TECHNICAL MEMORANDUM

TO: Jim Homolya / OAQPS

FROM: Michael S. Clark / NAREL

COPY: Dr. Chuck McDade / UC Davis
Dr. Judy Chow / DRI
Dr. R.K.M. Jayanty / RTI
Dr. John Griggs / NAREL

DATE: June 20, 2003

SUBJECT: Performance Evaluation - IMPROVE Laboratories

Introduction

A study has been conducted over the past few months as part of the QA oversight for the Interagency Monitoring of Protected Visual Environments (IMPROVE) program. This study was sponsored by the US Environmental Protection Agency as part of its joint commitment, along with several other agencies, to support IMPROVE. The purpose of this study was to evaluate specific performance of the laboratories that routinely analyze $PM_{2.5}$ samples collected at IMPROVE sites. Performance Evaluation (PE) samples were prepared at EPA's National Air and Radiation Environmental Laboratory (NAREL) and submitted to the participating laboratories for analysis. Those laboratories that participated in this study are located at the University of California/Davis campus (UC/Davis), the Desert Research Institute (DRI) located in Reno, NV, and the Research Triangle Institute (RTI) located in Research Triangle Park, NC.

The PE samples were designed to evaluate three analytical techniques as briefly described in Table 1. PE samples for XRF analysis will be included in a separate report at a later date.

Table 1

Laboratory	Analysis	PE Sample Components
UC/Davis	Gravimetric Mass	ten Teflon® filters and three metallic weights
DRI	OC/EC by TOR	six Quartz filters and three spike solutions.
RTI	Ions by IC	six Nylon® filters, three anion spike solutions, and three cation spike solutions.

Detailed instructions for analyzing and reporting the PE samples were provided by NAREL. The analytical facilities at NAREL are similar to those at the participating laboratories. Each PE sample, or a replicate of the PE sample, was also analyzed at NAREL. This report will discuss the analytical results reported by the participating laboratory and will compare each result to an expected value.

A group of scientists and support personnel working at the Crocker Nuclear Center at UC/Davis provide most of the technical support for the IMPROVE program. The UC/Davis group has provided this support for more than fifteen years as the network grew from about thirty sites in the beginning years to 164 sites today. UC/Davis provides fresh filter packs to all of the IMPROVE field sites. A field operator receives the filter packs, and he is responsible for visiting the IMPROVE sampler every week to retrieve loaded filters and install fresh filters for the subsequent collection events. The typical IMPROVE sampler includes four modules [A, B, C, and D] that operate simultaneously to collect ambient aerosols onto a specific filter substrate during the 24-hour collection period. Modules A, B, and C are configured to collect $PM_{2.5}$ onto a Teflon®, a Nylon®, and a quartz filter substrate respectively. Module D is configured to collect PM_{10} onto a Teflon® filter. All of the loaded filter packs are returned to UC/Davis. The Teflon® filters recovered from Module A and Module D remain at UC/Davis for a variety of subsequent determinations that include the gravimetric mass analysis. The quartz filters recovered from Module C are shipped to DRI for carbon analysis using a Thermal-Optical Reflectance (TOR) technique. The Nylon® filters recovered from Module B are shipped to RTI for subsequent extraction and analysis using Ion Chromatography (IC).

Mass determination typically proceeds by weighing the Teflon® collection filter before and after the sampling event. The amount of Particulate Matter ($PM_{2.5}$) captured onto the surface of the filter can be calculated by a simple subtraction of the tare weight from the loaded filter weight. UC/Davis operates a laboratory that routinely measures the gravimetric mass of captured $PM_{2.5}$.

The quartz filters are routinely shipped to DRI for subsequent carbon analysis. A TOR technique is used at DRI to determine the carbon present on the quartz filter. A carefully measured portion of the quartz filter is placed into a special oven equipped to shine a laser at the sample. The oven is programmed to heat the quartz filter material to release captured $PM_{2.5}$. Carbon components released from the filter are swept through the oven by a controlled purge gas. The carbon released from the filter is catalytically converted to methane and measured by a flame ionization detector (FID) positioned at the end of the sample train. A thermogram produced by the analysis contains signals from the FID and from the laser. Interpretation of the thermogram provides results for thermal fractions of the organic carbon (OC) and the elemental carbon (EC). The instrument at DRI is slightly different from the instrument at NAREL, and those differences shall be discussed later in the carbon analysis section of this report.

The Nylon® filters are routinely shipped to RTI where the filters must be extracted using an appropriate solvent. Deionized water is currently used as the extraction solvent. The extract must be analyzed using an IC instrument that is optimized to determine the ions of interest. Target anions and target cations must be analyzed on separate IC instruments. All samples are analyzed for the presence of four anions: nitrate, sulfate, nitrite, and chloride. Ammonium is the only cation currently determined, and it is reported for only a few selected sites.

Gravimetric Analysis

NAREL provided ten new Teflon® filters and three metallic weights for this study. Metallic weights were included in this study to provide a material which is not as susceptible to problems with electrical static as the true filter material. The filters and the weights were shipped to

UC/Davis with a request to determine tare mass using local standard procedures. After tare mass had been determined at UC/Davis, the filters and metallic weights were shipped to NAREL in Montgomery, AL. The filters and the weights were immediately placed into the weighing chamber at NAREL for equilibration and determination of a NAREL tare mass. After the NAREL tare mass was determined, the filters were loaded with $PM_{2.5}$ captured from the outside air near NAREL. An IMPROVE air sampler was used to load seven of the filters, and the remaining three filters were utilized as blanks. Following sample collection, all filters and weights were returned to the weighing chamber at NAREL to equilibrate and to determine the loaded mass. Finally, the ten filters and three metallic weights were shipped back to UC/Davis for their gravimetric determination of $PM_{2.5}$ mass.

Gravimetric Results

The results of this study are summarized in Figure 1. The critical information needed by the program is the mass of $PM_{2.5}$ deposited onto the surface of a collection filter, and therefore, $PM_{2.5}$ capture is plotted in Figure 1 for the seven loaded filters, three travel blanks, and three metallic weights.

Figure 1

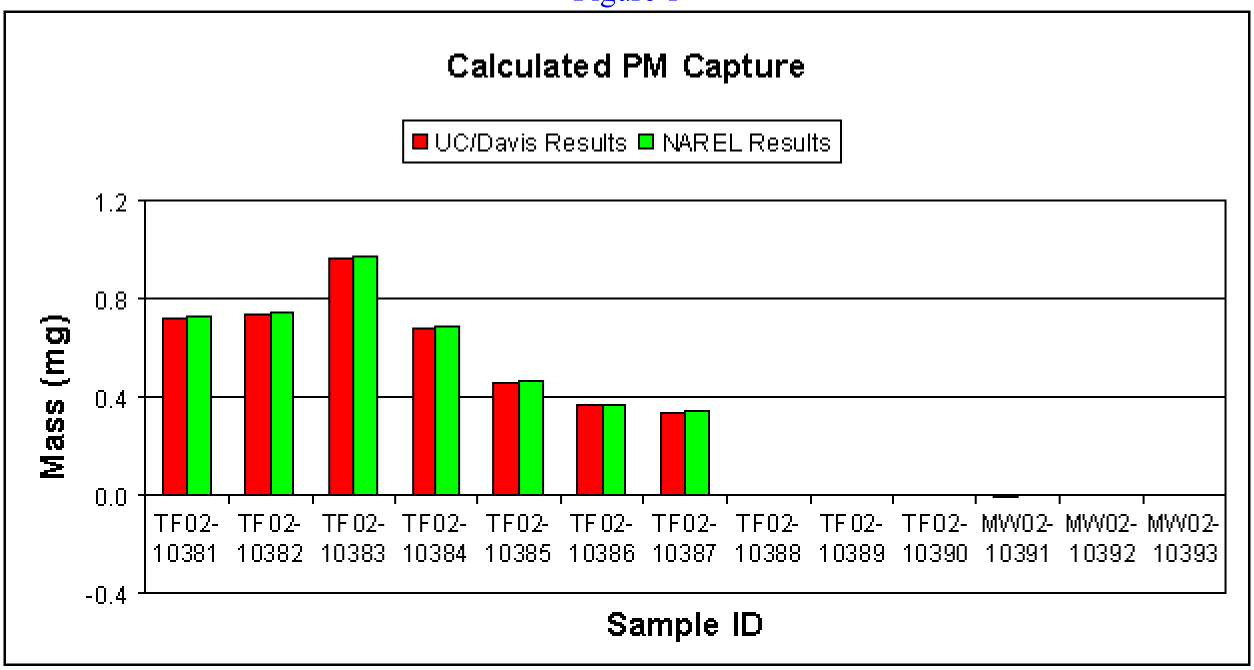
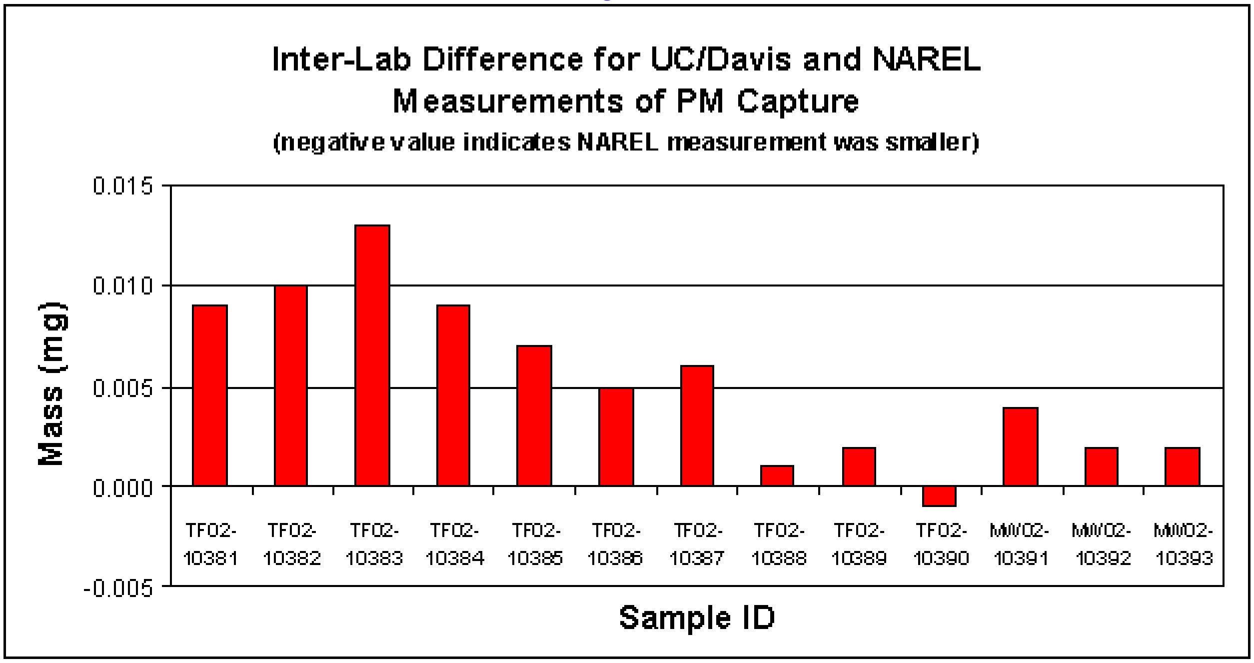


Figure 2 presents the inter-laboratory differences. Inter-laboratory differences were calculated by subtracting the $PM_{2.5}$ capture value determined at UC/Davis from the capture value determined at NAREL. Notice that a negative bar on the Figure 2 graph represents a smaller $PM_{2.5}$ capture value determined at NAREL.

Figure 2



All of the samples in this study were weighed several times at each laboratory to determine a reliable tare mass and a reliable final mass value for each sample. Figure 3 shows the results of weighing a routine loaded filter (TF02-10381) several times at each laboratory. Similarly, Figure 4 and Figure 5 show the results of weighing a filter blank (TF02-10388) and a metallic weight (MW02-10391) several times at each laboratory. It can be seen from the large number of measurements at NAREL, that the measured mass of the loaded filter seems to decrease slightly over time. This pattern of steadily decreasing mass over time was observed for all seven of the loaded filters but was not observed for the three blank filters nor for the three metallic weights.

Figure 3

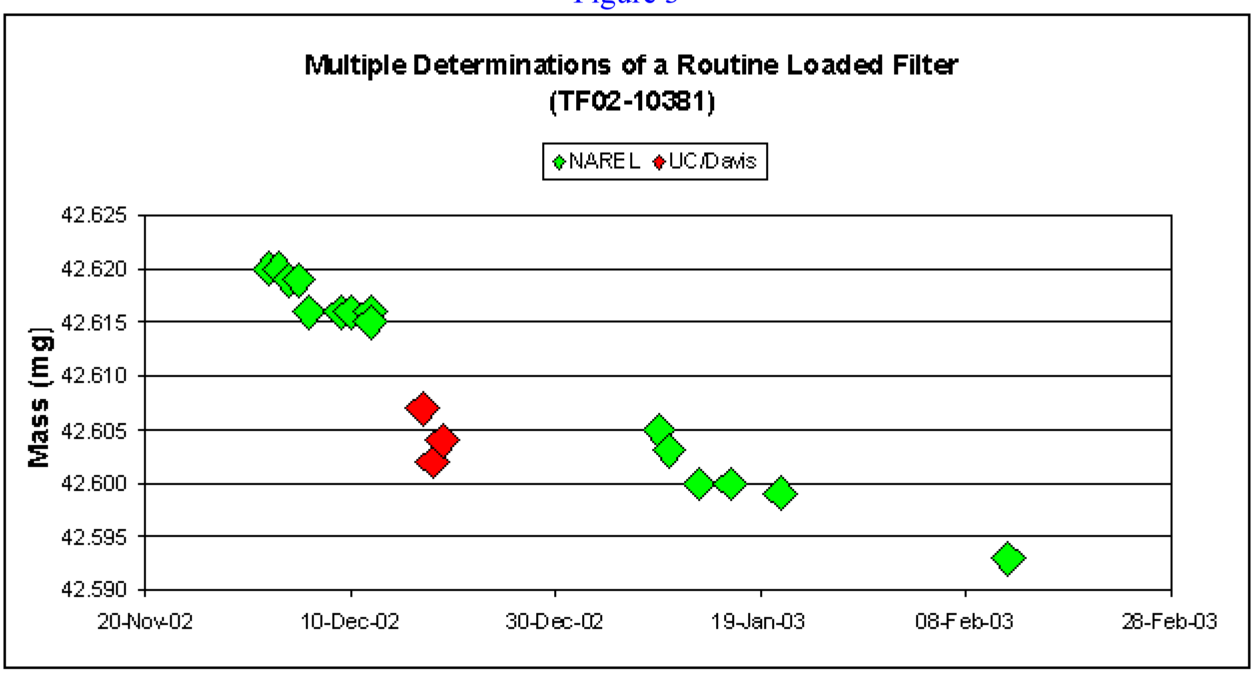


Figure 4

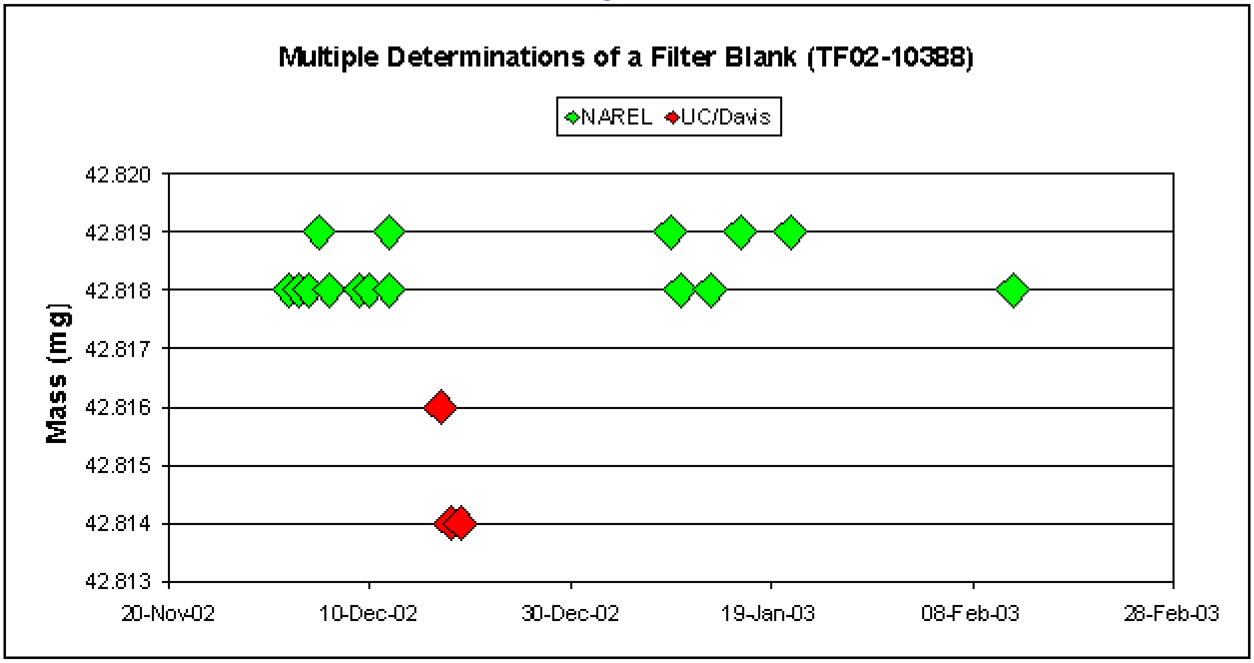
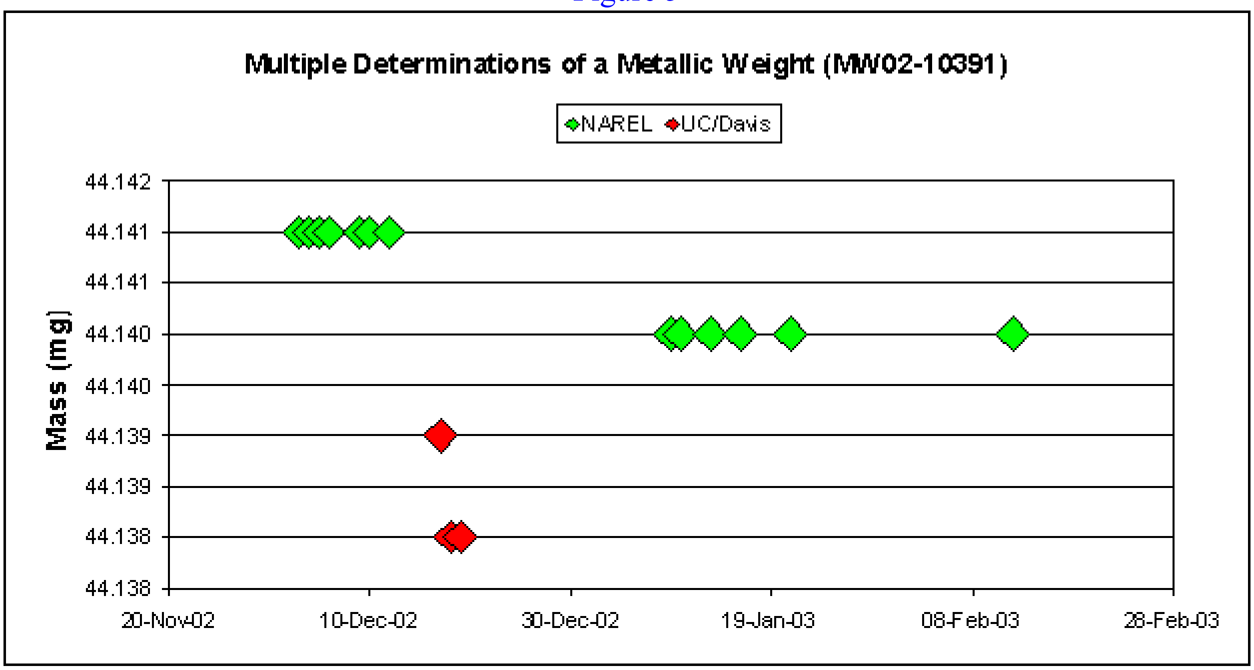


Figure 5



The critical raw data reported from both laboratories are presented in Table 3 at the end of this report. Table 3 contains the critical tare weight, the final weight, the calculated $PM_{2.5}$, and the calculated inter-laboratory difference for measuring the $PM_{2.5}$ capture. These critical data from ten shared filters and three metallic weights have been presented in Figure 1 and Figure 2.

Table 4 is also at the end of this report, and it contains all of the gravimetric raw data from multiple determinations of each sample reported by both labs. Representative sample data from Table 4 have been presented in Figure 3 through Figure 5.

IC Analysis

For this study, Nylon® filters and IC spike solutions were carefully prepared at NAREL and shipped to RTI for analysis. A Met One SASS sampler was used to load several Nylon® filters with $PM_{2.5}$ captured from the Montgomery air. Six filters were submitted to RTI for analysis, and replicates of each filter were retained at NAREL for in-house analysis. Six IC spike solutions were also prepared at NAREL. Each solution was designed for dilution by a factor of ten using reagent water available at the receiving laboratory. After dilution to full volume, each spike solution was utilized as the solvent to extract a clean blank filter also provided by the receiving laboratory. The filter extracts were analyzed using appropriate IC instrumentation available at the receiving laboratory. The results reported for each sample were based upon the mass of analyte per filter (µg/filter).

Two of the six filters submitted to RTI were actually Nylon® filter blanks. Two of the filters were replicates loaded with a 51-hour sampling event, and two filters were replicates loaded with a 96-hour event. Samples were collected over long periods to insure that all analytes were present in the samples at detectable levels. No information was given to RTI regarding the history of these Nylon® filters. Three of the six IC spike solutions were prepared for analysis of the anions, and three solutions were prepared for the analysis of cations. These solutions were designed to offer a mid-level concentration, a low-level concentration, and a blank for each analyte. Replicates of all samples were analyzed at NAREL following the same instructions provided to RTI.

IC Results

Results for the mid-level IC spikes are presented as a bar graph in Figure 6. For each analyte, the mid-level concentration of the fully diluted spike solution was between 20 and 120 µg/filter. Figure 6 presents the expected result, the RTI result, and the NAREL result for each analyte.

Figure 6

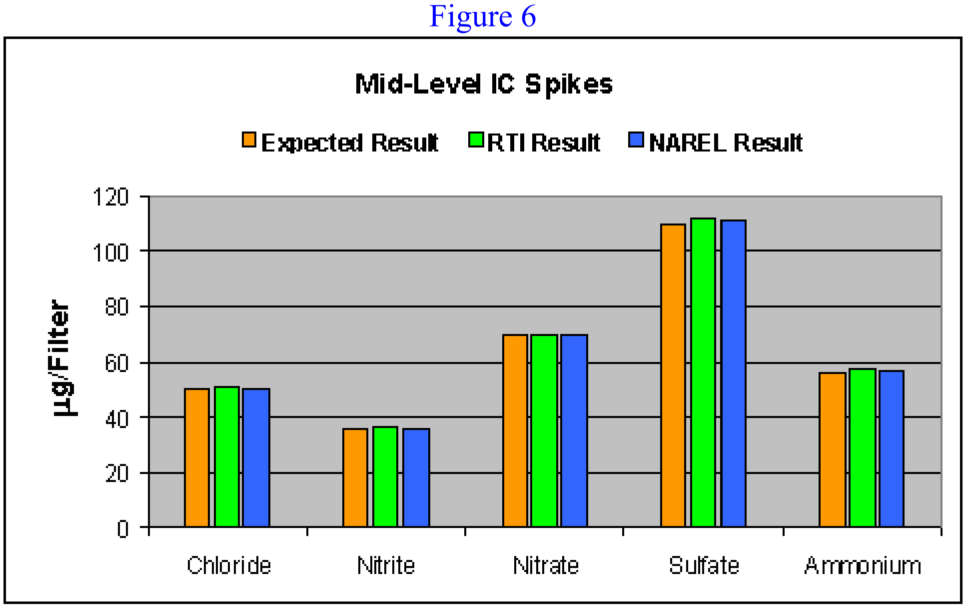
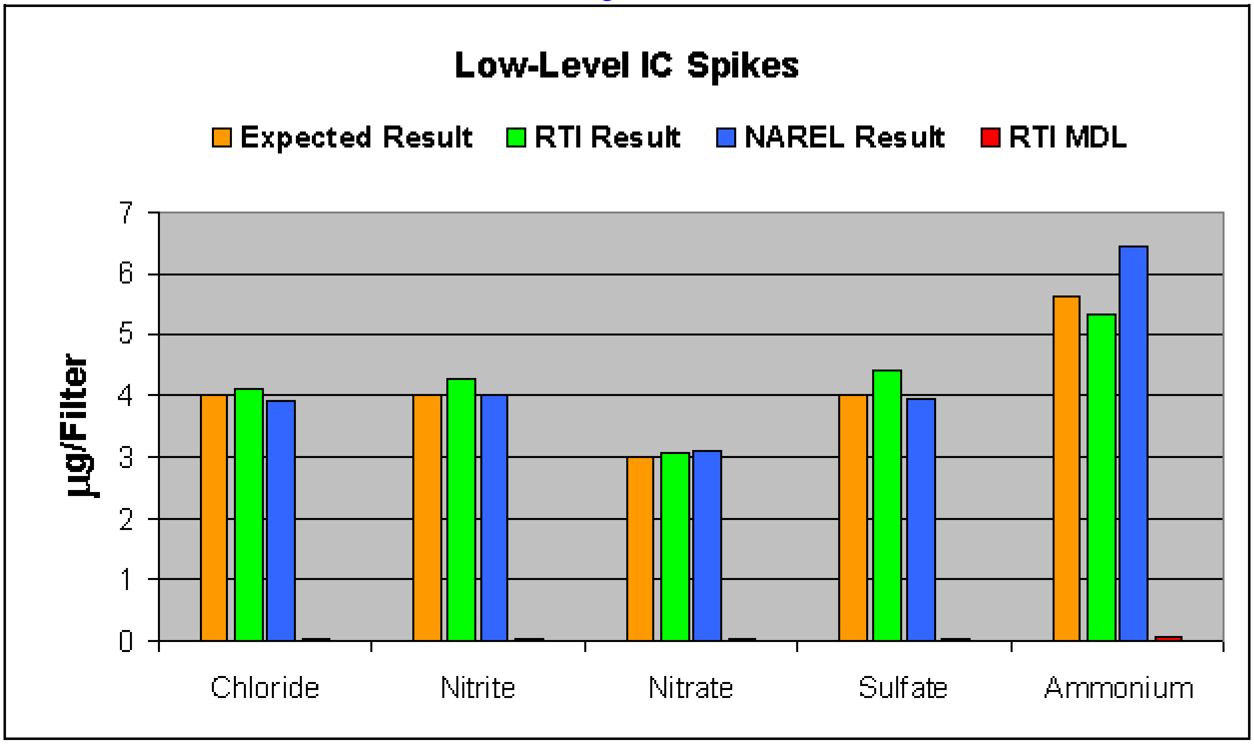


Figure 7



Results for the low-level spikes are presented as a bar graph in Figure 7. For each analyte, the low-level concentration of the fully diluted spike solution was between 3 and 6 µg/filter. Since the concentrations presented in Figure 10 are low, an extra bar was added to this graph showing the Method Detection Limit (MDL) reported by RTI. It should be noted that even the low-level spikes provided for this study are significantly above the reported MDL. All of the results from the IC spike solutions are summarized in Table 5 at the end of this report.

Results for five replicate filters are presented in Figure 8 and Figure 9. These filters were loaded with a 51-hour sampling event which began on May 21. Only two of these five Nylon® filter replicates were submitted to RTI for analysis, and the remaining three replicates were extracted and analyzed at NAREL. Sulfate and ammonium were the most abundant analytes captured from the Montgomery air during this sampling event, and these ions are plotted in Figure 8.

Figure 8

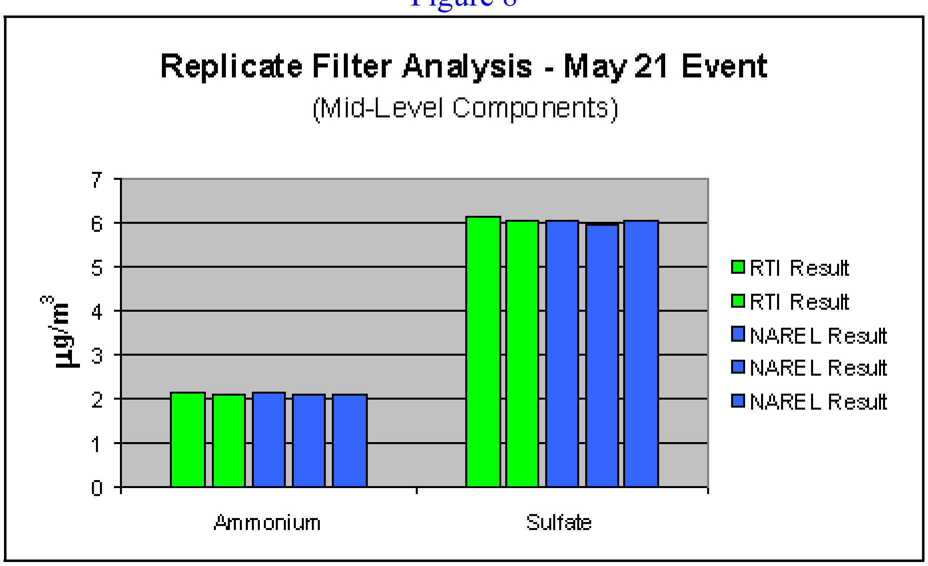
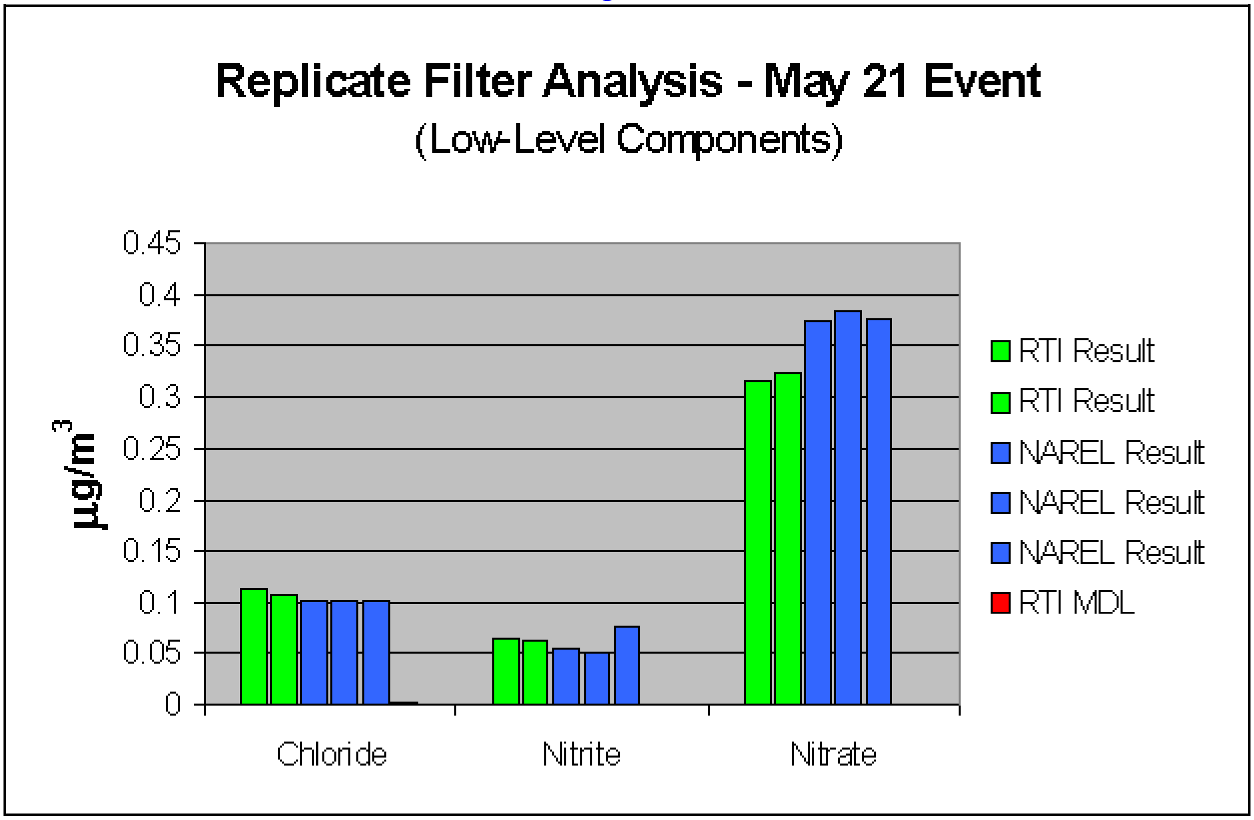


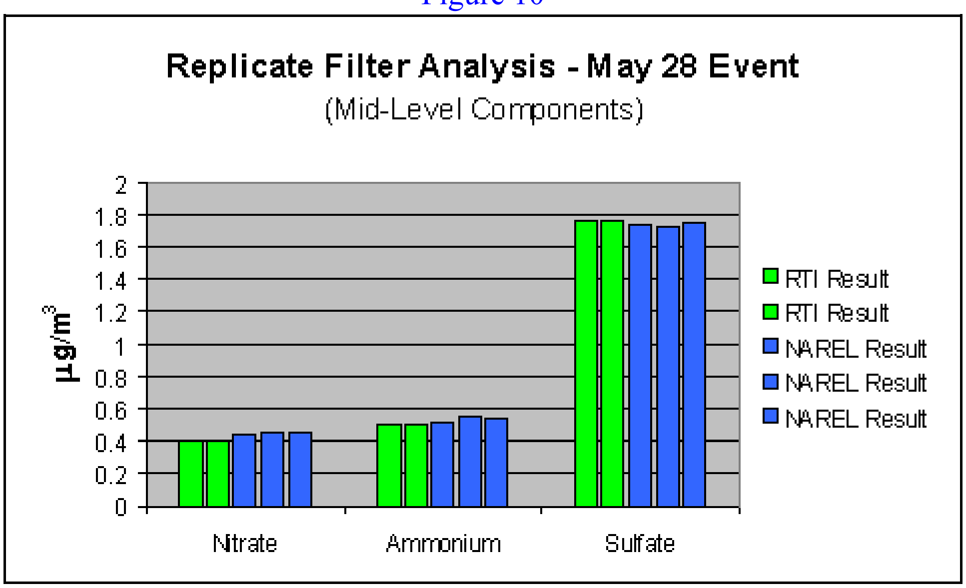
Figure 9



Chloride, nitrite, and nitrate were present in the PM capture at lower concentrations, and these three ions are plotted in Figure 9. Since the concentrations presented in Figure 9 are relatively low, an extra bar was added to this graph showing RTI's MDL expressed as mass per cubic meter of air sampled.

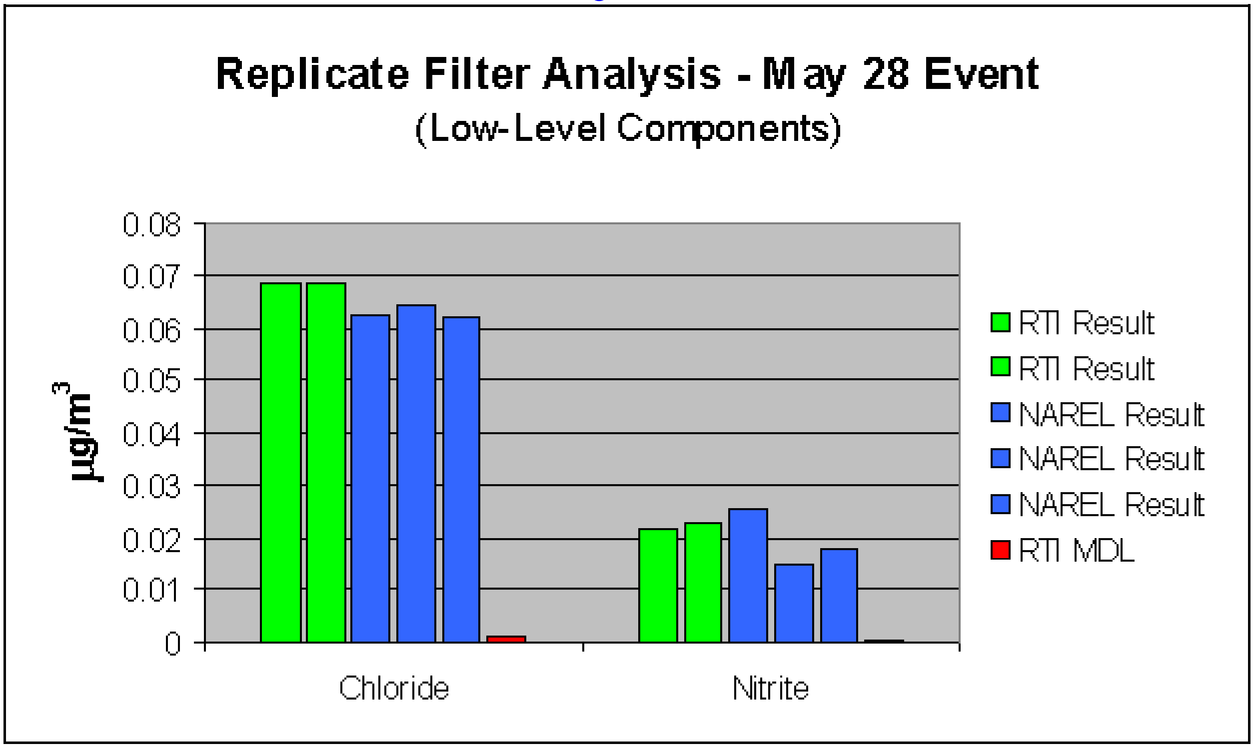
Results for five more replicate filters are presented in Figure 10 and Figure 11. These filters were loaded with a 96-hour sampling event which began on May 28. Once again, only two of these five Nylon® filter replicates were submitted to RTI for analysis, and the remaining three replicates were extracted and analyzed at NAREL. For this event, the most abundant analytes were sulfate, ammonium, and nitrate which are plotted in Figure 10.

Figure 10



Chloride and nitrite were present at low concentration during the May 28 event, and these two ions are plotted in Figure 11.

Figure 11



Results for all of the loaded Nylon® filters are presented in Table 6 and Table 7 at the end of this report. Two of the six Nylon® filters submitted to RTI for analysis were actually blank filters which were pre-cleaned at NAREL along with all the other Nylon® filters used in this study. The results for all blank Nylon® filters are presented in Table 8 at the end of this report.

Carbon Analysis

Earlier in the introduction of this report, it was stated that carbon analysis at DRI is slightly different from the carbon analysis at NAREL. The carbon analyzer at NAREL was manufactured by Sunset Laboratories, and the carbon analyzer at DRI was a unit of their own design. The Sunset instrument uses a Thermal-Optical Transmittance (TOT) technique which heats the sample while monitoring the laser light that passes through the sample. The DRI unit heats the sample while monitoring the laser light which reflects from the sample. The DRI unit is programmed to provide an analysis based upon Thermal-Optical Reflectance (TOR). Even though both instruments heat the sample during the analysis cycle, the thermal profiles are different. Two thermograms are presented in Figure 12 and Figure 13 to illustrate the OC/EC analysis at DRI and NAREL respectively. These thermograms were produced during this study when each lab analyzed replicates of the same sample. Significant differences can be seen in the raw data even though the samples are not significantly different.

Figure 12

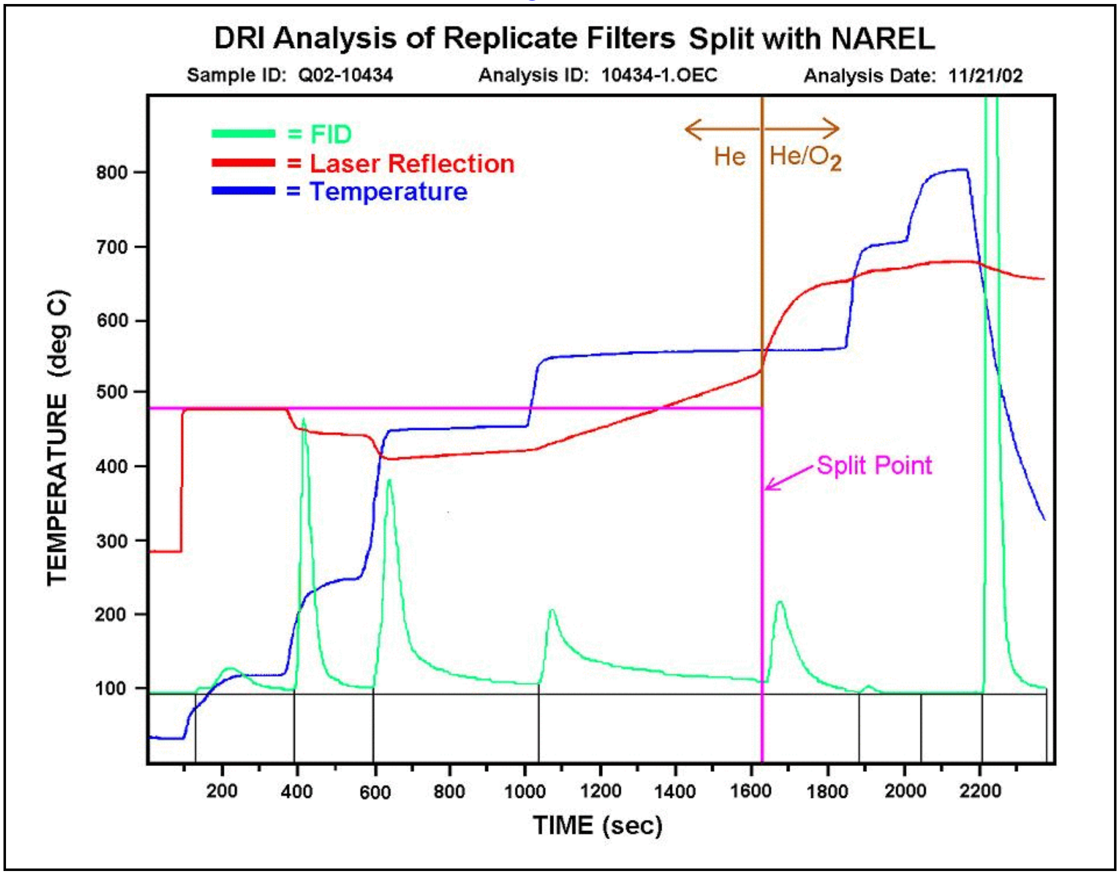
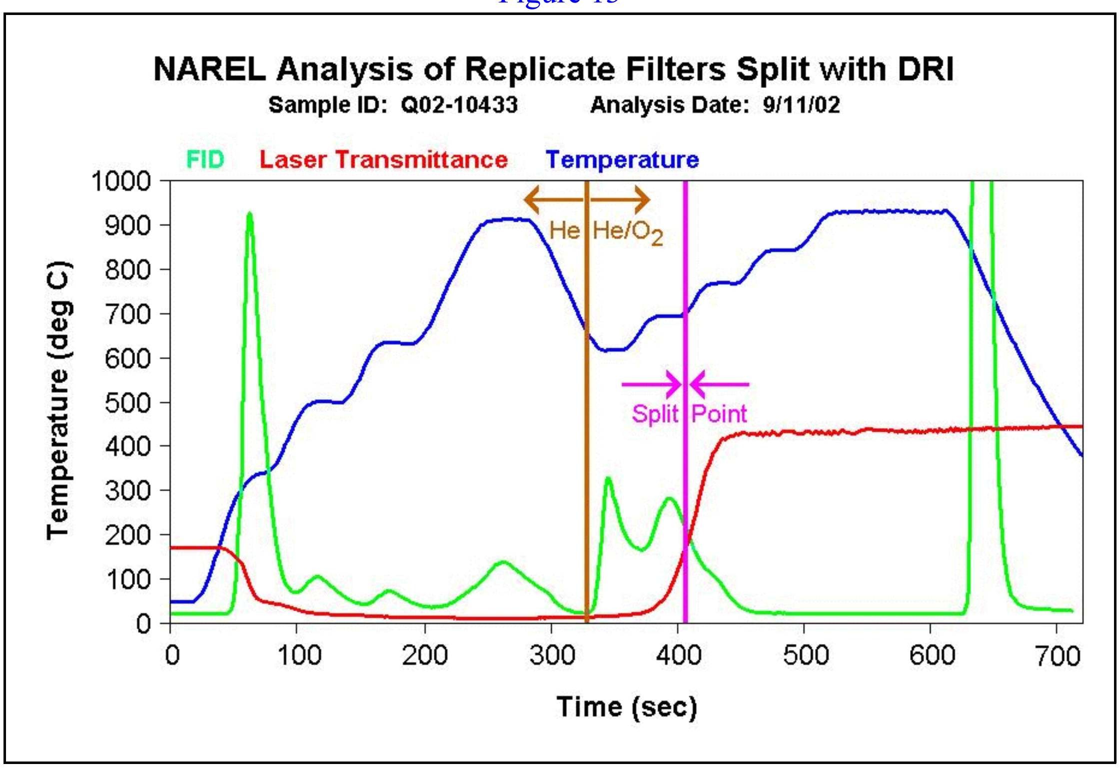


Figure 13



The two thermograms should be examined carefully to compare the FID traces, the laser traces, and the assigned split points. Differences are due to instrument hardware as well as instrument software and programming. It is significant to observe in Figure 12 that the split point was not assigned when the laser signal returned to its initial value. The DRI software will not assign the split point before the helium/oxygen valve opens. However, the Sunset software will assign the split point before the helium/oxygen valve opens as long as the laser signal supports that assignment. The thermal programs used by the two instruments are significantly different as shown here in Table 2.

Table 2

TOR Parameters at DRI			TOT Parameters at NAREL		
Temperature Setpoint (°C)	Duration (seconds)	Purge Gas	Temperature Setpoint (°C)	Duration (seconds)	Purge Gas
Ambient	10	He	Ambient	10	He
120	varies*	He	310	60	He
250	varies*	He	480	60	He
450	varies*	He	615	60	He
550	varies*	He	900	90	He
550	varies*	He/Ox	cool down	30	He
700	varies*	He/Ox	cool down	10	He/Ox
800	varies*	He/Ox	600	35	He/Ox
			675	45	He/Ox
			750	45	He/Ox
			825	45	He/Ox
			920	120	He/Ox

Varies to allow the FID signal to approach baseline between temperature steps.

It should also be pointed out that the DRI analysis is designed to produce OC fractions and EC fractions that are not resolved by NAREL's analysis. Consequently, this study was designed to evaluate only the total organic carbon and the total elemental carbon present in the samples. NAREL's analysis during this study has been identical to the analysis used by the Research Triangle Institute to analyze samples from the Speciation Trends Network (STN). By design, the OC/EC results from this study can be extrapolated to indicate the level of agreement between two national monitoring networks.

For this study, quartz filters and spike solutions were carefully prepared at NAREL and shipped to DRI for analysis. A Met One SASS sampler was used to load several quartz filters with $PM_{2.5}$ captured from the Montgomery air. Nine filters were submitted to DRI for analysis, and replicates of each filter were retained at NAREL for in-house analysis. Three of the nine filters submitted to DRI were actually quartz filter blanks, three filters were replicates of a 96-hour sampling event which began on July 31, and three filters were replicates of a 264-hour sampling event which began on August 20. No information was given to DRI regarding the history of the quartz filters. A routine analysis of each filter was requested.

Three spike solutions were also prepared at NAREL. One solution was blank water, one solution provided a low-level concentration of sucrose, and one solution contained a mid-level concentration of sucrose. No information was given to DRI regarding the composition of the spike solutions. The instructions for spiking and analyzing each solution are repeated here.

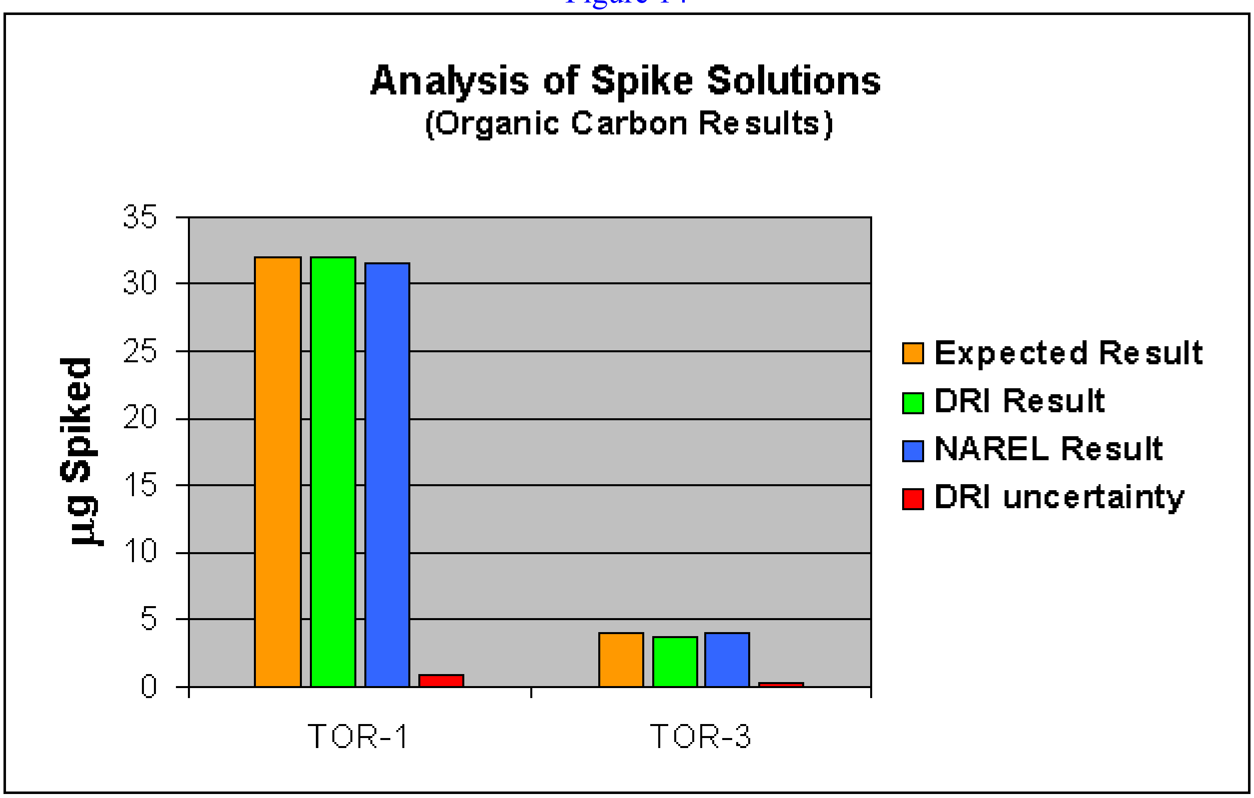
Pre-clean a standard-size punch from a blank quartz filter using the TOR instrument oven program. After the punch has cooled carefully spike 10.0 µL of the PE solution onto the clean quartz punch. Allow the solvent to evaporate from the punch, and then analyze the punch.. This procedure should be similar to the calibration checks using a known concentration of sucrose or KHP.

The final results from DRI were reported as mass of carbon per square centimeter of filter material (µg/cm^2). Once received at NAREL, the results from the loaded filters were converted to mass of carbon per cubic meter of air sampled.

Carbon Results

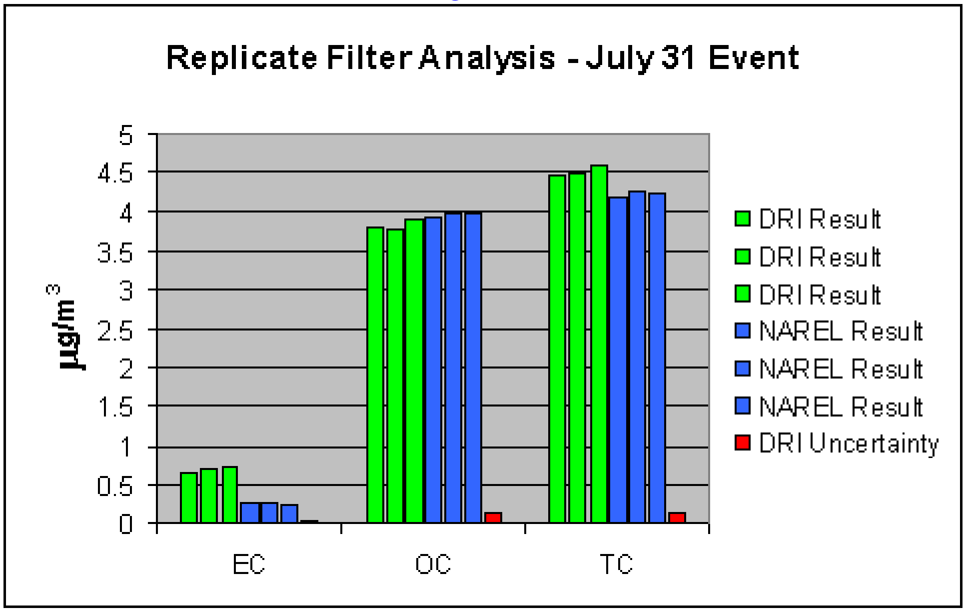
Results for the blind spike solutions are presented as a bar graph in Figure 14. TOR-1 was a mid-level sucrose spike, TOR-3 was a low-level sucrose spike, and TOR-2 (not shown in the graph) was blank water. Figure 14 presents the expected result, the DRI result, the NAREL result, and the uncertainty of measurement reported by DRI for the organic carbon analysis. All results reported for the three spike solutions are presented in Table 9 at the end of this report.

Figure 14



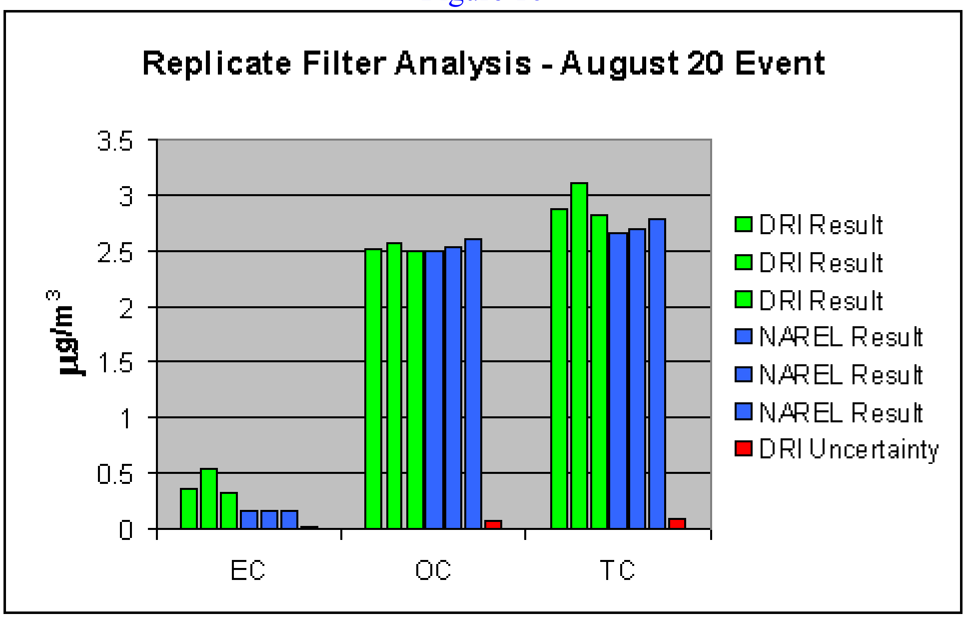
Results for six replicate filters are presented in Figure 15. These filters were loaded with a 96-hour sampling event which began on July 31. Only three of these six quartz filter replicates were submitted to DRI for analysis, and the remaining three replicates were analyzed at NAREL. The results were reported as elemental carbon (EC) and organic carbon (OC) the sum of which was total carbon (TC).

Figure 15



Results for six more replicate filters are presented in Figure 16. These filters were loaded with a 264-hour sampling event which began on August 20. Again only three of these six quartz filter replicates were submitted to DRI for analysis, and the remaining three replicates were analyzed at NAREL.

Figure 16

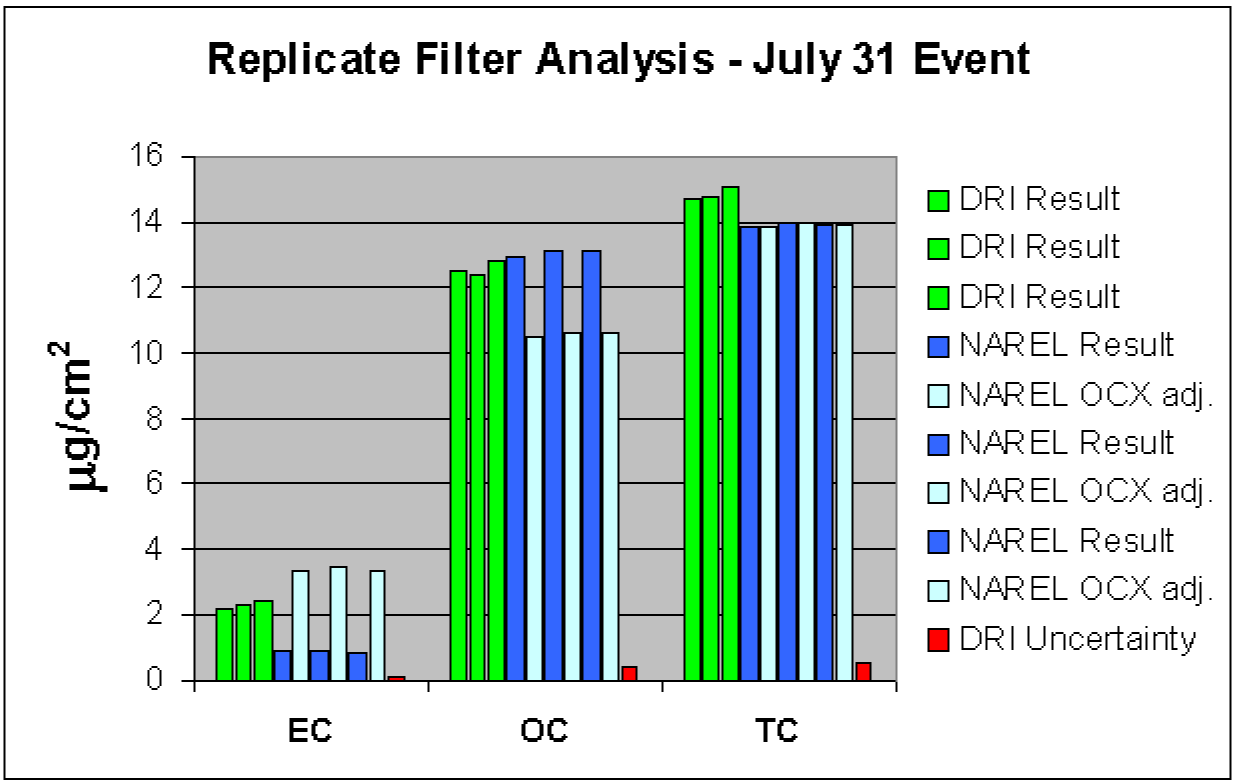


For both sampling events, the uncertainty of measurement expressed by DRI has been converted to units of mass captured per cubic meter of air sampled. All results for the loaded quartz filters are presented in Table 10 and Table 11 at the end of this report. Three blank quartz filters were submitted to DRI for analysis, and the results for blanks are presented in Table 12 at the end of this report.

As stated earlier, the OC/EC analysis performed at NAREL for this study is identical to the OC/EC analysis performed at RTI for STN samples. Although they are similar, the IMPROVE method and the STN method of OC/EC analysis are different, and for many samples there is a significant difference between the results generated by the two methods! Several years ago, a formula was developed to adjust the OC/EC results produced by the STN method so that the adjusted results would more closely agree with the IMPROVE results. That formula required measurement of a unique carbon fraction named OCX. The OCX fraction is that carbon released from the sample as it is heated above 550 °C in a pure helium atmosphere. As shown previously in Table 2 and Figure 9, this OCX fraction would apply only to the STN analysis, and would always be near zero for the IMPROVE analysis. The history and logic supporting the OCX fraction was presented in a report first released July 15, 2000, which examined aerosol data from four cities [1]. The STN carbon analysis may be adjusted by subtracting the OCX value from the OC result and adding the OCX value to the EC result. The net effect is to leave the TC result unchanged while increasing the EC and decreasing the OC. Three years ago when the STN method was implemented at RTI, a new version of OCX was adopted (OCX2) because the original thermal program supporting OCX was modified slightly. RTI reports an OCX2 value along with the other [unadjusted] parameters of OC, EC, CC (carbonate carbon), and TC.

OCX2 values have been calculated for all of the analyses performed at NAREL, and they are listed in Table 13 at the end of this report. Some of the adjusted results are presented in Figure 17 along with the unadjusted results previously shown. It should be noticed that TC results did not change. The inter-laboratory agreement became worse for OC, and are still less than satisfying for the EC.

Figure 17



OCX2 adjustments were also calculated for the August 20 samples, and the adjusted results are presented in Figure 18. Again, the overall inter-laboratory agreement is not better for adjusted results.

Figure 18

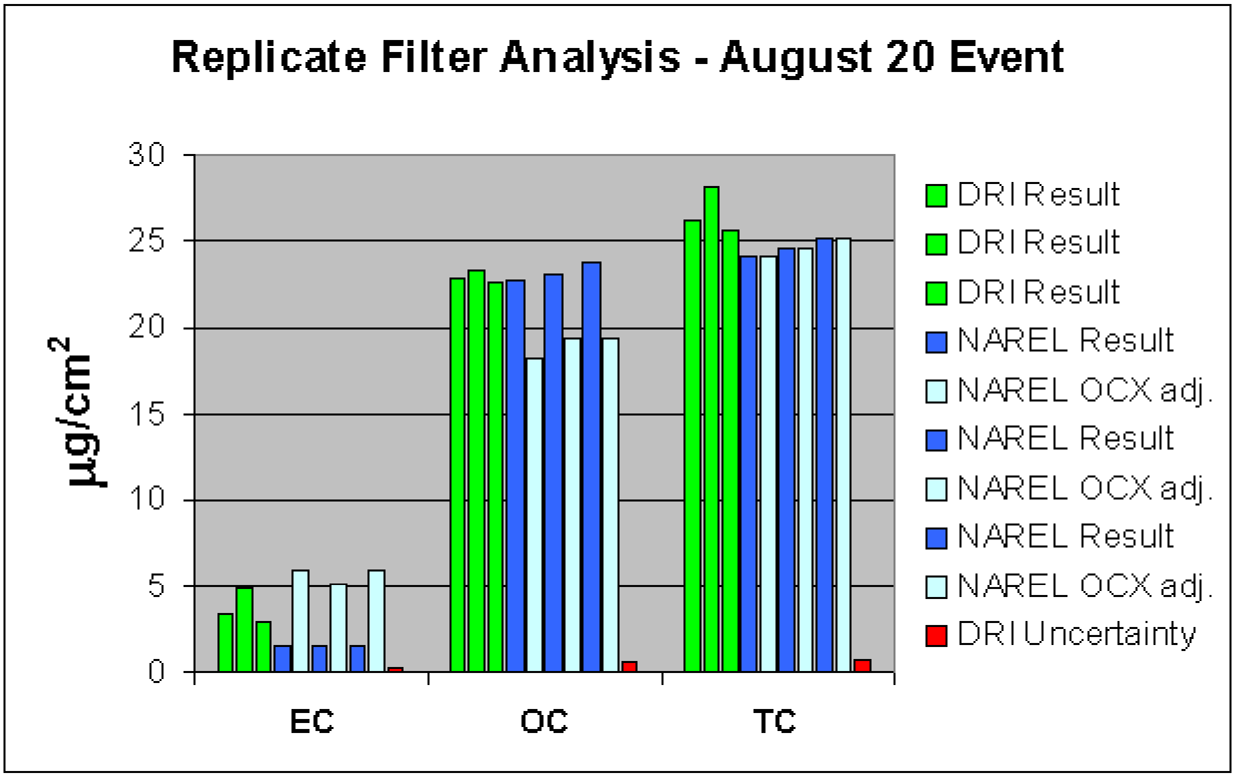


Figure 19 and Figure 20 show OCX2 adjustments made to the low-level and mid-level sucrose spikes. These adjustments are especially noteworthy since the sucrose samples contained no elemental carbon.

Figure 19

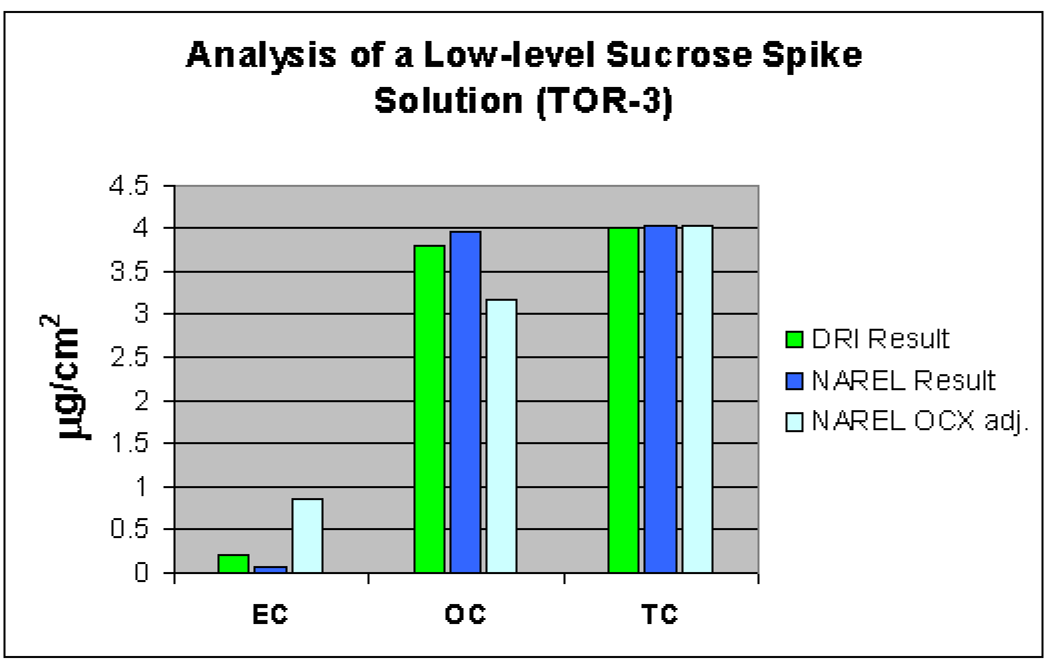
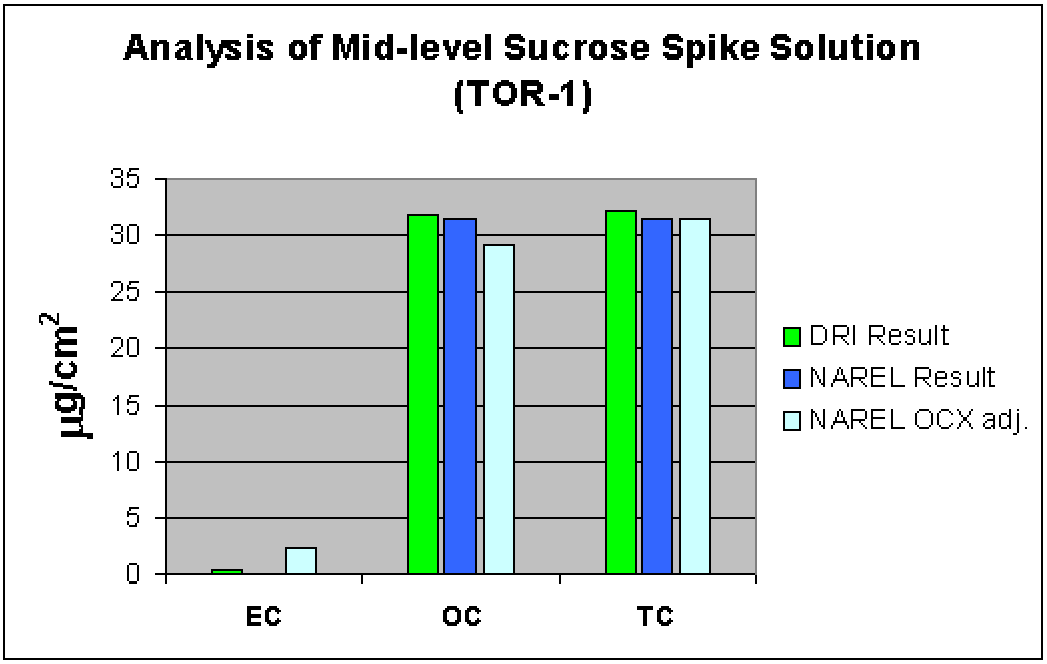


Figure 20



Conclusions

This was NAREL's first occasion to use 25-mm filters for PE samples, and therefore more than the usual number of gravimetric measurements were performed at NAREL to better understand the stability of these filters. Good agreement was observed for all critical mass measurements performed at UC/Davis and at NAREL. Good performance was observed for the metallic weights which provided a wide range of mass measurements. All three field blanks showed $PM_{2.5}$ capture well below the 0.030-mg failure threshold. The largest inter-laboratory difference for captured $PM_{2.5}$ was 0.013 mg which is smaller than a reasonable warning limit of 0.015 mg and significantly below a reasonable failure limit of 0.030 mg. This study indicates good performance by the gravimetric laboratory at UC/Davis.

Excellent recoveries (99-103%) were obtained at RTI and at NAREL for the mid-level IC spikes. Good recoveries (96-115%) were also observed for the low-level spikes. Sample spike solutions identified as A-2 and C-2 were actually blank water. These blanks provided a mechanism to measure laboratory contamination from a variety of sources such as (1) the reagent water used to dilute every sample, (2) the "clean" filter extracted by the test solution which is normally provided to the field for $PM_{2.5}$ capture, and (3) containers used to hold and transfer the sample during the extraction and analysis process. No contamination was reported for the cation blank (C-2), but low levels of chloride (0.22 µg/filter) and sulfate (0.41 µg/filter) were reported for the anion blank (A-2). Both of these levels are above the reported MDL values for chloride and sulfate which may indicate the need for a more conservative estimate of the analytical uncertainty.

Replicate Nylon® filters from two sampling events were available for this study. The longer-than-normal collection periods were necessary to provide a sample with all ions sufficiently above the detection threshold. The results reported by RTI show good agreement with the results produced at NAREL. A difference from the mean value was calculated for each analyte, and this Relative Percent Difference (RPD) is included in Table 6 and Table 7. Except for nitrite, all RPD's were well below 20 percent. At NAREL it is not uncommon to observe a low level of nitrite present in the extract of a “blank” filter. Blank Nylon® filters were also prepared for this study, and Table 8 provides a summary of those results. MDL’s are also included in Table 8 for easy comparison to the ions detected in these blanks. This study indicates good analytical performance by the IC laboratory at RTI.

Good recoveries were obtained at DRI and at NAREL for the mid-level sucrose spike (100% and 98% respectively). Good recoveries (95% and 100% respectively) were also observed for the low-level sucrose spike. The spike solution identified as TOT-2 was actually blank water. This blank spike provided a mechanism to evaluate the measurement baseline at both laboratories. Neither laboratory found carbon present in the blank spike solution above the level of uncertainty.

Replicate quartz filters from two sampling events were available for this study. The longer-than-normal collection periods were used again, this time to boost the amount of EC captured from the relatively clean Montgomery air. It was important for this study to have the EC levels significantly above the detection threshold. The OC results reported by DRI show excellent agreement with the results produced at NAREL. The EC results determined at DRI were consistently higher than the results determined at NAREL, and this was not a surprise. Previous studies within the last five years have shown that the IMPROVE analysis produces larger EC than the STN analysis. A difference from the mean value was calculated for each sample, and this Relative Percent Difference (RPD) is included in Table 10 and Table 11. Except for EC, all RPD’s were below 20 percent. The inter-laboratory agreement for TC was not always as good as expected. TC values reported by DRI were 0-10% above the average value while TC values reported by NAREL were 2-6% below the average value. It is interesting to note that good agreement was observed for TC results derived from the sucrose spikes, yet a bias seems to be present in the TC results derived from the analysis of loaded filters. The travel blanks show no indication that the quartz filters somehow gained carbon during transit to DRI.

It is unclear at this time how to explain the inter-laboratory differences observed in the OC/EC results. It is clear, however, that OCX adjustments previously reported in the literature are not appropriate for this data set.

References

1. EPA-454/R-01-005 *Evaluation of PM2.5 Chemical Speciation Samplers for Use in EPA National PM2.5 Chemical Speciation Network*, U.S. Environmental Protection Agency, May 2001. [Currently available on the web at the following address]

http://www.epa.gov/ttnamti1/files/ambient/pm25/spec/fourcty.pdf

Table 3. Final Gravimetric Data

Filter ID	Tare Mass UC/Davis (mg)	Tare Mass NAREL (mg)	Final Mass UC/Davis (mg)	Final Mass NAREL (mg)	Captured $PM_{2.5}$ UC/Davis (mg)	Captured $PM_{2.5}$ NAREL (mg)	Inter-Lab Difference* of Captured $PM_{2.5}$ (mg)
TF02-10381	41.885	41.887	42.604	42.615	0.719	0.728	0.009
TF02-10382	42.288	42.291	43.027	43.040	0.739	0.749	0.010
TF02-10383	42.534	42.536	43.496	43.511	0.962	0.975	0.013
TF02-10384	41.510	41.512	42.190	42.201	0.680	0.689	0.009
TF02-10385	42.214	42.216	42.678	42.687	0.464	0.471	0.007
TF02-10386	42.164	42.167	42.533	42.541	0.369	0.374	0.005
TF02-10387	41.963	41.965	42.300	42.308	0.337	0.343	0.006
TF02-10388	42.814	42.818	42.814	42.819	0.000	0.001	0.001
TF02-10389	42.607	42.610	42.606	42.611	-0.001	0.001	0.002
TF02-10390	41.536	41.538	41.537	41.538	0.001	0.000	-0.001
MW02-10391	44.143	44.142	44.138	44.141	-0.005	-0.001	0.004
MW02-10392	40.521	40.520	40.519	40.520	-0.002	0.000	0.002
MW02-10393	35.660	35.659	35.658	35.659	-0.002	0.000	0.002

Negative values indicate a smaller capture determined by NAREL.

Table 4. All Reported Gravimetric Data

Sample ID	Sample Status	Date	Mass (mg)	Laboratory	Comments
MW02-10391	Tare	02-Oct-02	44.143	NAREL	
MW02-10391	Tare	12-Nov-02	44.143	NAREL	
MW02-10391	Tare	14-Nov-02	44.143	UC/Davis	mass of record
MW02-10391	Tare	19-Nov-02	44.142	UC/Davis	
MW02-10391	Tare	20-Nov-02	44.142	NAREL	
MW02-10391	Tare	21-Nov-02	44.142	NAREL	
MW02-10391	Tare	21-Nov-02	44.142	NAREL	
MW02-10391	Tare	22-Nov-02	44.142	NAREL	mass of record
MW02-10391	Loaded	03-Dec-02	44.141	NAREL	
MW02-10391	Loaded	04-Dec-02	44.141	NAREL	
MW02-10391	Loaded	05-Dec-02	44.141	NAREL	
MW02-10391	Loaded	06-Dec-02	44.141	NAREL	
MW02-10391	Loaded	09-Dec-02	44.141	NAREL	
MW02-10391	Loaded	10-Dec-02	44.141	NAREL	
MW02-10391	Loaded	12-Dec-02	44.141	NAREL	
MW02-10391	Loaded	12-Dec-02	44.141	NAREL	mass of record
MW02-10391	Loaded	17-Dec-02	44.139	UC/Davis	
MW02-10391	Loaded	18-Dec-02	44.138	UC/Davis	
MW02-10391	Loaded	19-Dec-02	44.138	UC/Davis	mass of record
MW02-10391	Loaded	09-Jan-03	44.140	NAREL	
MW02-10391	Loaded	10-Jan-03	44.140	NAREL	
MW02-10391	Loaded	13-Jan-03	44.140	NAREL	
MW02-10391	Loaded	16-Jan-03	44.140	NAREL	
MW02-10391	Loaded	21-Jan-03	44.140	NAREL	
MW02-10391	Loaded	12-Feb-03	44.140	NAREL	
MW02-10391	Loaded	05-May-03	44.140	NAREL	
MW02-10392	Tare	02-Oct-02	40.521	NAREL	
MW02-10392	Tare	12-Nov-02	40.521	NAREL	
MW02-10392	Tare	14-Nov-02	40.521	UC/Davis	mass of record
MW02-10392	Tare	19-Nov-02	40.521	UC/Davis	
MW02-10392	Tare	20-Nov-02	40.521	NAREL	
MW02-10392	Tare	21-Nov-02	40.521	NAREL	
MW02-10392	Tare	21-Nov-02	40.520	NAREL	
MW02-10392	Tare	22-Nov-02	40.520	NAREL	mass of record
MW02-10392	Loaded	03-Dec-02	40.520	NAREL	
MW02-10392	Loaded	04-Dec-02	40.521	NAREL	
MW02-10392	Loaded	05-Dec-02	40.521	NAREL	
MW02-10392	Loaded	06-Dec-02	40.520	NAREL	
MW02-10392	Loaded	09-Dec-02	40.520	NAREL	

Table 4. All Reported Gravimetric Data

Sample ID	Sample Status	Date	Mass (mg)	Laboratory	Comments
MW02-10392	Loaded	10-Dec-02	40.521	NAREL	
MW02-10392	Loaded	12-Dec-02	40.520	NAREL	
MW02-10392	Loaded	12-Dec-02	40.520	NAREL	mass of record
MW02-10392	Loaded	17-Dec-02	40.519	UC/Davis	
MW02-10392	Loaded	18-Dec-02	40.519	UC/Davis	
MW02-10392	Loaded	19-Dec-02	40.519	UC/Davis	mass of record
MW02-10392	Loaded	09-Jan-03	40.520	NAREL	
MW02-10392	Loaded	10-Jan-03	40.520	NAREL	
MW02-10392	Loaded	13-Jan-03	40.521	NAREL	
MW02-10392	Loaded	16-Jan-03	40.520	NAREL	
MW02-10392	Loaded	21-Jan-03	40.520	NAREL	
MW02-10392	Loaded	12-Feb-03	40.520	NAREL	
MW02-10392	Loaded	05-May-03	40.520	NAREL	
MW02-10393	Tare	02-Oct-02	35.659	NAREL	
MW02-10393	Tare	12-Nov-02	35.660	NAREL	
MW02-10393	Tare	14-Nov-02	35.660	UC/Davis	mass of record
MW02-10393	Tare	19-Nov-02	35.660	UC/Davis	
MW02-10393	Tare	20-Nov-02	35.659	NAREL	
MW02-10393	Tare	21-Nov-02	35.659	NAREL	
MW02-10393	Tare	21-Nov-02	35.659	NAREL	
MW02-10393	Tare	22-Nov-02	35.659	NAREL	mass of record
MW02-10393	Loaded	03-Dec-02	35.659	NAREL	
MW02-10393	Loaded	04-Dec-02	35.659	NAREL	
MW02-10393	Loaded	05-Dec-02	35.659	NAREL	
MW02-10393	Loaded	06-Dec-02	35.659	NAREL	
MW02-10393	Loaded	09-Dec-02	35.659	NAREL	
MW02-10393	Loaded	10-Dec-02	35.659	NAREL	
MW02-10393	Loaded	12-Dec-02	35.659	NAREL	
MW02-10393	Loaded	12-Dec-02	35.659	NAREL	mass of record
MW02-10393	Loaded	17-Dec-02	35.657	UC/Davis	
MW02-10393	Loaded	18-Dec-02	35.658	UC/Davis	
MW02-10393	Loaded	19-Dec-02	35.658	UC/Davis	mass of record
MW02-10393	Loaded	09-Jan-03	35.658	NAREL	
MW02-10393	Loaded	10-Jan-03	35.649	NAREL	lab accident
MW02-10393	Loaded	13-Jan-03	35.649	NAREL	
MW02-10393	Loaded	16-Jan-03	35.649	NAREL	
MW02-10393	Loaded	21-Jan-03	35.649	NAREL	
MW02-10393	Loaded	12-Feb-03	35.648	NAREL	
MW02-10393	Loaded	05-May-03	35.649	NAREL	

Table 4. All Reported Gravimetric Data

Sample ID	Sample Status	Date	Mass (mg)	Laboratory	Comments
TF02-10381	Tare	02-Oct-02	41.888	NAREL	
TF02-10381	Tare	12-Nov-02	41.889	NAREL	
TF02-10381	Tare	14-Nov-02	41.885	UC/Davis	mass of record
TF02-10381	Tare	19-Nov-02	41.885	UC/Davis	
TF02-10381	Tare	20-Nov-02	41.887	NAREL	
TF02-10381	Tare	21-Nov-02	41.887	NAREL	
TF02-10381	Tare	21-Nov-02	41.887	NAREL	
TF02-10381	Tare	22-Nov-02	41.887	NAREL	mass of record
TF02-10381	Loaded	02-Dec-02	42.620	NAREL	
TF02-10381	Loaded	03-Dec-02	42.620	NAREL	
TF02-10381	Loaded	04-Dec-02	42.619	NAREL	
TF02-10381	Loaded	05-Dec-02	42.619	NAREL	
TF02-10381	Loaded	06-Dec-02	42.616	NAREL	
TF02-10381	Loaded	09-Dec-02	42.616	NAREL	
TF02-10381	Loaded	10-Dec-02	42.616	NAREL	
TF02-10381	Loaded	12-Dec-02	42.616	NAREL	
TF02-10381	Loaded	12-Dec-02	42.615	NAREL	mass of record
TF02-10381	Loaded	17-Dec-02	42.607	UC/Davis	
TF02-10381	Loaded	18-Dec-02	42.602	UC/Davis	
TF02-10381	Loaded	19-Dec-02	42.604	UC/Davis	mass of record
TF02-10381	Loaded	09-Jan-03	42.605	NAREL	
TF02-10381	Loaded	10-Jan-03	42.603	NAREL	
TF02-10381	Loaded	13-Jan-03	42.600	NAREL	
TF02-10381	Loaded	16-Jan-03	42.600	NAREL	
TF02-10381	Loaded	21-Jan-03	42.599	NAREL	
TF02-10381	Loaded	12-Feb-03	42.593	NAREL	
TF02-10381	Loaded	05-May-03	42.589	NAREL	
TF02-10382	Tare	02-Oct-02	42.293	NAREL	
TF02-10382	Tare	12-Nov-02	42.294	NAREL	
TF02-10382	Tare	14-Nov-02	42.288	UC/Davis	mass of record
TF02-10382	Tare	19-Nov-02	42.288	UC/Davis	
TF02-10382	Tare	20-Nov-02	42.290	NAREL	
TF02-10382	Tare	21-Nov-02	42.291	NAREL	
TF02-10382	Tare	21-Nov-02	42.292	NAREL	
TF02-10382	Tare	22-Nov-02	42.291	NAREL	mass of record
TF02-10382	Loaded	02-Dec-02	43.046	NAREL	
TF02-10382	Loaded	03-Dec-02	43.045	NAREL	
TF02-10382	Loaded	04-Dec-02	43.043	NAREL	
TF02-10382	Loaded	05-Dec-02	43.044	NAREL	

Table 4. All Reported Gravimetric Data

Sample ID	Sample Status	Date	Mass (mg)	Laboratory	Comments
TF02-10382	Loaded	06-Dec-02	43.041	NAREL	
TF02-10382	Loaded	09-Dec-02	43.040	NAREL	
TF02-10382	Loaded	10-Dec-02	43.040	NAREL	
TF02-10382	Loaded	12-Dec-02	43.039	NAREL	
TF02-10382	Loaded	12-Dec-02	43.040	NAREL	mass of record
TF02-10382	Loaded	17-Dec-02	43.030	UC/Davis	
TF02-10382	Loaded	18-Dec-02	43.027	UC/Davis	
TF02-10382	Loaded	19-Dec-02	43.027	UC/Davis	mass of record
TF02-10382	Loaded	09-Jan-03	43.029	NAREL	
TF02-10382	Loaded	10-Jan-03	43.028	NAREL	
TF02-10382	Loaded	13-Jan-03	43.025	NAREL	
TF02-10382	Loaded	16-Jan-03	43.024	NAREL	
TF02-10382	Loaded	21-Jan-03	43.024	NAREL	
TF02-10382	Loaded	12-Feb-03	43.016	NAREL	
TF02-10382	Loaded	05-May-03	43.012	NAREL	
TF02-10383	Tare	02-Oct-02	42.539	NAREL	
TF02-10383	Tare	12-Nov-02	42.539	NAREL	
TF02-10383	Tare	14-Nov-02	42.534	UC/Davis	mass of record
TF02-10383	Tare	19-Nov-02	42.534	UC/Davis	
TF02-10383	Tare	20-Nov-02	42.537	NAREL	
TF02-10383	Tare	21-Nov-02	42.537	NAREL	
TF02-10383	Tare	21-Nov-02	42.537	NAREL	
TF02-10383	Tare	22-Nov-02	42.536	NAREL	mass of record
TF02-10383	Loaded	02-Dec-02	43.518	NAREL	
TF02-10383	Loaded	03-Dec-02	43.516	NAREL	
TF02-10383	Loaded	04-Dec-02	43.514	NAREL	
TF02-10383	Loaded	05-Dec-02	43.514	NAREL	
TF02-10383	Loaded	06-Dec-02	43.512	NAREL	
TF02-10383	Loaded	09-Dec-02	43.511	NAREL	
TF02-10383	Loaded	10-Dec-02	43.511	NAREL	
TF02-10383	Loaded	12-Dec-02	43.510	NAREL	
TF02-10383	Loaded	12-Dec-02	43.511	NAREL	mass of record
TF02-10383	Loaded	17-Dec-02	43.500	UC/Davis	
TF02-10383	Loaded	18-Dec-02	43.496	UC/Davis	
TF02-10383	Loaded	19-Dec-02	43.496	UC/Davis	mass of record
TF02-10383	Loaded	09-Jan-03	43.498	NAREL	
TF02-10383	Loaded	10-Jan-03	43.496	NAREL	
TF02-10383	Loaded	13-Jan-03	43.492	NAREL	
TF02-10383	Loaded	16-Jan-03	43.491	NAREL	

Table 4. All Reported Gravimetric Data

Sample ID	Sample Status	Date	Mass (mg)	Laboratory	Comments
TF02-10383	Loaded	21-Jan-03	43.492	NAREL	
TF02-10383	Loaded	12-Feb-03	43.485	NAREL	
TF02-10383	Loaded	05-May-03	43.481	NAREL	
TF02-10384	Tare	02-Oct-02	41.515	NAREL	
TF02-10384	Tare	12-Nov-02	41.514	NAREL	
TF02-10384	Tare	14-Nov-02	41.510	UC/Davis	mass of record
TF02-10384	Tare	19-Nov-02	41.510	UC/Davis	
TF02-10384	Tare	20-Nov-02	41.513	NAREL	
TF02-10384	Tare	21-Nov-02	41.512	NAREL	
TF02-10384	Tare	21-Nov-02	41.513	NAREL	
TF02-10384	Tare	22-Nov-02	41.512	NAREL	mass of record
TF02-10384	Loaded	02-Dec-02	42.216	NAREL	
TF02-10384	Loaded	03-Dec-02	42.212	NAREL	
TF02-10384	Loaded	04-Dec-02	42.208	NAREL	
TF02-10384	Loaded	05-Dec-02	42.207	NAREL	
TF02-10384	Loaded	06-Dec-02	42.204	NAREL	
TF02-10384	Loaded	09-Dec-02	42.201	NAREL	
TF02-10384	Loaded	10-Dec-02	42.202	NAREL	
TF02-10384	Loaded	12-Dec-02	42.200	NAREL	
TF02-10384	Loaded	12-Dec-02	42.201	NAREL	mass of record
TF02-10384	Loaded	17-Dec-02	42.193	UC/Davis	
TF02-10384	Loaded	18-Dec-02	42.189	UC/Davis	
TF02-10384	Loaded	19-Dec-02	42.190	UC/Davis	mass of record
TF02-10384	Loaded	09-Jan-03	42.192	NAREL	
TF02-10384	Loaded	10-Jan-03	42.191	NAREL	
TF02-10384	Loaded	13-Jan-03	42.186	NAREL	
TF02-10384	Loaded	16-Jan-03	42.185	NAREL	
TF02-10384	Loaded	21-Jan-03	42.184	NAREL	
TF02-10384	Loaded	12-Feb-03	42.174	NAREL	
TF02-10384	Loaded	05-May-03	42.171	NAREL	
TF02-10385	Tare	02-Oct-02	42.220	NAREL	
TF02-10385	Tare	12-Nov-02	42.220	NAREL	
TF02-10385	Tare	14-Nov-02	42.214	UC/Davis	mass of record
TF02-10385	Tare	19-Nov-02	42.214	UC/Davis	
TF02-10385	Tare	20-Nov-02	42.217	NAREL	
TF02-10385	Tare	21-Nov-02	42.217	NAREL	
TF02-10385	Tare	21-Nov-02	42.217	NAREL	
TF02-10385	Tare	22-Nov-02	42.216	NAREL	mass of record
TF02-10385	Loaded	02-Dec-02	42.691	NAREL	

Table 4. All Reported Gravimetric Data

Sample ID	Sample Status	Date	Mass (mg)	Laboratory	Comments
TF02-10385	Loaded	03-Dec-02	42.691	NAREL	
TF02-10385	Loaded	04-Dec-02	42.690	NAREL	
TF02-10385	Loaded	05-Dec-02	42.690	NAREL	
TF02-10385	Loaded	06-Dec-02	42.688	NAREL	
TF02-10385	Loaded	09-Dec-02	42.687	NAREL	
TF02-10385	Loaded	10-Dec-02	42.687	NAREL	
TF02-10385	Loaded	12-Dec-02	42.686	NAREL	
TF02-10385	Loaded	12-Dec-02	42.687	NAREL	mass of record
TF02-10385	Loaded	17-Dec-02	42.679	UC/Davis	
TF02-10385	Loaded	18-Dec-02	42.677	UC/Davis	
TF02-10385	Loaded	19-Dec-02	42.678	UC/Davis	mass of record
TF02-10385	Loaded	09-Jan-03	42.680	NAREL	
TF02-10385	Loaded	10-Jan-03	42.679	NAREL	
TF02-10385	Loaded	13-Jan-03	42.676	NAREL	
TF02-10385	Loaded	16-Jan-03	42.676	NAREL	
TF02-10385	Loaded	21-Jan-03	42.675	NAREL	
TF02-10385	Loaded	12-Feb-03	42.669	NAREL	
TF02-10385	Loaded	05-May-03	42.666	NAREL	
TF02-10386	Tare	02-Oct-02	42.171	NAREL	
TF02-10386	Tare	12-Nov-02	42.171	NAREL	
TF02-10386	Tare	14-Nov-02	42.164	UC/Davis	mass of record
TF02-10386	Tare	19-Nov-02	42.165	UC/Davis	
TF02-10386	Tare	20-Nov-02	42.168	NAREL	
TF02-10386	Tare	21-Nov-02	42.169	NAREL	
TF02-10386	Tare	21-Nov-02	42.168	NAREL	
TF02-10386	Tare	22-Nov-02	42.167	NAREL	mass of record
TF02-10386	Loaded	02-Dec-02	42.549	NAREL	
TF02-10386	Loaded	03-Dec-02	42.547	NAREL	
TF02-10386	Loaded	04-Dec-02	42.545	NAREL	
TF02-10386	Loaded	05-Dec-02	42.545	NAREL	
TF02-10386	Loaded	06-Dec-02	42.543	NAREL	
TF02-10386	Loaded	09-Dec-02	42.541	NAREL	
TF02-10386	Loaded	10-Dec-02	42.541	NAREL	
TF02-10386	Loaded	12-Dec-02	42.541	NAREL	
TF02-10386	Loaded	12-Dec-02	42.541	NAREL	mass of record
TF02-10386	Loaded	17-Dec-02	42.535	UC/Davis	
TF02-10386	Loaded	18-Dec-02	42.533	UC/Davis	
TF02-10386	Loaded	19-Dec-02	42.533	UC/Davis	mass of record
TF02-10386	Loaded	09-Jan-03	42.535	NAREL	

Table 4. All Reported Gravimetric Data

Sample ID	Sample Status	Date	Mass (mg)	Laboratory	Comments
TF02-10386	Loaded	10-Jan-03	42.534	NAREL	
TF02-10386	Loaded	13-Jan-03	42.531	NAREL	
TF02-10386	Loaded	16-Jan-03	42.531	NAREL	
TF02-10386	Loaded	21-Jan-03	42.530	NAREL	
TF02-10386	Loaded	12-Feb-03	42.523	NAREL	
TF02-10386	Loaded	05-May-03	42.521	NAREL	
TF02-10387	Tare	02-Oct-02	41.969	NAREL	
TF02-10387	Tare	12-Nov-02	41.968	NAREL	
TF02-10387	Tare	14-Nov-02	41.963	UC/Davis	mass of record
TF02-10387	Tare	19-Nov-02	41.963	UC/Davis	
TF02-10387	Tare	20-Nov-02	41.966	NAREL	
TF02-10387	Tare	21-Nov-02	41.966	NAREL	
TF02-10387	Tare	21-Nov-02	41.966	NAREL	
TF02-10387	Tare	22-Nov-02	41.965	NAREL	mass of record
TF02-10387	Loaded	02-Dec-02	42.316	NAREL	
TF02-10387	Loaded	03-Dec-02	42.314	NAREL	
TF02-10387	Loaded	04-Dec-02	42.313	NAREL	
TF02-10387	Loaded	05-Dec-02	42.311	NAREL	
TF02-10387	Loaded	06-Dec-02	42.310	NAREL	
TF02-10387	Loaded	09-Dec-02	42.308	NAREL	
TF02-10387	Loaded	10-Dec-02	42.309	NAREL	
TF02-10387	Loaded	12-Dec-02	42.308	NAREL	
TF02-10387	Loaded	12-Dec-02	42.308	NAREL	mass of record
TF02-10387	Loaded	17-Dec-02	42.303	UC/Davis	
TF02-10387	Loaded	18-Dec-02	42.301	UC/Davis	
TF02-10387	Loaded	19-Dec-02	42.300	UC/Davis	mass of record
TF02-10387	Loaded	09-Jan-03	42.303	NAREL	
TF02-10387	Loaded	10-Jan-03	42.301	NAREL	
TF02-10387	Loaded	13-Jan-03	42.299	NAREL	
TF02-10387	Loaded	16-Jan-03	42.298	NAREL	
TF02-10387	Loaded	21-Jan-03	42.298	NAREL	
TF02-10387	Loaded	12-Feb-03	42.292	NAREL	
TF02-10387	Loaded	05-May-03	42.289	NAREL	
TF02-10388	Tare	02-Oct-02	42.820	NAREL	
TF02-10388	Tare	12-Nov-02	42.820	NAREL	
TF02-10388	Tare	14-Nov-02	42.814	UC/Davis	mass of record
TF02-10388	Tare	19-Nov-02	42.814	UC/Davis	
TF02-10388	Tare	20-Nov-02	42.819	NAREL	
TF02-10388	Tare	21-Nov-02	42.819	NAREL	

Table 4. All Reported Gravimetric Data

Sample ID	Sample Status	Date	Mass (mg)	Laboratory	Comments
TF02-10388	Tare	21-Nov-02	42.818	NAREL	
TF02-10388	Tare	22-Nov-02	42.818	NAREL	mass of record
TF02-10388	Loaded	02-Dec-02	42.818	NAREL	
TF02-10388	Loaded	03-Dec-02	42.818	NAREL	
TF02-10388	Loaded	04-Dec-02	42.818	NAREL	
TF02-10388	Loaded	05-Dec-02	42.819	NAREL	
TF02-10388	Loaded	06-Dec-02	42.818	NAREL	
TF02-10388	Loaded	09-Dec-02	42.818	NAREL	
TF02-10388	Loaded	10-Dec-02	42.818	NAREL	
TF02-10388	Loaded	12-Dec-02	42.818	NAREL	
TF02-10388	Loaded	12-Dec-02	42.819	NAREL	mass of record
TF02-10388	Loaded	17-Dec-02	42.816	UC/Davis	
TF02-10388	Loaded	18-Dec-02	42.814	UC/Davis	
TF02-10388	Loaded	19-Dec-02	42.814	UC/Davis	mass of record
TF02-10388	Loaded	09-Jan-03	42.819	NAREL	
TF02-10388	Loaded	10-Jan-03	42.818	NAREL	
TF02-10388	Loaded	13-Jan-03	42.818	NAREL	
TF02-10388	Loaded	16-Jan-03	42.819	NAREL	
TF02-10388	Loaded	21-Jan-03	42.819	NAREL	
TF02-10388	Loaded	12-Feb-03	42.818	NAREL	
TF02-10388	Loaded	05-May-03	42.821	NAREL	
TF02-10389	Tare	02-Oct-02	42.611	NAREL	
TF02-10389	Tare	12-Nov-02	42.612	NAREL	
TF02-10389	Tare	14-Nov-02	42.607	UC/Davis	mass of record
TF02-10389	Tare	19-Nov-02	42.606	UC/Davis	
TF02-10389	Tare	20-Nov-02	42.611	NAREL	
TF02-10389	Tare	21-Nov-02	42.611	NAREL	
TF02-10389	Tare	21-Nov-02	42.610	NAREL	
TF02-10389	Tare	22-Nov-02	42.610	NAREL	mass of record
TF02-10389	Loaded	02-Dec-02	42.610	NAREL	
TF02-10389	Loaded	03-Dec-02	42.610	NAREL	
TF02-10389	Loaded	04-Dec-02	42.610	NAREL	
TF02-10389	Loaded	05-Dec-02	42.611	NAREL	
TF02-10389	Loaded	06-Dec-02	42.610	NAREL	
TF02-10389	Loaded	09-Dec-02	42.610	NAREL	
TF02-10389	Loaded	10-Dec-02	42.611	NAREL	
TF02-10389	Loaded	12-Dec-02	42.611	NAREL	
TF02-10389	Loaded	12-Dec-02	42.611	NAREL	mass of record
TF02-10389	Loaded	17-Dec-02	42.608	UC/Davis	

Table 4. All Reported Gravimetric Data

Sample ID	Sample Status	Date	Mass (mg)	Laboratory	Comments
TF02-10389	Loaded	18-Dec-02	42.607	UC/Davis	
TF02-10389	Loaded	19-Dec-02	42.606	UC/Davis	mass of record
TF02-10389	Loaded	09-Jan-03	42.612	NAREL	
TF02-10389	Loaded	10-Jan-03	42.611	NAREL	
TF02-10389	Loaded	13-Jan-03	42.611	NAREL	
TF02-10389	Loaded	16-Jan-03	42.611	NAREL	
TF02-10389	Loaded	21-Jan-03	42.611	NAREL	
TF02-10389	Loaded	12-Feb-03	42.611	NAREL	
TF02-10389	Loaded	05-May-03	42.613	NAREL	
TF02-10390	Tare	02-Oct-02	41.538	NAREL	
TF02-10390	Tare	12-Nov-02	41.539	NAREL	
TF02-10390	Tare	14-Nov-02	41.536	UC/Davis	mass of record
TF02-10390	Tare	19-Nov-02	41.536	UC/Davis	
TF02-10390	Tare	20-Nov-02	41.538	NAREL	
TF02-10390	Tare	21-Nov-02	41.539	NAREL	
TF02-10390	Tare	21-Nov-02	41.539	NAREL	
TF02-10390	Tare	22-Nov-02	41.538	NAREL	mass of record
TF02-10390	Loaded	02-Dec-02	41.539	NAREL	
TF02-10390	Loaded	03-Dec-02	41.538	NAREL	
TF02-10390	Loaded	04-Dec-02	41.538	NAREL	
TF02-10390	Loaded	05-Dec-02	41.539	NAREL	
TF02-10390	Loaded	06-Dec-02	41.538	NAREL	
TF02-10390	Loaded	09-Dec-02	41.538	NAREL	
TF02-10390	Loaded	10-Dec-02	41.539	NAREL	
TF02-10390	Loaded	12-Dec-02	41.538	NAREL	
TF02-10390	Loaded	12-Dec-02	41.538	NAREL	mass of record
TF02-10390	Loaded	17-Dec-02	41.536	UC/Davis	
TF02-10390	Loaded	18-Dec-02	41.536	UC/Davis	
TF02-10390	Loaded	19-Dec-02	41.537	UC/Davis	mass of record
TF02-10390	Loaded	09-Jan-03	41.540	NAREL	
TF02-10390	Loaded	10-Jan-03	41.539	NAREL	
TF02-10390	Loaded	13-Jan-03	41.539	NAREL	
TF02-10390	Loaded	16-Jan-03	41.539	NAREL	
TF02-10390	Loaded	21-Jan-03	41.539	NAREL	
TF02-10390	Loaded	12-Feb-03	41.539	NAREL	
TF02-10390	Loaded	05-May-03	41.541	NAREL	

Table 5. IC Spike Solutions

Sample ID	Analyte	Expected Result (µg/Filter)	RTI Result (µg/Filter)	NAREL Result (µg/Filter)	RTI Recovery	NAREL Recovery	RTI MDL* (µg/Filter)
A-1	Chloride	4.00	4.13	3.93	103%	98%	0.04
A-1	Nitrite	36.00	36.34	35.78	101%	99%	0.02
A-1	Nitrate	70.00	70.19	69.87	100%	100%	0.02
A-1	Sulfate	4.00	4.43	3.93	111%	98%	0.03
A-2	Chloride	0.00	0.22	not detected	-----	-----	0.04
A-2	Nitrite	0.00	0.00	not detected	-----	-----	0.02
A-2	Nitrate	0.00	0.00	not detected	-----	-----	0.02
A-2	Sulfate	0.00	0.41	not detected	-----	-----	0.03
A-3	Chloride	50.00	50.99	50.31	102%	101%	0.04
A-3	Nitrite	4.00	4.26	4.01	106%	100%	0.02
A-3	Nitrate	3.00	3.08	3.11	103%	104%	0.02
A-3	Sulfate	110.00	112.09	110.69	102%	101%	0.03
C-1	Ammonium	5.60	5.35	6.44	96%	115%	0.05
C-2	Ammonium	0.00	0.00	not detected	-----	-----	0.05
C-3	Ammonium	56.00	57.48	56.74	103%	101%	0.05

Method Detection Limit

Table 6. Nylon Filter Replicates - May 21 Event

Analyte	Sample ID	RTI Result (µg/Filter)	NAREL Result (µg/Filter)	Air Volume (m^3)	Air Conc. (µg/m^3)	RTI MDL* (µg/m^3)	Air Conc. RPD**
Chloride	N02-10252	2.318	-----	20.594	0.113	0.002	8%
	N02-10253	2.213	-----	20.577	0.108	-----	3%
	N02-10254	-----	2.086	20.603	0.101	-----	-4%
	N02-10255	-----	1.920	19.059	0.101	-----	-4%
	N02-10256	-----	1.961	19.202	0.102	-----	-3%
Nitrite	N02-10252	1.326	-----	20.594	0.064	0.001	5%
	N02-10253	1.275	-----	20.577	0.062	-----	1%
	N02-10254	-----	1.112	20.603	0.054	-----	-12%
	N02-10255	-----	0.975	19.059	0.051	-----	-17%
	N02-10256	-----	1.463	19.202	0.076	-----	24%
Nitrate	N02-10252	6.497	-----	20.594	0.315	0.001	-11%
	N02-10253	6.629	-----	20.577	0.322	-----	-9%
	N02-10254	-----	7.687	20.603	0.373	-----	5%
	N02-10255	-----	7.293	19.059	0.383	-----	8%
	N02-10256	-----	7.214	19.202	0.376	-----	6%
Sulfate	N02-10252	126.073	-----	20.594	6.122	0.001	1%
	N02-10253	124.695	-----	20.577	6.060	-----	0%
	N02-10254	-----	125.058	20.603	6.070	-----	0%
	N02-10255	-----	113.680	19.059	5.965	-----	-1%
	N02-10256	-----	115.472	19.202	6.014	-----	-1%
Ammonium	N02-10252	44.413	-----	20.594	2.157	0.002	2%
	N02-10253	43.372	-----	20.577	2.108	-----	-1%
	N02-10254	-----	44.028	20.603	2.137	-----	1%
	N02-10255	-----	39.908	19.059	2.094	-----	-1%
	N02-10256	-----	40.597	19.202	2.114	-----	0%

MDL = Method Detection Limit

*****RPD = Relative Percent Difference = (result-average result)/average result***

Table 7. Nylon Filter Replicates - May 28 Event

Analyte	Sample ID	RTI Result (µg/Filter)	NAREL Result (µg/Filter)	Air Volume (m^3)	Air Conc. (µg/m^3)	RTI MDL* (µg/m^3)	Air Conc. RPD**
Chloride	N02-10262	2.650	-----	38.707	0.068	0.001	5%
	N02-10263	2.660	-----	38.765	0.069	-----	5%
	N02-10264	-----	2.403	38.707	0.062	-----	-5%
	N02-10265	-----	2.347	36.518	0.064	-----	-1%
	N02-10266	-----	2.235	36.058	0.062	-----	-5%
Nitrite	N02-10262	0.836	-----	38.707	0.022	0.001	5%
	N02-10263	0.890	-----	38.765	0.023	-----	12%
	N02-10264	-----	0.988	38.707	0.026	-----	25%
	N02-10265	-----	0.539	36.518	0.015	-----	-28%
	N02-10266	-----	0.635	36.058	0.018	-----	-14%
Nitrate	N02-10262	15.793	-----	38.707	0.408	0.001	-5%
	N02-10263	15.781	-----	38.765	0.407	-----	-6%
	N02-10264	-----	17.024	38.707	0.440	-----	2%
	N02-10265	-----	16.529	36.518	0.453	-----	5%
	N02-10266	-----	16.230	36.058	0.450	-----	4%
Sulfate	N02-10262	68.309	-----	38.707	1.765	0.001	1%
	N02-10263	68.363	-----	38.765	1.764	-----	1%
	N02-10264	-----	67.298	38.707	1.739	-----	0%
	N02-10265	-----	62.976	36.518	1.725	-----	-1%
	N02-10266	-----	62.916	36.058	1.745	-----	0%
Ammonium	N02-10262	19.497	-----	38.707	0.504	0.001	-4%
	N02-10263	19.525	-----	38.765	0.504	-----	-4%
	N02-10264	-----	19.808	38.707	0.512	-----	-2%
	N02-10265	-----	20.169	36.518	0.552	-----	6%
	N02-10266	-----	19.518	36.058	0.541	-----	4%

MDL = Method Detection Limit

*****RPD = Relative Percent Difference = (result-average result)/average result***

Table 8. Blank Nylon Filters

Analyte	Sample ID	RTI Result (µg/Filter)	NAREL Result (µg/Filter)	RTI MDL* (µg/Filter)
Chloride	N02-10368	0.194	-----	0.04
	N02-10369	0.219	-----	-----
	N02-10370	-----	not detected	-----
	N02-10371	-----	not detected	-----
Nitrite	N02-10368	0.987	-----	0.02
	N02-10369	1.023	-----	-----
	N02-10370	-----	0.672	-----
	N02-10371	-----	0.727	-----
Nitrate	N02-10368	0.440	-----	0.02
	N02-10369	0.447	-----	-----
	N02-10370	-----	not detected	-----
	N02-10371	-----	not detected	-----
Sulfate	N02-10368	0.000	-----	0.03
	N02-10369	0.459	-----	-----
	N02-10370	-----	not detected	-----
	N02-10371	-----	not detected	-----
Ammonium	N02-10368	0.000	-----	0.05
	N02-10369	0.000	-----	-----
	N02-10370	-----	not detected	-----
	N02-10371	-----	not detected	-----

MDL = Method Detection Limit

Table 9. Carbon (Sucrose) Spike Solutions

Sample ID	Analyte	Expected Result (μg spiked)	DRI Result (μg spiked)	NAREL Result (μg spiked)	DRI Recovery	NAREL Recovery	DRI Uncertainty (μg spiked)
TOR-1	EC	0.0	0.3	0.0	-----	-----	0.1
TOR-1	OC	32.0	31.9	31.5	100%	98%	0.9
TOR-1	TC	32.0	32.2	31.5	101%	98%	0.9
TOR-2	EC	0.0	0.0	0.0	-----	-----	0.1
TOR-2	OC	0.0	0.1	0.3	-----	-----	0.3
TOR-2	TC	0.0	0.1	0.3	-----	-----	0.3
TOR-3	EC	0.0	0.2	0.1	-----	-----	0.1
TOR-3	OC	4.0	3.8	4.0	95%	99%	0.3
TOR-3	TC	4.0	4.0	4.0	100%	100%	0.3

Table 10. Quartz Filter Replicates - July 31 Event

Analyte	Sample ID	DRI Result (µg/cm²)	NAREL Result (µg/cm²)	Air Volume (m³)	Air Conc. (µg/m³)	DRI Uncer.* (µg/m³)	Air Conc. RPD**
EC	Q02-10402	2.2	-----	38.71	0.668	0.03	77%
	Q02-10403	2.3	-----	38.76	0.698	0.03	89%
	Q02-10404	2.4	-----	38.71	0.729	0.03	102%
	Q02-10405	-----	0.9	38.76	0.276	-----	-84%
	Q02-10406	-----	0.9	38.71	0.273	-----	-85%
	Q02-10407	-----	0.8	38.71	0.244	-----	-97%
OC	Q02-10402	12.5	-----	38.71	3.797	0.12	-2%
	Q02-10403	12.4	-----	38.76	3.762	0.12	-3%
	Q02-10404	12.8	-----	38.71	3.889	0.12	0%
	Q02-10405	-----	12.9	38.76	3.917	-----	1%
	Q02-10406	-----	13.1	38.71	3.983	-----	2%
	Q02-10407	-----	13.1	38.71	3.991	-----	3%
TC	Q02-10402	14.7	-----	38.71	4.466	0.15	2%
	Q02-10403	14.8	-----	38.76	4.490	0.15	3%
	Q02-10404	15.1	-----	38.71	4.587	0.15	5%
	Q02-10405	-----	13.8	38.76	4.197	-----	-4%
	Q02-10406	-----	14.0	38.71	4.256	-----	-3%
	Q02-10407	-----	13.9	38.71	4.235	-----	-3%

Uncer. = Uncertainty
*****RPD = Relative Percent Difference = (result-average result)/average result***

Table 11. Quartz Filter Replicates - August 30 Event

Analyte	Sample ID	DRI Result (µg/cm^2)	NAREL Result (µg/cm^2)	Air Volume (m^3)	Air Conc. (µg/m^3)	DRI Uncer.* (µg/m^3)	Air Conc. RPD**
EC	Q02-10434	3.4	-----	106.69	0.375	0.02	29%
	Q02-10435	4.9	-----	106.68	0.540	0.02	86%
	Q02-10436	3.0	-----	106.67	0.331	0.02	14%
	Q02-10431	-----	1.5	106.73	0.166	-----	-43%
	Q02-10432	-----	1.5	106.69	0.169	-----	-42%
	Q02-10433	-----	1.5	106.68	0.166	-----	-43%
OC	Q02-10434	22.8	-----	106.69	2.513	0.08	-1%
	Q02-10435	23.3	-----	106.68	2.569	0.08	1%
	Q02-10436	22.6	-----	106.67	2.492	0.08	-2%
	Q02-10431	-----	22.6	106.73	2.494	-----	-2%
	Q02-10432	-----	23.0	106.69	2.532	-----	0%
	Q02-10433	-----	23.7	106.68	2.618	-----	3%
TC	Q02-10434	26.2	-----	106.69	2.888	0.09	2%
	Q02-10435	28.2	-----	106.68	3.109	0.09	10%
	Q02-10436	25.6	-----	106.67	2.822	0.09	0%
	Q02-10431	-----	24.1	106.73	2.660	-----	-6%
	Q02-10432	-----	24.5	106.69	2.701	-----	-4%
	Q02-10433	-----	25.3	106.68	2.784	-----	-2%

Uncer. = Uncertainty
****RPD = Relative Percent Difference = (result-average result)/average result***

Table 12. Blank Quartz Filters

Analyte	Sample ID	DRI Result ($\mu g/cm^2$)	NAREL Result ($\mu g/cm^2$)	DRI Uncertainty ($\mu g/cm^2$)
EC	Q02-10410	0.0	-----	0.1
	Q02-10411	0.0	-----	0.1
	Q02-10412	0.0	-----	0.1
	Q02-10413	-----	0.0	-----
	Q02-10414	-----	0.0	-----
	Q02-10415	-----	0.0	-----
OC	Q02-10410	0.2	-----	0.3
	Q02-10411	0.1	-----	0.3
	Q02-10412	0.2	-----	0.3
	Q02-10413	-----	0.1	-----
	Q02-10414	-----	0.3	-----
	Q02-10415	-----	0.2	-----
TC	Q02-10410	0.2	-----	0.3
	Q02-10411	0.1	-----	0.3
	Q02-10412	0.2	-----	0.3
	Q02-10413	-----	0.1	-----
	Q02-10414	-----	0.3	-----
	Q02-10415	-----	0.2	-----

Table 13. OCX2 Adjusted Results

Sample Description	Sample ID	Analyte	DRI Result (µg/cm^2)	NAREL Result (µg/cm^2)	OCX2 (µg/cm^2)	Adjusted NAREL Result (µg/cm^2)
July 31 Event	Q02-10402	EC	2.2	-----	-----	-----
July 31 Event	Q02-10403	EC	2.3	-----	-----	-----
July 31 Event	Q02-10404	EC	2.4	-----	-----	-----
July 31 Event	Q02-10405	EC	-----	0.9	2.4	3.3
July 31 Event	Q02-10406	EC	-----	0.9	2.5	3.4
July 31 Event	Q02-10407	EC	-----	0.8	2.5	3.3
July 31 Event	Q02-10402	OC	12.5	-----	-----	-----
July 31 Event	Q02-10403	OC	12.4	-----	-----	-----
July 31 Event	Q02-10404	OC	12.8	-----	-----	-----
July 31 Event	Q02-10405	OC	-----	12.9	2.4	10.5
July 31 Event	Q02-10406	OC	-----	13.1	2.5	10.6
July 31 Event	Q02-10407	OC	-----	13.1	2.5	10.6
July 31 Event	Q02-10402	TC	14.7	-----	-----	-----
July 31 Event	Q02-10403	TC	14.8	-----	-----	-----
July 31 Event	Q02-10404	TC	15.1	-----	-----	-----
July 31 Event	Q02-10405	TC	-----	13.8	-----	-----
July 31 Event	Q02-10406	TC	-----	14.0	-----	-----
July 31 Event	Q02-10407	TC	-----	13.9	-----	-----
August 20 Event	Q02-10434	EC	3.4	-----	-----	-----
August 20 Event	Q02-10435	EC	4.9	-----	-----	-----
August 20 Event	Q02-10436	EC	3.0	-----	-----	-----
August 20 Event	Q02-10431	EC	-----	1.5	4.4	5.9
August 20 Event	Q02-10432	EC	-----	1.5	3.6	5.1
August 20 Event	Q02-10433	EC	-----	1.5	4.3	5.8
August 20 Event	Q02-10434	OC	22.8	-----	-----	-----
August 20 Event	Q02-10435	OC	23.3	-----	-----	-----
August 20 Event	Q02-10436	OC	22.6	-----	-----	-----

Table 13. OCX2 Adjusted Results

Sample Description	Sample ID	Analyte	DRI Result ($\mu g/cm^2$)	NAREL Result ($\mu g/cm^2$)	OCX2 ($\mu g/cm^2$)	Adjusted NAREL Result ($\mu g/cm^2$)
August 20 Event	Q02-10431	OC	-----	22.6	4.4	18.3
August 20 Event	Q02-10432	OC	-----	23.0	3.6	19.4
August 20 Event	Q02-10433	OC	-----	23.7	4.3	19.4
August 20 Event	Q02-10434	TC	26.2	-----	-----	-----
August 20 Event	Q02-10435	TC	28.2	-----	-----	-----
August 20 Event	Q02-10436	TC	25.6	-----	-----	-----
August 20 Event	Q02-10431	TC	-----	24.1	-----	-----
August 20 Event	Q02-10432	TC	-----	24.5	-----	-----
August 20 Event	Q02-10433	TC	-----	25.3	-----	-----
Sucrose Spike	TOR-1	EC	0.3	0.0	2.3	2.3
Sucrose Spike	TOR-1	OC	31.9	31.5	2.3	29.2
Sucrose Spike	TOR-1	TC	32.2	31.5	-----	-----
Sucrose Spike	TOR-2	EC	0.0	0.0	0.1	0.1
Sucrose Spike	TOR-2	OC	0.1	0.3	0.1	0.3
Sucrose Spike	TOR-2	TC	0.1	0.3	-----	-----
Sucrose Spike	TOR-3	EC	0.2	0.1	0.8	0.8
Sucrose Spike	TOR-3	OC	3.8	4.0	0.8	3.2
Sucrose Spike	TOR-3	TC	4.0	4.0	-----	-----