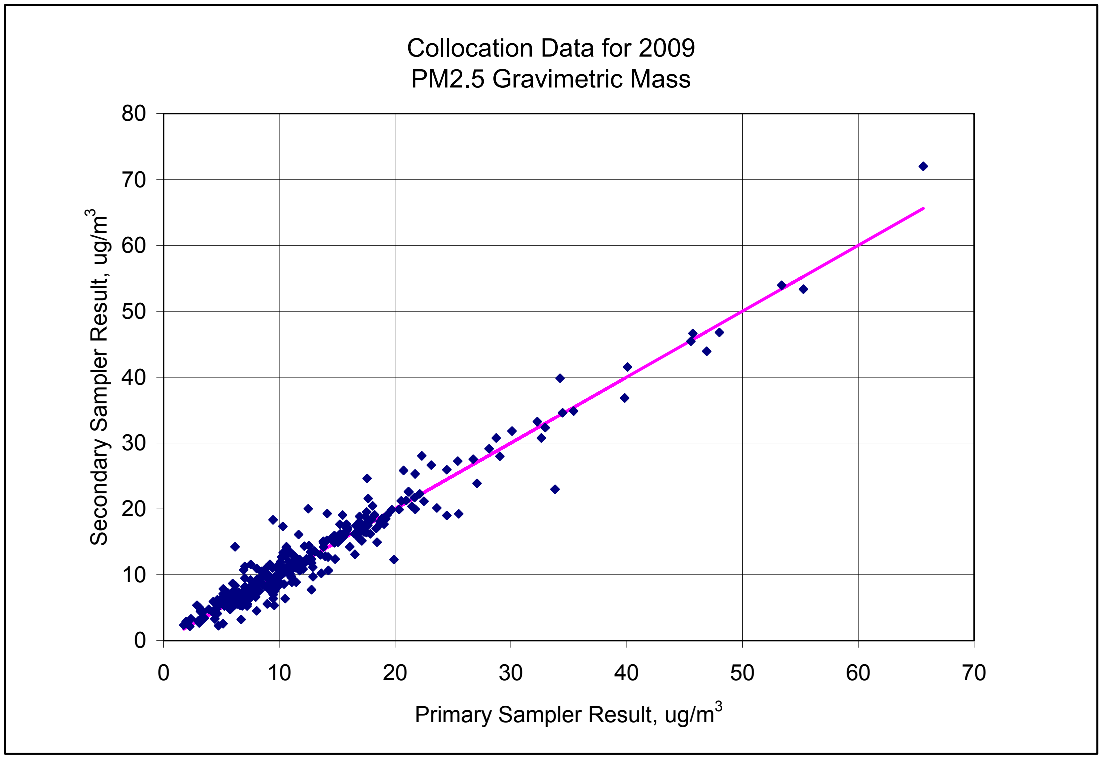

Figure 5-1. (continued).

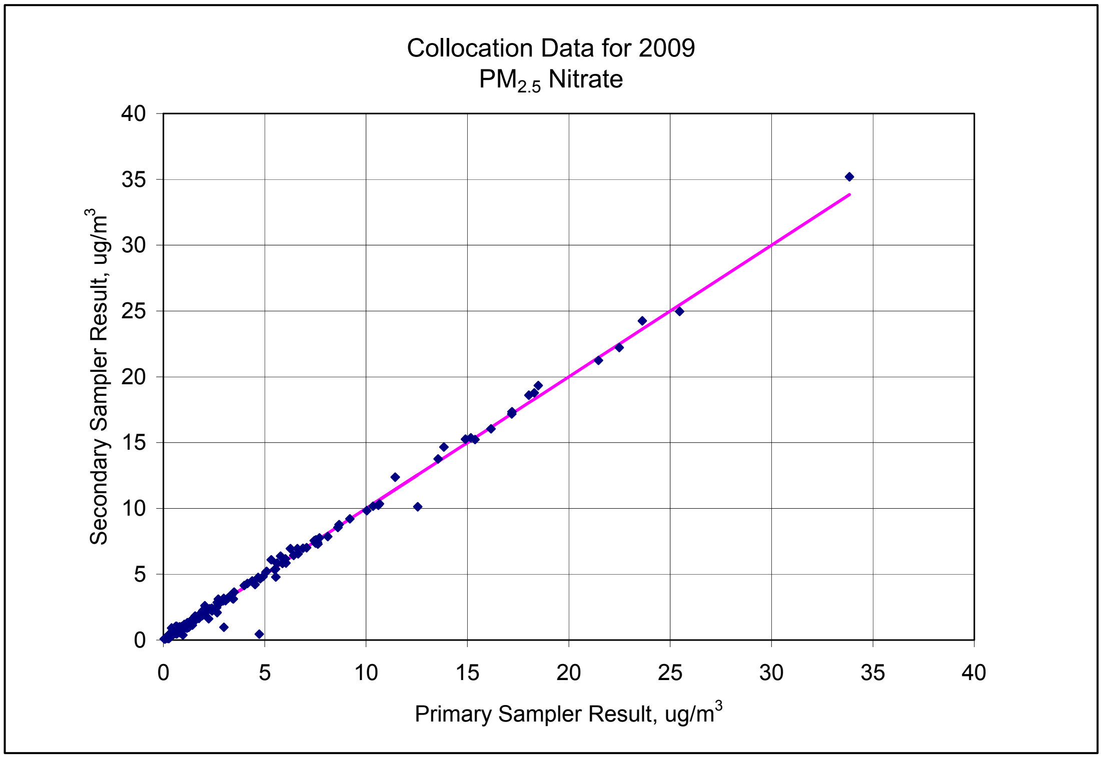

Figure 5-1. (continued).

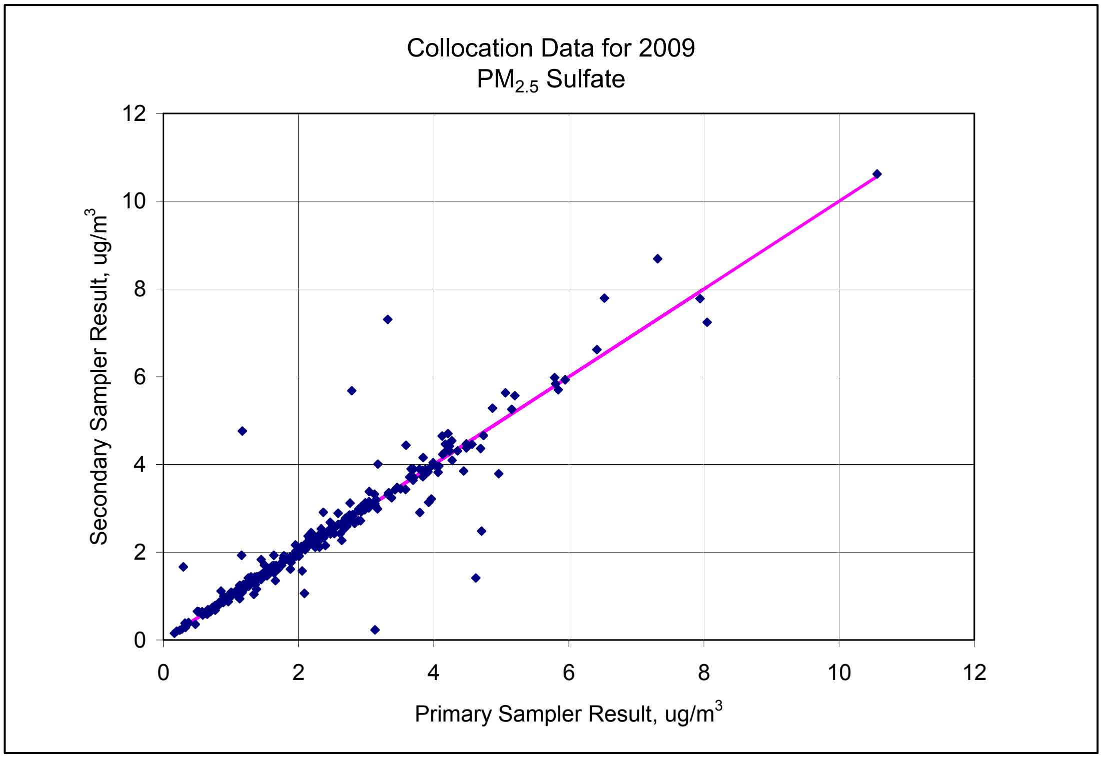

Figure 5-1. (continued).

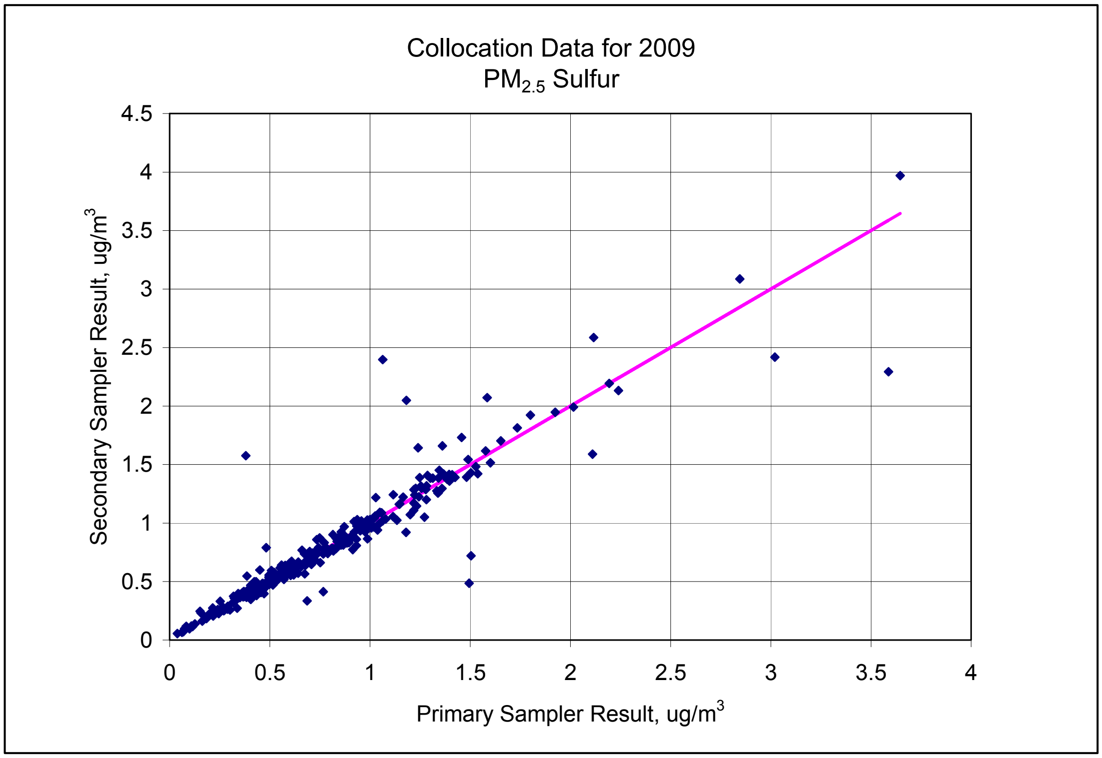

Figure 5-1. (continued).

Table 5-5 shows the results of collocated sampling and provides a comparison with the uncertainties reported to AQS. The first column indicates the name of the chemical analyte. Column 2 shows the average value from the primary sampler. Note that the standard deviations reflect environmental variability of the concentration and are not determined by the laboratory uncertainties. The column titled "Average Relative Diff" is the average of the unsigned differences between the two samplers, which is calculated using the following formula:

$$ARD = \frac{1}{\sqrt{2}} \sum \frac{|C_1 - C_2|}{(C_1 + C_2)/2}$$

Where

- C_1 and C_2 are the concentrations from the primary and collocated samplers, respectively
- The factor of $1/\sqrt{2}$ is used to convert the difference to a single-sampler basis
- The summation is over all valid concentration values where the concentration (C1 or C2) is greater than twice the uncertainty reported to AQS.

The column titled "Average AQS Uncert." is simply the grand average of all the relative uncertainties associated with the C_1 and C_2 values and is calculated as follows:

$$AvAQS = \sum_i \sum_j U_{ij} / C_{ij}$$

Table 5-5. Precision of Collocated Samplers

Analyte	Sampler 1		Sampler 2		Average Relative Diff.[2]	Average Rel. AQS Uncert.[3]	Ratio AQS/ARD percent[4]	Counts[5]
	Avg Conc	Std[1] Dev	Avg Conc	Std Dev				
Trace Elements by XRF								
Aluminum	0.095	0.371	0.073	0.111	38%	35%	91%	202
Arsenic	0.002	0.002	0.002	0.001	39%	94%	**241%**	44
Bromine	0.004	0.003	0.005	0.003	25%	38%	155%	259
Calcium	0.055	0.103	0.052	0.053	21%	13%	65%	300
Chlorine	0.108	0.208	0.092	0.172	39%	23%	59%	254
Chromium	0.008	0.029	0.003	0.005	56%	69%	125%	111
Cobalt	0.002	0.003	0.001	0.001	45%	79%	178%	74
Copper	0.019	0.021	0.014	0.018	33%	20%	60%	281
Iron	0.124	0.312	0.101	0.092	18%	8%	44%	302
Lead	0.005	0.005	0.005	0.004	39%	74%	189%	72
Magnesium	0.035	0.031	0.033	0.031	40%	37%	92%	90
Manganese	0.004	0.006	0.003	0.002	36%	48%	135%	173
Nickel	0.003	0.012	0.002	0.002	42%	47%	110%	182
Potassium	0.075	0.108	0.073	0.082	12%	10%	81%	302
Selenium	0.004	0.007	0.004	0.006	32%	70%	**223%**	38
Silicon	0.170	0.552	0.148	0.234	21%	17%	81%	293
Sodium	0.162	0.202	0.164	0.190	29%	27%	94%	245
Strontium	0.003	0.004	0.002	0.001	32%	87%	**269%**	19
Sulfur	0.779	0.517	0.786	0.519	6%	7%	117%	302
Titanium	0.010	0.029	0.009	0.010	39%	51%	132%	130
Vanadium	0.003	0.002	0.004	0.002	37%	57%	152%	84
Zinc	0.012	0.014	0.012	0.014	23%	23%	98%	263

Analyte	Sampler 1 Avg Conc	Sampler 1 Std[1] Dev	Sampler 2 Avg Conc	Sampler 2 Std Dev	Average Relative Diff.[2]	Average Rel. AQS Uncert.[3]	Ratio AQS/ARD percent[4]	Counts[5]
Anions and Cations by IC								
Ammonium	1.573	1.719	1.587	1.757	8%	7%	94%	297
Potassium	0.103	0.094	0.107	0.092	26%	11%	43%	165
Sodium	0.193	0.215	0.198	0.203	26%	47%	184%	282
Nitrate	2.717	4.614	2.718	4.660	10%	7%	78%	308
Sulfate	2.315	1.474	2.343	1.537	5%	7%	132%	297
Particulate Matter (Gravimetry)								
Particulate matter 2.5u	12.945	9.209	13.190	9.317	10%	6%	64%	301
Organic and Elemental Carbon by IMPROVE_A Method (Sampled by URG 3000N)								
EC IMPROVE TOR	0.918	0.699	0.916	0.727	9%			113
EC IMPROVE TOT	0.627	0.658	0.628	0.650	10%			113
OC IMPROVE TOR	2.614	1.675	2.575	1.642	7%			114
OC IMPROVE TOT	2.904	1.862	2.860	1.818	7%			114
E1 IMPROVE	1.327	1.033	1.276	0.943	9%			113
E2 IMPROVE	0.049	0.021	0.054	0.035	22%			112
E3 IMPROVE	0.004	0.003	0.006	0.009	97%			5
O1 IMPROVE	0.367	0.329	0.370	0.338	28%			111
O2 IMPROVE	0.635	0.362	0.622	0.351	10%			114
O3 IMPROVE	0.689	0.474	0.707	0.512	9%			114
O4 IMPROVE	0.473	0.289	0.474	0.299	15%			114
OP IMPROVE TOR	0.465	0.424	0.442	0.340	23%			106
OP IMPROVE TOT	0.743	0.585	0.699	0.535	14%			111

Analyte	Sampler 1 Avg Conc	Sampler 1 Std[1] Dev	Sampler 2 Avg Conc	Sampler 2 Std Dev	Average Relative Diff.[2]	Average Rel. AQS Uncert.[3]	Ratio AQS/ARD percent[4]	Counts[5]
Organic and Elemental Carbon by Original CSN Method (Sampled by MetOne SASS and URG MASS)								
Elemental carbon	0.562	0.288	0.582	0.300	18%	58%	**316%**	140
Organic carbon	3.424	1.542	3.493	1.852	13%	14%	112%	156
Pk1_OC	0.757	0.403	0.771	0.444	24%	47%	**200%**	156
Pk2_OC	1.126	0.570	1.122	0.572	15%	31%	199%	156
Pk3_OC	0.766	0.402	0.781	0.476	18%	43%	**241%**	156
Pk4_OC	0.805	0.479	0.841	0.640	28%	51%	**183%**	156
PyrolC	0.258	0.176	0.496	0.687	47%	675%	**1422%**	8

1 The standard deviations are a function of the natural variability of the environmental levels and are not indicative of the analytical precision.
2 Calculated as the average of the absolute value of the relative difference between the two samplers' values, divided by the square root of 2.
3 Average value of the relative uncertainties as reported to AQS.
4 AQS/ARD is the ratio of reported uncertainties divided by the uncertainty determined by average relative difference of the collocated samples. Values greater than 200% are shown in bold and discussed in the text.
5 Counts are the number of individual observations included in the statistics. Only observations where both concentration values were above twice the uncertainty are included in the statistics.

Where

- U_{ij} and C_{ij} refer to the uncertainty and concentration for the i^{th} exposure with the j^{th} sampler (j=1 or 2).

The criteria for inclusion in the average (index i) is the same as in the previous equation.

The next column provides the ratio of AvAQS to ARD defined above. This is essentially the average under- or over-estimate of the uncertainty for each chemical species reported during 2009. Finally, the last column provides the number of sampling events included in the averages defined above. Only events where both concentrations were greater than twice their respective uncertainties were included.

Ratios greater than 200% or less than 50% indicate situations in which the uncertainties reported to AQS were different from the uncertainty estimated from collocation data by a factor of 2 or more. The following species disagreed by a factor of 2 or more; ratios are shown in parentheses:

- Arsenic (241%), Selenium (223%), Strontium (269%) – these are all trace elements that are infrequently detected.
- Elemental Carbon and several of the organic carbon peaks from the CSN analysis method disagreed by a factor of two or more. This analysis is being phased out in favor of the IMPROVE_A method, with sampling by the URG 3000N sampler.

5.4 Analysis of Trip and Field Blanks

In the CSN program, field blanks are run at a frequency of 10% or more, whereas trip blanks are run at approximately 3%. Historical data has shown little difference between the two types of blanks, perhaps because the field SOPs for running them are very similar, the only difference being that the Field Blanks are mounted on the sampler for a few minutes, whereas the Trip Blanks are kept closed. Data from these blanks allow evaluation of contamination, which may come from a number of different sources. In addition, the Trip and Field Blank data can sometimes provide clues to problems in the analytical laboratories or with filters received from the manufacturers. **Table 5-6** shows the distributions (percentiles) for trip and field blanks during 2009.

Trip and Field Blanks. For XRF analysis, the average and 95th percentiles were acceptably low for all elements. Of the ions, nitrate and ammonium were somewhat higher than other chemical species. The high values for organic carbon and total carbon by the CSN TOT method were not unexpected because of the well-known adsorption artifact. The corresponding levels for the IMPROVE_A method were much lower, when expressed in $\mu g/m^3$, because of sample volume and filter area differences.

Table 5-6. Concentration Percentiles for Trip, Field, and 24-hour Blanks (Reporting Batches 108 through 120).

Analyte	Mean ug/m3	Percentiles of Concentration (ug/m3)						
		5	10	25	Median	75	90	95
Cations and anions by ion chromatography								
Ammonium	0.016	0.000	0.000	0.000	0.000	0.000	0.015	0.092
Potassium	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sodium	0.023	0.000	0.000	0.000	0.000	0.029	0.054	0.072
Nitrate	0.057	0.000	0.016	0.033	0.043	0.056	0.092	0.150
Nitrate (URG Nylon)	0.033	0.019	0.020	0.024	0.030	0.041	0.046	0.049
Nitrate (URG Teflon)	0.032	0.021	0.021	0.022	0.026	0.029	0.041	0.066
Sulfate	0.034	0.000	0.000	0.000	0.019	0.033	0.050	0.076
Mass by gravimetry								
Particulate matter 2.5u	0.667	-0.104	0.000	0.208	0.521	0.938	1.458	1.979
Organic and elemental carbon CSN TOT Method								
Elemental carbon	0.035	0.000	0.000	0.000	0.005	0.034	0.077	0.152
Organic carbon	1.253	0.497	0.653	0.909	1.108	1.316	1.692	2.544
Pk1_OC	0.343	0.116	0.164	0.244	0.331	0.421	0.490	0.555
Pk2_OC	0.541	0.181	0.244	0.336	0.438	0.560	0.754	1.322
Pk3_OC	0.294	0.098	0.124	0.177	0.247	0.314	0.439	0.622
Pk4_OC	0.076	0.004	0.015	0.030	0.049	0.076	0.130	0.218
PyrolC	-0.002	-0.010	0.000	0.000	0.000	0.000	0.012	0.028
Total carbon	1.288	0.509	0.664	0.926	1.131	1.348	1.739	2.731
Organic and elemental carbon by IMPROVE A Method (TOT and TOR)								
E1 IMPROVE	0.004	0.000	0.000	0.000	0.000	0.001	0.008	0.017
E2 IMPROVE	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.003
E3 IMPROVE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
EC IMPROVE TOR	0.004	0.000	0.000	0.000	0.000	0.001	0.009	0.018
EC IMPROVE TOT	0.002	0.000	0.000	0.000	0.000	0.000	0.004	0.010
O1 IMPROVE	0.023	0.000	0.003	0.011	0.020	0.031	0.044	0.053
O2 IMPROVE	0.045	0.016	0.020	0.028	0.039	0.053	0.073	0.091
O3 IMPROVE	0.070	0.027	0.031	0.039	0.052	0.073	0.112	0.160
O4 IMPROVE	0.009	0.000	0.000	0.000	0.002	0.009	0.022	0.039
OC IMPROVE TOR	0.149	0.061	0.070	0.088	0.120	0.163	0.226	0.321
OC IMPROVE TOT	0.151	0.061	0.070	0.088	0.120	0.163	0.230	0.324
OP IMPROVE TOR	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
OP IMPROVE TOT	0.003	0.000	0.000	0.000	0.000	0.000	0.003	0.011
TC IMPROVE	0.153	0.061	0.070	0.088	0.121	0.167	0.233	0.337
Trace elements by XRF (48 Elements)								
Aluminum	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.003
Antimony	0.001	0.000	0.000	0.000	0.000	0.000	0.002	0.011
Arsenic	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Barium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002
Bromine	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Cadmium	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Calcium	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001

Analyte	Mean ug/m^3	Percentiles of Concentration (ug/m3)						
		5	10	25	Median	75	90	95
Cerium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cesium	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002
Chlorine	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Chromium	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.002
Cobalt	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Copper	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Europium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gallium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Gold	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Hafnium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Indium	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002
Iridium	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Iron	0.002	0.000	0.000	0.000	0.000	0.001	0.004	0.007
Lanthanum	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Lead	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Magnesium	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.003
Manganese	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Mercury	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Molybdenum	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nickel	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Niobium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Phosphorus	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Potassium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rubidium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Samarium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Scandium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Selenium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Silicon	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Silver	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002
Sodium	0.005	0.000	0.000	0.000	0.000	0.000	0.001	0.027
Strontium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Sulfur	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tantalum	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Terbium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tin	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.003
Titanium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Vanadium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wolfram	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Yttrium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Zinc	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Zirconium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Trace elements by XRF (33 Elements)								
Aluminum	0.001	0.000	0.000	0.000	0.000	0.001	0.002	0.003
Antimony	0.001	0.000	0.000	0.000	0.000	0.000	0.004	0.006
Arsenic	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Barium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bromine	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001

Analyte	Mean ug/m^3	Percentiles of Concentration (ug/m3)						
		5	10	25	Median	75	90	95
Cadmium	0.001	0.000	0.000	0.000	0.000	0.000	0.002	0.006
Calcium	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Cerium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cesium	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Chlorine	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Chromium	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002
Cobalt	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Copper	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Indium	0.001	0.000	0.000	0.000	0.000	0.000	0.004	0.008
Iron	0.001	0.000	0.000	0.000	0.000	0.001	0.003	0.006
Lead	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Magnesium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Manganese	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Nickel	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Phosphorus	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Potassium	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Rubidium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Selenium	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Silicon	0.002	0.000	0.000	0.000	0.000	0.000	0.001	0.002
Silver	0.001	0.000	0.000	0.000	0.000	0.000	0.004	0.007
Sodium	0.003	0.000	0.000	0.000	0.000	0.000	0.001	0.005
Strontium	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Sulfur	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Tin	0.001	0.000	0.000	0.000	0.000	0.000	0.003	0.006
Titanium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Vanadium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Zinc	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Zirconium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001

Trends and Offsets in Blank Data. Other than the isolated outliers identified in the previous section, no significant trends or offsets have been observed in the trip and field data for any of the CSN analytes.

5.5 Analysis of Trip and Field Blanks for the URG 3000N

URG 3000N modules began acquiring quartz filter samples at 57 CSN sites in May, 2007. The remaining sites received URG 3000N samplers during 2009. One important feature is the acquisition of a new type of blank, called "backup filters," which are intended to help assess the organic carbon artifact. Table 5-7 shows the percentile points of the backup filters acquired during 2009. The median value from the backup filters (shown in the table) are proposed as the value to be used as the artifact correction, similar to what is done in the IMPROVE program; however, RTI has not received a directive to implement such a correction.

Table 5-7. Concentration Percentiles for 3000N Backup Filter Blanks

ANALYTE	MEAN	PERCENTILES OF CONCENTRATION (as μg/m³)						
		5	10	25	MEDIAN	75	90	95
EC IMPROVE TOR	0.011	0.000	0.000	0.000	0.007	0.016	0.027	0.036
EC IMPROVE TOT	0.001	0.000	0.000	0.000	0.000	0.000	0.003	0.007
OC IMPROVE TOR	0.394	0.140	0.179	0.261	0.368	0.498	0.624	0.739
OC IMPROVE TOT	0.404	0.141	0.179	0.267	0.378	0.514	0.648	0.756
TC IMPROVE	0.406	0.141	0.179	0.268	0.378	0.514	0.650	0.756
E1 IMPROVE	0.014	0.000	0.000	0.002	0.009	0.017	0.030	0.042
E2 IMPROVE	0.003	0.000	0.000	0.000	0.000	0.004	0.009	0.014
E3 IMPROVE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
O1 IMPROVE	0.076	0.004	0.017	0.033	0.056	0.107	0.162	0.198
O2 IMPROVE	0.121	0.044	0.053	0.081	0.112	0.152	0.196	0.228
O3 IMPROVE	0.147	0.055	0.066	0.094	0.133	0.179	0.232	0.286
O4 IMPROVE	0.043	0.005	0.009	0.019	0.036	0.062	0.089	0.106
OP IMPROVE TOR	0.007	0.000	0.000	0.000	0.000	0.002	0.017	0.029
OP IMPROVE TOT	0.017	0.000	0.000	0.001	0.008	0.020	0.037	0.051

6.0 External Audits

6.1 Performance Evaluation Audit Results

As part of a multi-laboratory study, PE samples were received and analyzed during late 2008, and the results were reported to EPA in February 2009. A preliminary report of the results was sent to RTI for comment on April 1, 2009. The PE study was conducted as part of EPA's QA oversight for two air monitoring networks: the CSN, and the Interagency Monitoring of Protected Visual Environments (IMPROVE) Program. This study was similar to one carried out in 2007. Preliminary results were circulated to the participating labs for comment on April 1, 2009. The final report was issued on September 9, 2009, and may be found at the following URL:

http://www.epa.gov/ttn/amtic/files/ambient/pm25/spec/MultilabSpeciationPT2008_09Sep09.pdf (accessed 2/19/2009)

The PE samples were prepared at the National Air and Radiation Environmental Laboratory (NAREL) located in Montgomery, AL. The samples were prepared by multiple collocation of samplers at the NAREL facility. Since the samples (except for metallic weights included in the gravimetry evaluation) were of unknown mass or concentration, agreement among the participating laboratories was the primary metric of performance. In addition, reference labs were designated for each of the analyses. RTI and the University of California, Davis (UCD) served as reference labs for the XRF filters before they were distributed among the other participating laboratories.

The multi-lab study required each participating laboratory to analyze a set of blind PE samples, and each lab received detailed instructions for analyzing the samples and reporting the results to NAREL. A sufficient number of replicates were prepared so that each laboratory could receive PE filters for the following analyses:

- Gravimetric Mass Analysis
  - Teflon® filters
  - Metallic transfer weights
- Ion Chromatography (IC) Analysis – Nylon filters
- Carbon by Thermal Optical Analysis (TOA) – quartz filters
  - IMPROVE_A Method
  - CSN Method
- Elemental analysis by X-Ray Fluorescence (XRF) – Teflon® filters
  - 25 mm filters
  - 47 mm filters

RTI's performance on gravimetric mass, IC, and XRF was uniformly within the range of the other laboratories and in good agreement with the designated reference labs. However, significant variations within and among laboratories were noted for the various OC/EC methods. See the final report cited above for more details.

6.2 Technical Systems Audit Results

On September 1, 2009, a Technical Systems Audit (TSA) was conducted at RTI by as part of the U.S. Environmental Protection Agency's (EPA's) quality assurance oversight for the PM2.5 Chemical Speciation Network (CSN). The results of the TSA were provided in a Technical Memorandum dated November 24, 2009, which can be found at the following URL:

http://www.epa.gov/ttn/amtic/files/ambient/pm25/spec/RTI_TSA_2009.pdf

The EPA audit team included Jewell Smiley and Steve Taylor, from the National Air and Radiation Environmental Laboratory (NAREL), with Dennis Crumpler, David Shelow, and Solomon Ricks from the Office of Air Quality Planning and Standards (OAQPS).

Documents reviewed in preparation for the audit included:

- RTI's Quality Assurance Project Plan
- Standard Operating Procedures for the CSN
- The report from an on-site audit conducted by NAREL in 2005
- The data summary and quality control report for January 1 through December 31, 2008.
- Results from the recently completed inter-laboratory PE study described above

Members of the EPA audit team inspected the following areas:

- Gravimetric Laboratory
- Organic Carbon/Elemental Carbon (OC/EC) Laboratory
- X-ray Fluorescence (XRF) Laboratory
- Ion Chromatography (IC) Laboratory
- Sample Handling and Archiving Laboratory (SHAL)

The following staff were also interviewed:

- Dr. R.K.M. Jayanty - RTI Services Program Manager
- Dr. James Flanagan - Quality Assurance Manager
- Mr. Ed Rickman - Data Management Technical Supervisor

Conclusions

Detailed observations and findings can be found at the URL cited above. The audit report concluded as follows:

> "This TSA was conducted as part of the EPA required quality assurance oversight of the PM2.5 Chemical Speciation Network. RTI was awarded a new contract by the U.S. EPA in January 2009 to continue providing laboratory support for the PM CSN Program. RTI has been EPA's primary support laboratory for the program since it began in 2000 and therefore all support systems such as analytical, shipping, receiving, data management and QA/QC were already in place. Observations were made during the TSA by the audit team to determine RTI's compliance with good laboratory practices, their current QAPP,

and SOPs. RTI documents including the QAPP and SOPs have been recently updated and were made available to the auditors before the TSA. Also available was RTI's annual data summary report of the QA/QC activities performed by RTI for the period January 1 to December 31, 2008. The TSA was preceded by a six-lab Inter-laboratory comparison PT study and results of the study indicated good analytical performance from RTI. Several experimental activities conducted during the TSA also gave additional objective evidence that good quality control and good laboratory practices are being followed at the RTI laboratory. The RTI lab is a well organized facility with very experienced staff. This was the sixth TSA of RTI conducted by the NAREL audit team. Over the past years, the auditors have found that RTI continues to make improvements to the efficiency and quality of support the lab provides to the CSN program. No significant technical problems were found during this audit."

7.0 List of References

7.1 List of CSN Documents

Type	Title	Date Revised	Author	Document No.
SOP	Standard Operating Procedure for Sample Handling and Archiving Laboratory (SHAL)	2/18/2009	O'Rourke	
SOP	Standard Operating Procedure for Shipping Filters to and from an Off-Site Laboratory	2/18/2009	Peterson	
SOP	Standard Operating Procedure for Long-Term Archiving of PM Filters and Extracts	5/13/2008	C. Haas	
SOP	Standard Operating Procedure for Procurement and Acceptance Testing of Teflon, Nylon, and Quartz Filters	2/16/2008	E. Hardison	
SOP	Standard Operating Procedure for Cleaning Nylon Filters Used for the Collection of $PM_{2.5}$ Material	5/13/2008	E. Hardison	
SOP	Standard Operating Procedure for Particulate Matter (PM) Gravimetric Analysis	7/8/2008	Greene	
SOP	Analysis of Elements in Air Particulates by X-Ray Fluorescence (Kevex 770 & 772)	8/19/2009	Chester	
SOP	Kevex XRF Spectrometer Calibration (CHESTER LabNet Proprietary Method)	1/8/2008	Chester	
SOP	Kevex Spectrometer Data Generation, Interpretation and Reporting (CHESTER LabNet Proprietary Method)	1/30/2009	Chester	
SOP	Sample Receipt and Log In Chester LabNet Proprietary Method	6/20/2008	Chester	
SOP	Standard Operating Procedure for the X-Ray Fluorescence Analysis of Particulate Matter Deposits on Teflon Filters	July 2008	McWilliams	
SOP	Standard Operating Procedure for $PM_{2.5}$ Anion Analysis	5/13/2008	E. Hardison	
SOP	Standard Operating Procedure for $PM_{2.5}$ Cation Analysis	5/13/2008	E. Hardison	
SOP	DRI Model 2001 Thermal/Optical Carbon Analysis (TOR/TOT) of Aerosol Filter Samples – Method IMPROVE_A	7/1/2008	DRI	

Type	Title	Date Revised	Author	Document No.
SOP	Standard Operating Procedure for the Determination of Carbon Fractions in Particulate Matter Using the IMPROVE_A Heating Protocol on a DRI Model 2001 Analyzer	2/13/2008	Peterson	
SOP	Standard Operating Procedures for Temperature Calibration of the Sample Thermocouple in a Sunset Laboratory or a DRI Model 2001 Carbon Aerosol Analyzer	2/13/2009	Peterson	
SOP	Standard Operating Procedure for the Determination of Organic, Elemental, and Total Carbon in Particulate Matter Using a Thermal/Optical-Transmittance Carbon Analyzer	2/16/2009	Peterson	
SOP	Standard Operating Procedure for the Determination of Carbon Fractions in Particulate Matter Using the IMPROVE_A Heating Protocol on a Sunset Laboratory Dual-Mode Analyzer	2/13/2009	Peterson	
SOP	DRI Standard Operating Procedure: Analysis of Semi-Volatile Organic Compound by GC/MS	9/24/2008	DRI	
SOP	Standard Operating Procedure for Sample Preparation and Analysis of PM_{10} and $PM_{2.5}$ Samples by Scanning Electron Microscopy	7/8/2008	Crankshaw	
SOP	Standard Operating Procedure for Coating and Extracting Annular Denuders with Sodium Carbonate	7/8/2008	Eaton	
SOP	Standard Operating Procedures for Coating Aluminum Honeycomb Denuders With Magnesium Oxide	2/17/2009	Eaton	
SOP	Standard Operating Procedure for Coating Annular Denuders with XAD-4 Resin	5/9/2008	Eaton	
SOP	Procedures for Coating R&P Speciation Sampler Chemcomb™ Denuders with Sodium Carbonate	5/21/2008	Eaton	
SOP	Standard Operating Procedure for Coating and Extracting Denuders for Capture of Ammonia and Its Measurement	2/14/2008	Eaton	
SOP	Standard Operating Procedure for Database Operations	5/8/2008	Rickman	
SOP	Standard Operating Procedure for Assigning Data Validation Flags for the Chemical Speciation Network	5/15/2008	Wall	
SOP	Standard Operating Procedure—Speciation Data Processing Disaster Recovery Plan	5/21/2008	Rickman	
SOP	Standard Operating Procedure for the X-Series ICP-MS for the Analysis of Particulate Deposits on Teflon Filters	7/8/2008	Weber	

Type	Title	Date Revised	Author	Document No.
SOP	DRI Standard Operating Procedure: Procedure for Light Transmission Analysis	7/14/2008	DRI	
SOP	Standard Operating Procedure for Document Control and Storage for the $PM_{2.5}$ Chemical Speciation Program	2/18/2009	D. Haas	
SOP	Standard Operating Procedure for Corrective Action for the $PM_{2.5}$ Chemical Speciation Program	5/21/2008	Flanagan/Haas	
SOP	Standard Operating Procedure for Training for Staff Working on the $PM_{2.5}$ Chemical Speciation Program	5/8/2008	Haas	
QAPP	QAPP for PM2.5 of Chemical Speciation Samples	2/20/2009	RTI	RTI/0212053/01QA
Report	Tests of Acceptance of X-Ray Fluorescence Instrument #4 Operated by RTI International	11/4/2009	McWilliams/Flanagan	0212053.001.T06/01D
Report	Annual Data Summary Report (1/1/09 – 12/31/09)	2/25/10	RTI	RTI/0212053/01ADS

Appendix A

Method Detection Limits

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Appendix A
Method Detection Limits (Network-wide Maximum)

Analysis	Analyte	MASS (µg)	Concentration (ug/m³) by Sampler Type				
			MASS	R and P	RAAS	SASS	3000N
Cations - PM2.5 (NH4, Na, K)	Ammonium	0.24	0.010	0.017	0.024	0.026	
Cations - PM2.5 (NH4, Na, K)	Potassium	0.23	0.0095	0.016	0.023	0.025	
Cations - PM2.5 (NH4, Na, K)	Sodium	0.29	0.013	0.021	0.030	0.032	
Mass - PM2.5	Particulate matter	7.2	0.33	0.31	0.33	0.83	
Nitrate - PM2.5	Nitrate	0.21		0.015	0.0072	0.023	
Nitrate - PM2.5 (MASS/nylon)	Nitrate	0.21	0.0088				
Nitrate - PM2.5 (MASS/teflon	Nitrate	0.070	0.0032				
Organic and elemental carbon	E1 IMPROVE	0.010					0.00046
Organic and elemental carbon	E2 IMPROVE	0.010					0.00046
Organic and elemental carbon	E3 IMPROVE	0.010					0.00046
Organic and elemental carbon	EC IMPROVE TOR	0.034					0.0015
Organic and elemental carbon	EC IMPROVE TOT	0.034					0.0015
Organic and elemental carbon	O1 IMPROVE	0.014					0.00061
Organic and elemental carbon	O2 IMPROVE	0.34					0.015
Organic and elemental carbon	O3 IMPROVE	1.0					0.046
Organic and elemental carbon	O4 IMPROVE	0.034					0.0015
Organic and elemental carbon	OC IMPROVE TOR	1.3					0.059
Organic and elemental carbon	OC IMPROVE TOT	1.3					0.059
Organic and elemental carbon	OP IMPROVE TOR	0.034					0.0015
Organic and elemental carbon	OP IMPROVE TOT	0.034					0.0015
Organic and elemental carbon	TC IMPROVE	1.4					0.064
Organic and elemental carbon (NIOSH)	Elemental carbon	2.4	0.098	0.17	0.23	0.27	
Organic and elemental carbon (NIOSH)	Organic carbon	2.4	0.098	0.17	0.23	0.27	
Organic and elemental carbon (NIOSH)	Pk1_OC	2.4	0.098	0.17	0.23	0.27	
Organic and elemental carbon (NIOSH)	Pk2_OC	2.4	0.098	0.17	0.23	0.27	
Organic and elemental carbon (NIOSH)	Pk3_OC	2.4	0.098	0.17	0.23	0.27	

Analysis	Analyte	MASS (µg)	Concentration (ug/m^3) by Sampler Type				
			MASS	R and P	RAAS	SASS	3000N
Organic and elemental carbon (NIOSH)	Pk4_OC	2.4	0.098	0.17	0.23	0.27	
Organic and elemental carbon (NIOSH)	PyrolC	2.4	0.098	0.17	0.23	0.27	
Organic and elemental carbon (NIOSH)	Total carbon	2.4	0.098	0.17	0.23	0.27	
Sulfate - PM2.5	Sulfate	0.10	0.0045	0.0072	0.010	0.011	
Trace elements	Aluminum	0.24	0.0091	0.010	0.010	0.026	
Trace elements	Antimony	0.40	0.018	0.017	0.019	0.046	
Trace elements	Arsenic	0.026		0.0011	0.0011		
Trace elements	Barium	0.57	0.0048	0.025	0.025	0.066	
Trace elements	Bromine	0.022					
Trace elements	Cadmium	0.18	0.0080	0.0078	0.0083	0.021	
Trace elements	Calcium	0.073	0.0033	0.0031	0.0033		
Trace elements	Cerium	0.97	0.0042	0.040	0.042	0.11	
Trace elements	Cesium	0.44	0.015	0.019	0.020	0.051	
Trace elements	Chlorine	0.15	0.0034	0.0061	0.0063	0.016	
Trace elements	Chromium	0.025	0.0011	0.0011	0.0011		
Trace elements	Cobalt	0.019					
Trace elements	Copper	0.024	0.0010	0.0011	0.0011		
Trace elements	Europium	0.11	0.0022	0.0047	0.0048	0.013	
Trace elements	Gallium	0.051	0.0011	0.0021	0.0022		
Trace elements	Gold	0.078	0.0023	0.0034	0.0034		
Trace elements	Hafnium	0.26	0.011	0.011	0.011	0.029	
Trace elements	Indium	0.21	0.0094	0.0092	0.0098	0.025	
Trace elements	Iridium	0.075	0.0031	0.0032	0.0033		
Trace elements	Iron	0.032		0.0014	0.0014		
Trace elements	Lanthanum	0.71	0.0037	0.029	0.030	0.078	
Trace elements	Lead	0.061	0.0021	0.0026	0.0027		
Trace elements	Magnesium	0.63	0.0073	0.026	0.027	0.069	
Trace elements	Manganese	0.028		0.0012	0.0012		
Trace elements	Mercury	0.091	0.0040	0.0039	0.0042	0.010	
Trace elements	Molybdenum	0.087	0.0038	0.0038	0.0040	0.010	

Analysis	Analyte	MASS (μg)	Concentration (ug/m³) by Sampler Type				
			MASS	R and P	RAAS	SASS	3000N
Trace elements	Nickel	0.018					
Trace elements	Niobium	0.053	0.0020	0.0023	0.0023		
Trace elements	Phosphorus	0.15	0.0070	0.0066	0.0071	0.018	
Trace elements	Potassium	0.11	0.0044	0.0046	0.0047	0.012	
Trace elements	Rubidium	0.025		0.0011	0.0011		
Trace elements	Samarium	0.096	0.0022	0.0042	0.0042	0.011	
Trace elements	Scandium	0.36	0.016	0.015	0.016	0.041	
Trace elements	Selenium	0.025	0.0011	0.0011	0.0011		
Trace elements	Silicon	0.18	0.0074	0.0077	0.0078	0.020	
Trace elements	Silver	0.14	0.0063	0.0061	0.0065	0.016	
Trace elements	Sodium	2.1	0.022	0.089	0.092	0.23	
Trace elements	Strontium	0.030	0.0010	0.0013	0.0013		
Trace elements	Sulfur	0.095	0.0043	0.0040	0.0043	0.011	
Trace elements	Tantalum	0.18	0.0042	0.0075	0.0078	0.020	
Trace elements	Terbium	0.097	0.0019	0.0042	0.0043	0.011	
Trace elements	Tin	0.31	0.014	0.013	0.014	0.035	
Trace elements	Titanium	0.051	0.0023	0.0022	0.0023		
Trace elements	Vanadium	0.037	0.0017	0.0016	0.0017		
Trace elements	Wolfram	0.12	0.0031	0.0050	0.0051	0.013	
Trace elements	Yttrium	0.036	0.0012	0.0016	0.0016		
Trace elements	Zinc	0.034	0.0015	0.0015	0.0016		
Trace elements	Zirconium	0.045	0.0019	0.0019	0.0020		

Appendix B

Data Completeness Summary

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Table B-1. Percentage of Routine Exposure Records – STN Sites
Monthly Percent Data Completeness by Site

Site Name	State	AQS Code	POC	Sampler Type	Report Batch											
					107	108	109	110	111	112	113	114	115	116	117	118
Alabama (TN)	TN	471570024	5	SASS with URG 3000N												100
Alabama (TN)	TN	471570024	5	URG 3000N												83
Alabama (TN)	TN	471570024	5	SASS	100	100	100	100	100	99	80	89	100	100	89	100
Allen Park	MI	261630001	5	SASS	91	100	100	90	100	100	100	100	100	89	90	100
Allen Park	MI	261630001	5	URG 3000N						100	94	100	100	88	100	100
Bakersfield-California Ave	CA	060290014	5	SASS with URG 3000N	82	80	18	0						86	67	63
Bakersfield-California Ave	CA	060290014	5	URG 3000N	94	83	39	25						100	79	83
Bakersfield-California Ave (Collocated)	CA	060290014	6	URG 3000N	100	100	50	50						33	63	63
Bakersfield-California Ave (Collocated)	CA	060290014	6	SASS with URG 3000N	99	100	17	0						33	83	60
Beacon Hill - Met One	WA	530330080	6	SASS with URG 3000N	100	100	87	84	54	60	100					
Beacon Hill - Met One	WA	530330080	6	URG 3000N	100	90	93	42	100	83	100	100	100	100	93	100
Beacon Hill - Met One	WA	530330080	6	SASS							100	100	100	100	100	100
Blair Street	MO	295100085	6	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Blair Street	MO	295100085	6	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Burlington	VT	500070012	5	URG 3000N												100
Burlington	VT	500070012	5	SASS	100	100	73	100	100	91	100	100	100	100	100	100
Burlington	VT	500070012	5	SASS with URG 3000N												100
Capitol	LA	220330009	5	MASS	25	0										
Capitol - Met One	LA	220330009	5	SASS				100	90	100						
Capitol - Met One	LA	220330009	5	SASS with URG 3000N						100	100	90	91	100	100	100
Capitol - Met One	LA	220330009	5	URG 3000N						100	94	100	94	100	100	100
Chamizal	TX	481410044	5	MASS	100	74	83	0								
Chamizal - Met One	TX	481410044	5	SASS				100	90	89						
Chamizal - Met One	TX	481410044	5	URG 3000N						100	94	100	94	94	100	100
Chamizal - Met One	TX	481410044	5	SASS with URG 3000N						100	91	92	91	90	100	100
Chicopee	MA	250130008	5	SASS with URG 3000N												100
Chicopee	MA	250130008	5	SASS	100	100	87	80	100	100	100	90	100	94	100	100
Chicopee	MA	250130008	5	URG 3000N												88
Com Ed - Met One	IL	170310076	5	SASS with URG 3000N	100	100	100	71	100	100	100					
Com Ed - Met One	IL	170310076	5	URG 3000N	100	100	75	100	100	100	100	83	100	100	93	100

Site Name	State	AQS Code	POC	Sampler Type	Report Batch											
					107	108	109	110	111	112	113	114	115	116	117	118
Com Ed - Met One	IL	170310076	5	SASS							100	100	100	100	99	100
Commerce City	CO	080010006	5	SASS							100	100	100	100	100	89
Commerce City	CO	080010006	5	SASS with URG 3000N	100	100	91	73	89	100	100					
Commerce City	CO	080010006	5	URG 3000N	100	92	75	100	100	79	93	100	100	68	32	93
CPW	SC	450190049	5	SASS	100	100	100	100	100	100	100	100	100	91	100	100
CPW	SC	450190049	5	SASS with URG 3000N												24
CPW	SC	450190049	5	URG 3000N												100
Criscuolo Park	CT	090090027	5	SASS	100	100	100	100	85	93	100	89	100	89	100	100
Criscuolo Park	CT	090090027	5	SASS with URG 3000N												7
Criscuolo Park	CT	090090027	5	URG 3000N												88
Deer Park	TX	482011039	6	MASS	66	100	92	100								
Deer Park - Met One	TX	482011039	6	SASS with URG 3000N						100	99	100	91	99	98	100
Deer Park - Met One	TX	482011039	6	SASS				100	100	100						
Deer Park - Met One	TX	482011039	6	URG 3000N						50	83	100	100	100	100	100
Deer Park (Collocated)	TX	482011039	7	MASS	46	80	82	100								
Deer Park Collocated - Met One	TX	482011039	7	URG 3000N						100	100	100	100	100	100	100
Deer Park Collocated - Met One	TX	482011039	7	SASS				100	100	100	100					
Deer Park Collocated - Met One	TX	482011039	7	SASS with URG 3000N							100	100	99	97	100	100
Dover	DE	100010003	5	SASS with URG 3000N							100	100	75	100	100	100
Dover	DE	100010003	5	SASS	100	100	80	100	100	100						
Dover	DE	100010003	5	URG 3000N						100	100	100	83	100	100	100
El Cajon	CA	060730003	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
El Cajon	CA	060730003	5	SASS with URG 3000N	100	100	90	100	100	100	100	100	100	100	100	100
Elizabeth Lab	NJ	340390004	5	SASS	100	100	100	100	100	100	100	100	92	100	100	99
Elizabeth Lab	NJ	340390004	5	URG 3000N												100
Essex - Met One	MD	240053001	5	URG 3000N	100	90	100	100	100	100	100	100	100	100	100	93
Essex - Met One	MD	240053001	5	SASS with URG 3000N	100	74	100	100	100	100	100	100	100	100	100	89
Fargo NW	ND	380171004	5	SASS with URG 3000N												100
Fargo NW	ND	380171004	5	SASS	100	100	100	100	100	86	100	100	100	100	100	100
Fargo NW	ND	380171004	5	URG 3000N												100
Fresno - First Street	CA	060190008	5	URG 3000N						50	100	94	94	100	100	100
Fresno - First Street	CA	060190008	5	SASS with URG 3000N						100	100	100	100	100	100	100

Site Name	State	AQS Code	POC	Sampler Type	Report Batch											
					107	108	109	110	111	112	113	114	115	116	117	118
Fresno - First Street	CA	060190008	5	SASS	100	100	100	100	100	100						
G.T. Craig	OH	390350060	5	URG 3000N												100
G.T. Craig	OH	390350060	5	SASS	100	100	90	100	100	100	100	67		97	100	100
G.T. Craig - Collocated	OH	390350060	6	URG 3000N												100
G.T. Craig - Collocated	OH	390350060	6	SASS	100	100	0	98	99	79	94	31		97	94	94
Garinger High School	NC	371190041	5	URG 3000N						88	94	77	88	89	94	86
Garinger High School	NC	371190041	5	SASS	100	99	91	100	99	100						
Garinger High School	NC	371190041	5	SASS with URG 3000N						100	92	100	100	100	100	100
Gulfport	MS	280470008	5	SASS	100	88	70	86	98	92	89	100	100	100	100	100
Hawthorne	UT	490353006	5	SASS with URG 3000N	80	100	100	100	100	100	100	100	100	90	100	100
Hawthorne	UT	490353006	5	URG 3000N	94	100	100	88	93	100	100	100	100	94	100	100
Henrico Co.	VA	510870014	5	URG 3000N												33
Henrico Co.	VA	510870014	5	SASS	100	100	89	100	100	100	100	100	100	100	100	100
Hinton	TX	481130069	5	MASS	81	100	90	100								
Hinton - Met One	TX	481130069	5	URG 3000N						83	93	92	83	100	93	100
Hinton - Met One	TX	481130069	5	SASS with URG 3000N						100	100	100	100	100	92	100
Hinton - Met One	TX	481130069	5	SASS				97	100	100						
Jackson UMC	MS	280490019	5	URG 3000N												75
Jackson UMC	MS	280490019	5	SASS												64
Jackson UMC	MS	280490019	5	SASS with URG 3000N												100
JFK Center	KS	202090021	5	URG 3000N												50
JFK Center	KS	202090021	5	SASS	100	100	100	75	0	100	99	100	85	100	100	100
JFK Center	KS	202090021	5	SASS with URG 3000N												0
Lawrenceville	PA	420030008	6	SASS with URG 3000N												50
Lawrenceville	PA	420030008	6	URG 3000N												88
Lawrenceville	PA	420030008	6	SASS	100	100	100	100	100	87	100	100	100	89	100	86
Lindon	UT	490494001	5	URG 3000N	100	100	70	38	100	100	100	100	100	100	100	100
Lindon	UT	490494001	5	SASS with URG 3000N	100	100	100	100	76	100	100	100	100	100	100	100
McMillan Reservoir	DC	110010043	5	RAAS with URG 3000N	90	100	100	100	100	100						
McMillan Reservoir	DC	110010043	5	URG 3000N	100	100	100	100	100	100						
McMillan Reservoir - Met One	DC	110010043	5	SASS with URG 3000N						100	100	100	100	100	100	100
McMillan Reservoir - Met One	DC	110010043	5	URG 3000N						100	100	100	100	100	100	100

Site Name	State	AQS Code	POC	Sampler Type	Report Batch											
					107	108	109	110	111	112	113	114	115	116	117	118
Missoula County Health Dept.	MT	300630031	5	SASS with URG 3000N	83	90	100	100	90	92	100	79	100	61	100	89
Missoula County Health Dept.	MT	300630031	5	URG 3000N	94	100	100	94	86	83	100	100	94	94	100	93
MLK	DE	100032004	5	URG 3000N	100	88	90	88	100	55	25	100	100	100	100	100
MLK	DE	100032004	5	SASS with URG 3000N	100	100	83	100	100	100	100	80	100	100	100	100
New Brunswick	NJ	340230006	5	URG 3000N												100
New Brunswick	NJ	340230006	5	SASS	87	100	100	88	100	100	100	100	100	100	100	100
New Brunswick (Collocated)	NJ	340230006	6	URG 3000N												100
New Brunswick (Collocated)	NJ	340230006	6	SASS	100	100	100	100	100	100	100	100	98	100	97	94
North Birmingham	AL	010730023	5	URG 3000N	94	100	100	100	100	83	100	100	83	100	100	100
North Birmingham	AL	010730023	5	SASS with URG 3000N	100	100	100	100	100	92	100					
North Birmingham	AL	010730023	5	SASS							100	100	91	91	100	100
Peoria Site 1127	OK	401431127	5	SASS	100	75	100	88	100	100	100	100	100	100	100	86
Peoria Site 1127	OK	401431127	5	URG 3000N												100
Peoria Site 1127	OK	401431127	5	SASS with URG 3000N												100
PHILA - AMS Laboratory	PA	421010004	7	SASS with URG 3000N	93	100	91	100	87	100	100	100	100	100	93	100
PHILA - AMS Laboratory	PA	421010004	7	URG 3000N	100	86	100	100	75	100	38	100	100	94	75	100
Philips	MN	270530963	5	URG 3000N	94	100	85	100	93	72	94	100	100	100	100	100
Philips	MN	270530963	5	SASS with URG 3000N	100	100	73	100	100	100	100	99	100	100	100	100
Phoenix Supersite	AZ	040139997	7	URG 3000N												83
Phoenix Supersite	AZ	040139997	7	SASS	99	100	91	90	100	99	93	90	100	64	90	100
Phoenix Supersite	AZ	040139997	7	SASS with URG 3000N												100
Portland - SE Lafayette	OR	410510080	6	SASS with URG 3000N	100	100	100	100	100	100	100	92	100	90	91	100
Portland - SE Lafayette	OR	410510080	6	URG 3000N	100	100	100	93	100	100	100	100	100	100	75	100
Reno	NV	320310016	5	SASS with URG 3000N												100
Reno	NV	320310016	5	SASS	91	100	100	100	90	100	100	93	100	100	100	100
Reno	NV	320310016	5	URG 3000N												83
Riverside-Rubidoux	CA	060658001	5	URG 3000N	100	63	100	100	100	83	100	94	65	81	100	100
Riverside-Rubidoux	CA	060658001	5	SASS							97	100	100	100	100	100
Riverside-Rubidoux	CA	060658001	5	SASS with URG 3000N	100	71	100	100	100	92	100					
Riverside-Rubidoux (Collocated)	CA	060658001	6	URG 3000N	75	88	100	100	88	100	100	100	50	75	100	100
Riverside-Rubidoux (Collocated)	CA	060658001	6	SASS with URG 3000N	64	82	100	100	76	100	100	65	100	100	100	100
Roxbury (Boston)	MA	250250042	5	SASS with URG 3000N												100

Site Name	State	AQS Code	POC	Sampler Type	Report Batch											
					107	108	109	110	111	112	113	114	115	116	117	118
Roxbury (Boston)	MA	250250042	5	SASS	99	100	91	100	100	100	100	100	100	100	100	100
Roxbury (Boston)	MA	250250042	5	URG 3000N												100
Roxbury (Boston) - collocated	MA	250250042	6	URG 3000N												100
Roxbury (Boston) - collocated	MA	250250042	6	SASS	100	100	100	100	100	83	100	100	60	100	100	100
Sacramento - Del Paso Manor	CA	060670006	5	URG 3000N						88	94	100	100	100	100	93
Sacramento - Del Paso Manor	CA	060670006	5	SASS	100	100	100	100	100	100	100	90	100	100	100	89
San Jose - Jackson Street	CA	060850005	5	URG 3000N						83	100	93	100	100	93	93
San Jose - Jackson Street	CA	060850005	5	SASS with URG 3000N						100	100	100	100	100	89	89
San Jose - Jackson Street	CA	060850005	5	SASS	100	100	90	100	100	98						
SER-DNR Headquarters	WI	550790026	5	SASS	100	91	100	100	90	91	100	100	90	90	98	98
SER-DNR Headquarters	WI	550790026	5	URG 3000N												100
SER-DNR Headquarters	WI	550790026	5	SASS with URG 3000N												93
Simi Valley	CA	061112002	5	URG 3000N						100	100	100	100	100	100	100
Simi Valley	CA	061112002	5	SASS with URG 3000N						100	100	100	100	100	100	100
Simi Valley	CA	061112002	5	SASS	100	100	100	100	100	100						
South DeKalb - Met One	GA	130890002	5	SASS	88	100	100	100	100	100	100	100	100	89	100	88
South DeKalb - Met One	GA	130890002	5	URG 3000N						50	86	100	100	100	93	75
Springfield Pumping Station - Met One	IL	170310057	5	URG 3000N	100	100	90	100	75	13	100	100	100	63	0	100
Springfield Pumping Station - Met One	IL	170310057	5	SASS with URG 3000N	100	96	100	100	82	67	100	100	100	100	50	80
St. Lukes Meridian (IMS)	ID	160010010	5	URG 3000N	100	100	100	100	100	100	94	100	100	94	100	100
St. Lukes Meridian (IMS)	ID	160010010	5	SASS with URG 3000N	100	100	100	100	100	93	89	100	100	90	100	100
Sydney	FL	120573002	5	SASS	81	100	91	100	100	100						
Sydney	FL	120573002	5	SASS with URG 3000N						100	100	100	99	100	99	100
Sydney	FL	120573002	5	URG 3000N						100	100	100	100	100	100	100
Univ. of Florida Ag School	FL	120111002	5	URG 3000N						100	88	100	100	100	94	93
Univ. of Florida Ag School	FL	120111002	5	SASS with URG 3000N						100	100	100	100	100	91	89
Univ. of Florida Ag School	FL	120111002	5	SASS	100	100	100	90	69	88						
Urban League	RI	440070022	5	RAAS	98											
Urban League - Met One	RI	440070022	5	URG 3000N						50	81	62	67	64	94	86
Urban League - Met One	RI	440070022	5	SASS with URG 3000N						100	100	100	100	100	100	78
Urban League - Met One	RI	440070022	5	SASS	50	100	100	100	100	100						
Washington Park	IN	180970078	5	URG 3000N	75	100	100	100	92	100	100	100	100	100	100	100

Site Name	State	AQS Code	POC	Sampler Type	Report Batch											
					107	108	109	110	111	112	113	114	115	116	117	118
Washington Park	IN	180970078	5	SASS with URG 3000N	90	100	100	88	89	100	100	100	92	100	100	100
Woolworth St	NE	310550019	5	SASS with URG 3000N												42
Woolworth St	NE	310550019	5	URG 3000N												88
Woolworth St	NE	310550019	5	SASS	97	85	94	97	96	95	96	96	96	96	96	96
WV - Guthrie Agricultural Center	WV	540390011	5	SASS with URG 3000N	100	86	80	100	100	100	100	89	89	100	100	87
WV - Guthrie Agricultural Center	WV	540390011	5	URG 3000N	100	90	89	100	100	100	93	93	92	100	100	92

Table B-2. Percentage of Routine Exposure Records – Non-STN Sites
Monthly Percent Data Completeness by Site

Site Name	State	AQS Code	POC	Sampler Type	Report Batch											
					107	108	109	110	111	112	113	114	115	116	117	118
5 Points	OH	391530023	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
5 Points	OH	391530023	5	SASS with URG 3000N	100	100	100	100	100	96	97	98	100	100	98	98
AL - Phenix City	AL	011130001	5	URG 3000N	100	100	100	100	100	100	75	100	88	100	100	100
AL - Phenix City	AL	011130001	5	SASS with URG 3000N	100	100	100	80	81	83	75	100	100	100	100	85
Albany Co HD	NY	360010005	5	SASS with URG 3000N						100	78	100	100	100	100	100
Albany Co HD	NY	360010005	5	SASS	100	100	100	90	100	100						
Albany Co HD	NY	360010005	5	URG 3000N						50	94	77	88	94	89	88
Arendtsville	PA	420010001	5	SASS	80	100	60	100	70	100	100	100	100	80	100	100
Arendtsville	PA	420010001	5	URG 3000N												100
Army Reserve Center	IA	191130037	5	R & P 2300	96	100										
Army Reserve Center - Met One	IA	191130037	5	SASS		97	99	100	100	100						
Army Reserve Center - Met One	IA	191130037	5	SASS with URG 3000N							100	100	100	100	100	100
Army Reserve Center - Met One	IA	191130037	5	URG 3000N						100	100	100	100	100	100	100
Arnold West	MO	290990019	6	R & P 2300	91	100	73	100	100	50						
Arnold West - Met One	MO	290990019	6	SASS with URG 3000N						100	89	90	100	90	100	100
Arnold West - Met One	MO	290990019	6	URG 3000N						100	100	100	100	100	89	100
Arnold West - Met One	MO	290990019	6	SASS						100						
Ashland Health Department	KY	210190017	5	SASS	100	100	100	100	100	100	100	100	100	100	100	100
Ashland Health Department	KY	210190017	5	URG 3000N												100
Athens - Met One	GA	130590001	5	URG 3000N						75	100	100	100	100	100	100
Athens - Met One	GA	130590001	5	SASS with URG 3000N							100	100	100	100	100	100
Athens - Met One	GA	130590001	5	SASS	100	100	100	100	77	100						
Augusta - Met One	GA	132450091	5	SASS	80	98	85	67	100	100	100					
Augusta - Met One	GA	132450091	5	URG 3000N						100	100	100	100	75	100	100
Augusta - Met One	GA	132450091	5	SASS with URG 3000N							100	100	100	80	98	100
Bonne Terre	MO	291860005	5	R and P with URG 3000N	100	100	100	90	90	14						
Bonne Terre	MO	291860005	5	URG 3000N	100	93	95	69	100	55						
Bonne Terre - Met One	MO	291860005	5	SASS with URG 3000N						63	100	80	92	99	100	100
Bonne Terre - Met One	MO	291860005	5	URG 3000N						67	88	69	77	100	64	68
Bountiful	UT	490110004	5	SASS with URG 3000N	84	100	100	100	100	100	100	100	100	100	87	100

Site Name	State	AQS Code	POC	Sampler Type	Report Batch											
					107	108	109	110	111	112	113	114	115	116	117	118
Bountiful	UT	490110004	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Buffalo - Met One	NY	360290005	6	SASS with URG 3000N							100	100	100	100	100	100
Buffalo - Met One	NY	360290005	6	SASS	100	100	100	100	100	100						
Buffalo - Met One	NY	360290005	6	URG 3000N						100	75	100	100	100	100	38
Buncombe County Board of Education	NC	370210034	5	SASS	80	100	100	99	100	100	100	100	80	82	100	100
Buncombe County Board of Education	NC	370210034	5	URG 3000N												100
Butte-Greeley School	MT	300930005	5	URG 3000N												50
Butte-Greeley School	MT	300930005	5	SASS	100	100	80	100	100	100	100	80	100	100	100	100
Camden	NJ	340070003	5	URG 3000N												
Camden	NJ	340070003	5	SASS with URG 3000N												
Cannons Lane	KY	211110067	6	URG 3000N			100	88	100	38	75	100	100	100	38	63
Cannons Lane	KY	211110067	6	SASS with URG 3000N			100	80	100	100	100	99	80	100	67	100
Canton Fire Station	OH	391510017	5	SASS	80	85	100	67	22	100	100	100	100	100	100	100
Canton Fire Station	OH	391510017	5	URG 3000N												100
Chester	NJ	340273001	5	URG 3000N												100
Chester	NJ	340273001	5	SASS	100	100	100	100	100	100	100	100	100	100	100	100
Chester (PA)	PA	420450002	5	SASS	100	100	92	0								
Chesterfield	SC	450250001	5	URG 3000N												100
Chesterfield	SC	450250001	5	SASS	60	100	100	88	100	89	100	100	100	100	100	80
Children's Park	AZ	040191028	5	SASS	80	100	100	100	100	83	100	100	87	80	100	95
Children's Park	AZ	040191028	5	URG 3000N												100
Clarksville	TN	471251009	5	URG 3000N												100
Clarksville	TN	471251009	5	SASS	100	100	100	100	100	100	100	100	100	80	100	100
Columbus - Met One	GA	132150011	5	SASS with URG 3000N	100	100	100	100	100	100	100	80	100	96	97	100
Columbus - Met One	GA	132150011	5	URG 3000N	100	100	100	100	100	100	100	88	100	100	100	100
Covington - University College	KY	211170007	5	SASS	100	100	100	100	100	100	100	100	100	100	87	100
Covington - University College	KY	211170007	5	URG 3000N												100
Craig Road	NV	320030020	5	URG 3000N												100
Craig Road	NV	320030020	5	SASS	100	100	100	100	100	83	100	100	100	100	100	100
Crown Z	WA	530630016	5	RAAS	85	100	100									
Dearborn	MI	261630033	5	SASS with URG 3000N	100	100	100	100	61	100	100	100	100	100	100	100
Dearborn	MI	261630033	5	URG 3000N	100	100	100	50	100	100	100	88	100	88	100	100

Site Name	State	AQS Code	POC	Sampler Type	Report Batch											
					107	108	109	110	111	112	113	114	115	116	117	118
Del Norte - Met One	NM	350010023	5	SASS	80	100	100	100	100	100						
Del Norte - Met One	NM	350010023	5	SASS with URG 3000N							100	100	100	100	100	100
Del Norte - Met One	NM	350010023	5	URG 3000N						100	100	100	100	100	100	100
Division St.	NY	360610134	5	SASS with URG 3000N	100	90	75	100	100	100	100	80	91	82	100	100
Division St.	NY	360610134	5	URG 3000N	94	79	80	81	93	78	94	81	23	0	81	88
Douglas - Met One	GA	130690002	5	SASS	80	100	100	100	100	60	100					
Douglas - Met One	GA	130690002	5	SASS with URG 3000N							99	100	100	85	100	100
Douglas - Met One	GA	130690002	5	URG 3000N						100	100	100	100	100	100	100
Downtown Library	OH	391130032	5	SASS	100	100	100	100	100	100	100	80	100	100	80	100
Downtown Library	OH	391130032	5	URG 3000N												100
Elkhart Prairie Street	IN	180390008	5	URG 3000N						100	50	88	100	50	100	88
Elkhart Prairie Street	IN	180390008	5	SASS with URG 3000N							100	40	80	80	100	100
Elkhart Prairie Street	IN	180390008	5	SASS	80	100	100	51	63	100						
Elmwood	PA	421010055	5	SASS with URG 3000N	100	84	99	99	59	100	100	100	100	100	100	100
Elmwood	PA	421010055	5	URG 3000N	100	88	100	100	75	75	100	100	100	100	100	100
Erie	PA	420490003	5	SASS	80	80	80	100	100	100	80	100	100	80	100	100
Erie	PA	420490003	5	URG 3000N												0
Evansville - Mill Road	IN	181630012	5	SASS	98	80	100	66	100	80	100					
Evansville - Mill Road	IN	181630012	5	URG 3000N						100	75	88	88			
Evansville - Mill Road	IN	181630012	5	SASS with URG 3000N							100	100	80			
Evansville Buena Vista Rd	IN	181630021	5	URG 3000N										100	88	50
Evansville Buena Vista Rd	IN	181630021	5	SASS with URG 3000N										100	100	100
Fairbanks State Bldg	AK	020900010	6	URG 3000N												100
Fairbanks State Bldg	AK	020900010	6	SASS	100	89	100	90	100	82	100	90	100	100	100	100
Fairbanks State Bldg	AK	020900010	6	SASS with URG 3000N												100
Florence	PA	421255001	5	URG 3000N	88	100	100	100	100	100	100	100	100	100	100	100
Florence	PA	421255001	5	SASS with URG 3000N	80	100	100	80	100	100	100	100	100	100	100	100
Freemansburg	PA	420950025	5	URG 3000N												100
Freemansburg	PA	420950025	5	SASS	100	100	100	100	100	100	100	100	100	100	100	100
Gary litri	IN	180890022	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Gary litri	IN	180890022	5	SASS with URG 3000N	100	80	100	100	41	100	100	80	100	100	100	100
Grand Junction - Powell Building	CO	080770017	5	SASS	100	100	100	100	100	100	100					
Grand Junction - Powell Building	CO	080770017	5	URG 3000N						50	100	100	100	100	100	100

Site Name	State	AQS Code	POC	Sampler Type	Report Batch											
					107	108	109	110	111	112	113	114	115	116	117	118
Grand Junction - Powell Building	CO	080770017	5	SASS with URG 3000N							100	100	96	100	100	100
Grand Rapids	MI	260810020	5	SASS with URG 3000N							100	100	100	80	100	100
Grand Rapids	MI	260810020	5	SASS	99	100	100	100	100	80	100					
Grand Rapids	MI	260810020	5	URG 3000N						100	100	100	100	100	100	100
Granite City	IL	171190024	5	URG 3000N	100	100	100	63	100	100	75	100	100	100	100	100
Granite City	IL	171190024	5	SASS with URG 3000N	78	97	81	98	94	80	96	93	96	96	96	96
Grayson	KY	210430500	5	SASS	100	100	100	100	100	100						
Grayson	KY	210430500	5	URG 3000N						100	75	100	100	100	100	100
Grayson	KY	210430500	5	SASS with URG 3000N							100	100	100	100	100	100
Greensburg	PA	421290008	5	URG 3000N	100	100	90	0	100	100	100	100	100	100	100	75
Greensburg	PA	421290008	5	SASS with URG 3000N	100	100	100	80	100	100	97	100	100	100	100	100
Greenville ESC	SC	450450015	5	SASS									100	100	100	100
Greenville ESC	SC	450450015	5	URG 3000N												100
Greenville Health Dept	SC	450450008	5	SASS	100	100	100	100	100	100	100	100	100			
Hammond Purdue	IN	180892004	5	SASS with URG 3000N	100	100	100	83	0							
Hammond Purdue	IN	180892004	5	URG 3000N	100	100	100	75	0							
Harrisburg	PA	420430401	5	URG 3000N												100
Harrisburg	PA	420430401	5	SASS	100	100	100	100	77	100	100	100	100	100	100	100
Hattie Avenue	NC	370670022	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Hattie Avenue	NC	370670022	5	SASS with URG 3000N	100	100	99	100	100	100	100	100	100	99	99	85
Head Start	OH	390990014	5	SASS	100	100	100	100	100	100	80	100	100	100	100	100
Head Start	OH	390990014	5	URG 3000N												100
Hickory	NC	370350004	5	SASS	100	100	20	83	100	83	100	100	100	100	100	100
Hickory	NC	370350004	5	URG 3000N												100
Houghton Lake	MI	261130001	5	SASS	100	99	100	100	100	69						
Houghton Lake	MI	261130001	5	SASS with URG 3000N							100	100	83	83	100	80
Houghton Lake	MI	261130001	5	URG 3000N						75	100	88	100	63	63	88
HU-Beltsville Met One	MD	240330030	5	SASS	100	80	80	100	70	100						
HU-Beltsville Met One	MD	240330030	5	SASS with URG 3000N							100	98	100	100	83	100
HU-Beltsville Met One	MD	240330030	5	URG 3000N						100	100	100	100	100	100	100
Huntsville Old Airport	AL	010890014	5	SASS	100	100	100	100	100	100	100					
Huntsville Old Airport	AL	010890014	5	URG 3000N						50	100	100	100	100	100	88
Huntsville Old Airport	AL	010890014	5	SASS with URG 3000N							50	80	100	85	100	80

Site Name	State	AQS Code	POC	Sampler Type	Report Batch											
					107	108	109	110	111	112	113	114	115	116	117	118
IS 52 - Met One	NY	360050110	5	URG 3000N	94	79	90	88	93	78	94	88	88	94	94	88
IS 52 - Met One	NY	360050110	5	SASS							100	100	100	100	100	100
IS 52 - Met One	NY	360050110	5	SASS with URG 3000N	100	100	91	100	100	84	100					
Jasper Post Office	IN	180372001	5	URG 3000N						50	100	100	100	100	100	100
Jasper Post Office	IN	180372001	5	SASS	100	100	100	100	100	83						
Jasper Post Office	IN	180372001	5	SASS with URG 3000N							100	100	100	100	100	100
Jefferson Elementary - Met One	IA	191630015	5	SASS	100	100	100	100	100	100						
Jefferson Elementary - Met One	IA	191630015	5	URG 3000N						100	100	100	83	100	100	100
Jefferson Elementary - Met One	IA	191630015	5	SASS with URG 3000N						100	100	100	100	100	91	100
Jefferson Elementary (10th and Vine)	IA	191630015	5	R & P 2300	60											
Jeffersonville Walnut St	IN	180190006	5	URG 3000N		100	100	50	100	100	100	100	100	100	100	100
Jeffersonville Walnut St	IN	180190006	5	SASS with URG 3000N			100	82	18	100	100	80	65	100	100	100
Jeffersonville Walnut St	IN	180190006	5	SASS	100	100	100									
Johnstown	PA	420210011	5	URG 3000N												100
Johnstown	PA	420210011	5	SASS				75	100	100	100	80	100	100	100	100
Kapolei	HI	150030010	5	SASS												100
Kapolei	HI	150030010	5	URG 3000N												100
Karnack - Met One	TX	482030002	5	SASS with URG 3000N											83	100
Karnack - Met One	TX	482030002	5	URG 3000N											100	50
Kelo	SD	460990006	5	SASS	100	100	97	53								
Kingston	TN	471451001	5	SASS							100	100	100	87	100	100
Lancaster	PA	420710007	5	URG 3000N												100
Lancaster	PA	420710007	5	SASS	100	100	100	100	100	100	100	100	100	100	97	100
Laurel	MS	280670002	5	SASS	80	100	100	100	77	100	100	100	100	100	100	100
Laurel	MS	280670002	5	URG 3000N												100
Lawrence County	TN	470990002	5	SASS	100	100	100	100	100	100	100	100	100	100	100	97
Lawrence County	TN	470990002	5	URG 3000N												100
Lexington Health Department	KY	210670012	5	URG 3000N						50	100	100	88	100	100	100
Lexington Health Department	KY	210670012	5	SASS	100	98	100	100	77	83						
Lexington Health Department	KY	210670012	5	SASS with URG 3000N							100	100	100	100	100	100
Lexington (NC)	NC	370570002	5	URG 3000N												100
Lexington (NC)	NC	370570002	5	SASS	100	100	60	100	100	98	100	100	100	100	67	84

Site Name	State	AQS Code	POC	Sampler Type	Report Batch											
					107	108	109	110	111	112	113	114	115	116	117	118
Liberty	MO	290470005	5	R & P 2300	75	89	100	100	100	67						
Liberty - Met One	MO	290470005	5	SASS with URG 3000N						99	100	100	100	98	91	100
Liberty - Met One	MO	290470005	5	SASS						99						
Liberty - Met One	MO	290470005	5	URG 3000N						100	100	100	100	100	94	100
Liberty (PA)	PA	420030064	6	URG 3000N	100	100	100	88	100	75	100	100	100	100	100	50
Liberty (PA)	PA	420030064	6	SASS with URG 3000N	100	82	100	80	81	99	95	93	93	93	93	93
Lockeland School - Met One	TN	470370023	5	SASS	100	85	100	100	100	100						
Lockeland School - Met One	TN	470370023	5	SASS with URG 3000N							100	100	100	100	100	100
Lockeland School - Met One	TN	470370023	5	URG 3000N						100	100	100	100	88	100	100
Lorain	OH	390933002	5	SASS with URG 3000N	20	100	100	100	100	100	100	100	98	100	50	40
Lorain	OH	390933002	5	URG 3000N	100	50	100	100	100	100	100	100	100	100	100	100
Luna Pier	MI	261150005	5	URG 3000N						100	100	100	88	100	88	100
Luna Pier	MI	261150005	5	SASS	100	100	100	100	100	100						
Luna Pier	MI	261150005	5	SASS with URG 3000N							100	100	100	100	100	100
Macon - Met One	GA	130210007	5	SASS with URG 3000N	100	100	100	100	89	100	100	100	100	60	100	100
Macon - Met One	GA	130210007	5	URG 3000N	100	100	100	100	100	100	100	100	100	75	100	100
Maple Canyon	OH	390490081	6	URG 3000N	100	100	100	75	0	100	100	100	100	100	100	100
Maple Canyon	OH	390490081	6	SASS with URG 3000N	100	80	100	100	100	100	100	100	100	100	100	100
Marysville - 7th Ave	WA	530611007	5	SASS						100						
Marysville - 7th Ave	WA	530611007	5	URG 3000N						100	75	100	100	100	100	88
Marysville - 7th Ave	WA	530611007	5	SASS with URG 3000N							75	100	100	100	100	100
Mayville Hubbard Township site	WI	550270007	5	URG 3000N												100
Mayville Hubbard Township site	WI	550270007	5	SASS	99	100	89	99	100	100	99	100	100	79	100	100
Mayville Hubbard Township site	WI	550270007	5	SASS with URG 3000N												100
Middletown	OH	390171004	5	SASS	100	100	100	100	100	100	100	100	80	100	100	80
Middletown	OH	390171004	5	URG 3000N												100
Millbrook	NC	371830014	5	SASS	100	100	100	100	23	0	100	100	90	100	100	100
Millbrook	NC	371830014	5	URG 3000N												100
Millbrook	NC	371830014	5	SASS with URG 3000N												100
Mingo Junction	OH	390811001	5	SASS with URG 3000N	100	100	100	100	79	86	100	100	100	83	100	99
Mingo Junction	OH	390811001	5	URG 3000N	100	100	100	100	100	100	100	100	100	75	100	100
MN - Rochester	MN	271095008	5	SASS	85	100	100	100	77	100	100	100	100	100	100	100
MN - Rochester	MN	271095008	5	URG 3000N												0

Site Name	State	AQS Code	POC	Sampler Type	Report Batch											
					107	108	109	110	111	112	113	114	115	116	117	118
MOMS	AL	011011002	5	SASS with URG 3000N							100	80	100	100	100	100
MOMS	AL	011011002	5	URG 3000N						100	100	100	100	100	100	100
MOMS	AL	011011002	5	SASS	100	100	100	100	100	100						
Moundsville Armory	WV	540511002	5	SASS	100	100	100	100	100	100	100	100	100	100	100	100
Naperville	IL	170434002	5	SASS with URG 3000N	99	97	96	97	96	96	96	96	95	96	96	96
Naperville	IL	170434002	5	URG 3000N	100	100	70	50	100	100	100	100	100	100	100	100
New Garden	PA	420290100	5	URG 3000N												100
New Garden	PA	420290100	5	SASS	83	36	27	100	85	100	100	80	97	80	100	80
NLR Parr	AR	051190007	5	SASS	100	100	100	100	100	100	100	100	100	100	100	100
NLR Parr	AR	051190007	5	URG 3000N												100
North Los Angeles	CA	060371103	5	URG 3000N	100	90	0	38	100	100	100	100	100	100	100	100
North Los Angeles	CA	060371103	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	80	100	100	100
Northbrook	IL	170314201	5	URG 3000N	100	100	100	75	100	88	100	100	88	100	100	100
Northbrook	IL	170314201	5	SASS with URG 3000N	62	79	97	81	96	80	96	96	96	96	96	96
OCUSA Campus	OK	401091037	5	SASS	65	100	100	100	100	83	100	99	100	100	100	100
OCUSA Campus	OK	401091037	5	URG 3000N												100
ODOT Garage	OH	390870012	5	SASS	96	100	100	100	99	100						
ODOT Garage	OH	390870012	5	URG 3000N						75	75	100	100	88	100	100
ODOT Garage	OH	390870012	5	SASS with URG 3000N							100	100	100	100	100	100
Pearl City	HI	150032004	5	SASS	80	100	60	100	100	100	100	100	100	100	100	67
PerkinstownCASNET	WI	551198001	5	URG 3000N												100
PerkinstownCASNET	WI	551198001	5	SASS	100	100	100	100	77	100	100	80	100	100	100	100
Pinnacle State Park - Met One	NY	361010003	5	SASS with URG 3000N						100	78	100	100	100	100	100
Pinnacle State Park - Met One	NY	361010003	5	URG 3000N						50	94	94	88	63	64	88
Pinnacle State Park - Met One	NY	361010003	5	SASS	91	100	100	100	100	99						
Platteville	CO	081230008	5	URG 3000N						75	100	100	100	100	100	100
Platteville	CO	081230008	5	SASS	100	100	100	100	100	100						
Platteville	CO	081230008	5	SASS with URG 3000N							100	100	100	100	100	100
Port Huron	MI	261470005	5	SASS with URG 3000N							100	100	100	100	100	100
Port Huron	MI	261470005	5	URG 3000N						100	100	100	100	100	100	100
Port Huron	MI	261470005	5	SASS	100	100	100	100	100	83						
Public Health Building - Met One	IA	191530030	5	SASS	100	100	100	100	100	100						
Public Health Building - Met One	IA	191530030	5	URG 3000N						100	100	100	100	100	100	100

Site Name	State	AQS Code	POC	Sampler Type	Report Batch											
					107	108	109	110	111	112	113	114	115	116	117	118
Public Health Building - Met One	IA	191530030	5	SASS with URG 3000N							100	100	100	100	100	100
Queens College - Met One	NY	360810124	6	SASS	100	100	100	93	100	100	100	90	100	100	94	100
Queens College - Met One	NY	360810124	6	URG 3000N						100	100	94	88	100	100	100
Reading Airport	PA	420110011	5	URG 3000N												100
Reading Airport	PA	420110011	5	SASS	100	100	100	100	100	99	100	100	100	100	80	100
Rochester Primary - Met One	NY	360551007	5	URG 3000N						50	94	100	89	94	100	100
Rochester Primary - Met One	NY	360551007	5	SASS	99	89	100	80	79	100						
Rochester Primary - Met One	NY	360551007	5	SASS with URG 3000N						50	89	100	100	90	100	100
Rockwell	NC	371590021	5	URG 3000N												100
Rockwell	NC	371590021	5	SASS	80	100	100	100	100	100	100	100	100	100	100	82
Rome - Met One	GA	131150005	5	SASS	100	100	100	100	100							
Rome Elementary	GA	131150003	5	URG 3000N												100
Rome Elementary	GA	131150003	5	SASS						100	100	100	100	100	100	80
Rossville - Met One	GA	132950002	5	URG 3000N						100	100	100	100	100	100	100
Rossville - Met One	GA	132950002	5	SASS	100	100	100	100	100	100	100					
Rossville - Met One	GA	132950002	5	SASS with URG 3000N							100	100	100	98	83	91
Scranton	PA	420692006	5	SASS	100	100	100	100	100	100	100	100	100	100	99	100
Scranton	PA	420692006	5	URG 3000N												100
Shenandoah High School	IN	180650003	5	SASS	100	100	100	100	100	67						
Shenandoah High School	IN	180650003	5	SASS with URG 3000N							100	100	100	100	100	100
Shenandoah High School	IN	180650003	5	URG 3000N						100	100	100	100	88	100	100
Shreveport Airport	LA	220150008	5	MASS	100	3										
Shreveport Airport - Met One	LA	220150008	5	URG 3000N						100	100	100	100	75	100	100
Shreveport Airport - Met One	LA	220150008	5	SASS				100	100	100						
Shreveport Airport - Met One	LA	220150008	5	SASS with URG 3000N							100	100	80	80	100	100
Sioux Falls School Site	SD	460990008	5	SASS				90	97	96	100	100	100	100	97	100
Sioux Falls School Site	SD	460990008	5	URG 3000N												100
Skyview	FL	121030026	5	URG 3000N												100
Skyview	FL	121030026	5	SASS	100	88	100	100	100	100	100	100	100	100	86	100
South Charleston Library	WV	540391005	5	SASS with URG 3000N	100	83	100	99	85	100	100	80	100	100	100	100
South Charleston Library	WV	540391005	5	URG 3000N	100	70	38	100	88	100	100	50	100	100	100	100
Southwick Community Center	KY	211110043	5	SASS with URG 3000N	100	100	100									
Southwick Community Center	KY	211110043	5	URG 3000N	10	33	100									

Site Name	State	AQS Code	POC	Sampler Type	Report Batch											
					107	108	109	110	111	112	113	114	115	116	117	118
Spring Hill Elementary School	TN	470931020	5	RAAS with URG 3000N												
Spring Hill Elementary School	TN	470931020	5	SASS with URG 3000N	100	75	100	100	100	100	100	83	100	100	100	100
Spring Hill Elementary School	TN	470931020	5	URG 3000N	100	100	100	100	100	100	100	88	100	50	100	100
St Theo	OH	390350038	6	SASS with URG 3000N	100	100	100	100	100	99	100	100	100	75		
St Theo	OH	390350038	6	URG 3000N	70	33	20	0	0	0	0	0	0	0		
St Theo	OH	390350038	6	SASS										100	100	100
State College	PA	420270100	5	SASS	80	80	100	100	53	100	100	80	100	100	80	100
State College	PA	420270100	5	URG 3000N												100
SW HS	MI	261630015	5	URG 3000N	100	100	100	100	50	100	100	100	100	100	100	100
SW HS	MI	261630015	5	SASS with URG 3000N	100	82	100	100	100	100	100	100	100	100	100	100
Tacoma - Met One	WA	530530029	5	SASS with URG 3000N	100	100	82	100	100	98	100	100	100	100	100	100
Tacoma - Met One	WA	530530029	5	URG 3000N	90	100	100	100	100	100	100	100	75	100	100	100
Taft	OH	390610040	5	URG 3000N	100	100	100	100	100	100	100	100	100	100	100	88
Taft	OH	390610040	5	SASS with URG 3000N	100	100	100	100	100	100	100	100	100	100	100	100
Tallahassee Community College	FL	120730012	5	URG 3000N												100
Tallahassee Community College	FL	120730012	5	SASS	100	100	100	100	100	100	100	100	100	100	100	100
Taylors Fire Station	SC	450450009	5	SASS												
Tecumseh	MI	260910007	5	URG 3000N						100	100	100	100	100	88	100
Tecumseh	MI	260910007	5	SASS	100	100	100	83	100	100						
Tecumseh	MI	260910007	5	SASS with URG 3000N							100	100	100	100	100	100
Toledo Airport	OH	390950026	5	SASS	100	100	100	70	100	98	98	100	100	100	100	20
Toledo Airport	OH	390950026	5	URG 3000N												100
UTC	TN	470654002	5	SASS	100	100	100	67	53	67	80	100	100	100	60	0
UTC	TN	470654002	5	URG 3000N												100
VAN4PLN2	WA	530110013	5	SASS	100	100	100	100	100	100						
VAN4PLN2	WA	530110013	5	SASS with URG 3000N							100	100	100	100	100	100
VAN4PLN2	WA	530110013	5	URG 3000N						75	100	100	100	88	100	100
Water Treatment Plant	WV	540690010	5	URG 3000N												100
Water Treatment Plant	WV	540690010	5	SASS												100
Waukesha, Cleveland Ave. Site	WI	551330027	5	SASS	100	100	100	100	100	100	100	100	80	100	100	100
Waukesha, Cleveland Ave. Site	WI	551330027	5	URG 3000N												100
Whiteface - Met One	NY	360310003	5	SASS	100	100	100	100	100	100	100					
Whiteface - Met One	NY	360310003	5	URG 3000N						100	100	100	100	100	100	100

Site Name	State	AQS Code	POC	Sampler Type	Report Batch											
					107	108	109	110	111	112	113	114	115	116	117	118
Whiteface - Met One	NY	360310003	5	SASS with URG 3000N							100	100	100	100	87	100
Wichita Dept. of Env. Health - Met One	KS	201730010	5	URG 3000N												100
Wichita Dept. of Env. Health - Met One	KS	201730010	5	SASS										100	100	100
Wichita Dept. of Environmental Health	KS	201730010	5	R & P 2300	60	100	60	100	100	100	80	100	36	100		
Wylam	AL	010732003	5	URG 3000N						50	100	88	75	100	100	100
Wylam	AL	010732003	5	SASS with URG 3000N							100	83	100	100	100	100
Wylam	AL	010732003	5	SASS	100	100	100	100	100	83						
Yakima Mental Health	WA	530770009	5	SASS with URG 3000N	100	100	100	100	100	100						100
Yakima Mental Health	WA	530770009	5	URG 3000N	100	100	100	100	83	100						100
York	PA	421330008	5	SASS	100	100	100	100	97	100	100	80	100	100	100	100
York	PA	421330008	5	URG 3000N												50