TECHNICAL MEMORANDUM

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SUBJECT: Experimental Inter-comparison of Speciation Laboratories

Introduction

This study was conducted as part of the EPA's quality assurance oversight for the $PM_{2.5}$ chemical speciation air monitoring networks that include the Speciation Trends Network (STN) and the Interagency Monitoring of Protected Visual Environments (IMPROVE) program. The purpose of this study was to evaluate specific laboratory performance at those laboratories that routinely analyze $PM_{2.5}$ chemical speciation samples.

This study required each participating laboratory to analyze a set of blind Performance Evaluation (PE) filter samples. The PE samples were prepared at the National Air and Radiation Environmental Laboratory (NAREL) located in Montgomery, AL. NAREL was able to create replicate filter samples for this study by using co-located Met One speciation samplers. The co-located samplers were programmed to collect $PM_{2.5}$ from the Montgomery air and simultaneously load several filters during each collection event. A sufficient number of replicates were prepared so that each laboratory could receive the following set of PE samples.

- Gravimetric Mass Analysis - ten Teflon® filter samples and two metallic weights
- Ion Chromatography (IC) Analysis - six Nylon® filter samples or six Teflon® filter samples
- Carbon by Thermal Optical Analysis (TOA) - six quartz filter samples
- Elemental analysis by X-Ray Fluorescence (XRF) - six Teflon® filter samples

Detailed instructions for analyzing and reporting the PE samples were provided by NAREL. This report will compare and discuss the analytical results received from all of the laboratories. Some of the laboratories received a full set of PE samples, and some received a partial set due to limitations that will be explained later in the appropriate section of this report. Table 1 identifies all of the laboratories along with their level of participation.

Table 1. List of Participating Laboratories

Laboratory	Location	Analyses Reported
California Air Resources Board (CARB)	Sacramento, CA	Gravimetric mass IC analysis, Nylon® filters TOA carbon, modified STN method
Desert Research Institute (DRI)	Reno, NV	Gravimetric mass IC analysis, Teflon® filters IC analysis, Nylon® filters TOA carbon, STN method TOA carbon, IMPROVE method TOA carbon, IMPROVE_A method Elements by XRF
Oregon Dept. of Environmental Quality (ODEQ)	Portland, OR	Gravimetric mass IC analysis, Nylon® filters Elements by XRF
Research Triangle Institute (RTI)	Research Triangle Park, NC	Gravimetric mass IC analysis, Nylon® filters TOA carbon, STN method TOA carbon, IMPROVE method Elements by XRF
EPA's National Exposure Research Laboratory (NERL)	Research Triangle Park, NC	Elements by XRF
EPA's National Air and Radiation Environmental Laboratory (NAREL)	Montgomery, AL	Gravimetric mass IC analysis, Nylon® filters IC analysis, Teflon® filters TOA carbon, STN method TOA carbon, IMPROVE method TOA carbon, IMPROVE_A method

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 mass from the loaded filter mass. Each speciation laboratory routinely provides clean PRE-weighed air filters to the supported field sites. At the field site, an approved sampling device must be used to deposit the $PM_{2.5}$ onto the collection filter. The loaded filter is returned to the originating laboratory where the gravimetric analysis is completed by POST-weighing the filter. After the gravimetric measurements are complete, the Teflon® filter is examined further using XRF to determine the elemental composition of the filter deposit. Usually XRF is the final analysis of the Teflon® filter after which the filter is placed into an archive for storage, but in some cases the filter is subjected to one more [final] analysis to determine the ions present in the filter deposit.

If the Teflon® filter is examined for ions, it must be extracted, and the extract is subsequently analyzed using Ion Chromatography.

Most of the speciation laboratories provide clean Nylon® filters to the field sites. It is usually the Nylon® filter that is used to capture $PM_{2.5}$ for subsequent IC analysis. After the loaded filter is returned to the laboratory, the IC analysis typically proceeds by first extracting the filter using an appropriate 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.

The laboratories also provide clean quartz filters to the supported field sites. The quartz filter is used to capture $PM_{2.5}$ for subsequent carbon analysis. A thermal/optical analysis (TOA) is performed at the laboratory 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 TOA technique requires heating 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 the organic carbon (OC) and the elemental carbon (EC) the sum of which represents the total carbon (TC) present in the sample. Several slightly different TOA methods were used to analyze samples during this study. A more detailed description of each TOA method will be provided later in this report.

Gravimetric Analysis

Ten new filters and two metallic transfer weights were supplied by NAREL to each laboratory for this study. These samples were placed into individual petri slides and shipped by overnight mail to the receiving lab with instructions to PRE-weigh each filter and metallic weight using the local standard procedures. After tare measurements were completed at the receiving lab, the filters and metallic weights were returned to Montgomery and immediately placed into the weighing chamber at NAREL for equilibration and determination of a stable tare mass. Shortly after NAREL's tare measurements were complete, some of the filters were loaded with $PM_{2.5}$ captured from the Montgomery air. Co-located Met One SuperSASS air samplers were used to load seven of the filters in each sample set according to the sampling schedule presented in Table 2.

Table 2. Sampling Schedule for Gravimetric PE Filters

Filter ID	Serial Number	Sample Start	Event Duration	Receiving Lab
T05-11285	T2017288	20-Jan-05	24-hour	CARB
T05-11286	T2017289	20-Jan-05	24-hour	CARB
T05-11287	T2017290	21-Jan-05	48-hour	CARB
T05-11288	T2017291	21-Jan-05	48-hour	CARB
T05-11289	T2017292	23-Jan-05	12-hour	CARB
T05-11290	T2017293	23-Jan-05	12-hour	CARB
T05-11291	T2017310	24-Jan-05	24-hour	CARB

Table 2. Sampling Schedule for Gravimetric PE Filters

Filter ID	Serial Number	Sample Start	Event Duration	Receiving Lab
T05-11295	T2017314	20-Jan-05	24-hour	DRI
T05-11296	T2017315	20-Jan-05	24-hour	DRI
T05-11297	T2017316	21-Jan-05	48-hour	DRI
T05-11298	T2017317	21-Jan-05	48-hour	DRI
T05-11299	T2017318	23-Jan-05	12-hour	DRI
T05-11300	T2017319	23-Jan-05	12-hour	DRI
T05-11301	T2017320	24-Jan-05	24-hour	DRI
T05-11305	T2017324	20-Jan-05	24-hour	ODEQ
T05-11306	T2017325	20-Jan-05	24-hour	ODEQ
T05-11307	T2017326	21-Jan-05	48-hour	ODEQ
T05-11308	T2017327	21-Jan-05	48-hour	ODEQ
T05-11309	T2017328	23-Jan-05	12-hour	ODEQ
T05-11310	T2017329	23-Jan-05	12-hour	ODEQ
T05-11311	T2017330	24-Jan-05	24-hour	ODEQ
T05-11315	T2017334	20-Jan-05	24-hour	RTI
T05-11316	T2017335	20-Jan-05	24-hour	RTI
T05-11317	T2017358	21-Jan-05	48-hour	RTI
T05-11318	T2017337	21-Jan-05	48-hour	RTI
T05-11319	T2017338	23-Jan-05	12-hour	RTI
T05-11320	T2017339	23-Jan-05	12-hour	RTI
T05-11321	T2017354	24-Jan-05	24-hour	RTI

Table 2 shows twenty-eight filters that were loaded during four separate collection events. A sufficient number of replicates were prepared during each event such that each lab could be provided with an almost identical set of loaded filters. For example, eight replicates were created during a 24-hour collection event that started on January 20, and two of these replicates were submitted to each lab for analysis. Likewise, eight replicates were created during a 48-hour collection event that started on January 21, and two of these replicates were submitted to each lab for analysis. Table 2 does not list all of the filters that were PRE-weighed at the participating labs. Three of the ten filters that were PRE-weighed at each lab were not scheduled for loading because they were used as filter blanks for this study.

Following sample collection, the filters and the metallic weights were returned to the weighing chamber at NAREL and POST-weighed multiple times over the course of several days to demonstrate a stable final mass. Finally, the filters and metallic weights were placed into small Igloo® coolers with ice substitute and shipped back to the participating labs for POST-weighing. It is worth mentioning that the metallic weights were included in this study because they are usually less susceptible to weighing errors due to factors such as electrical static and volatility of filter constituents.

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 two metallic weights.

Figure 1

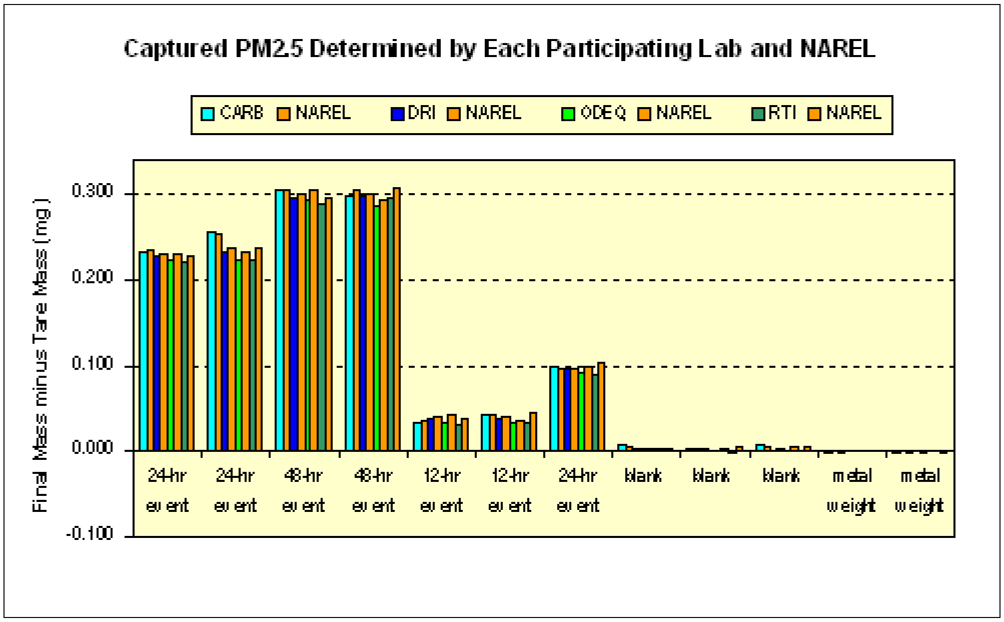
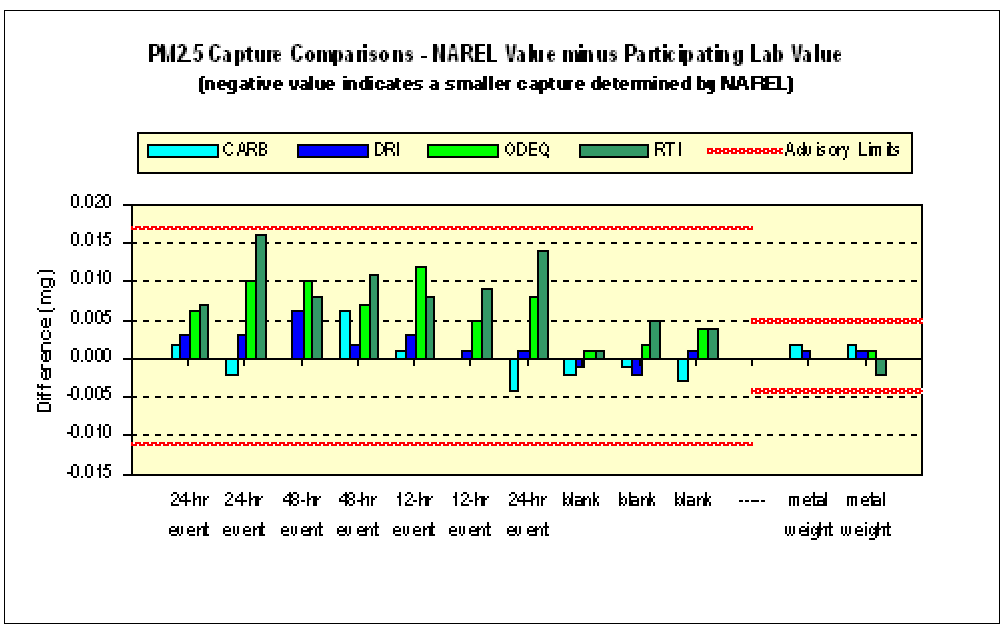


Figure 2 presents the inter-laboratory differences along with advisory limits. Inter-laboratory differences were calculated by subtracting the $PM_{2.5}$ capture value determined at each speciation lab from the capture value determined at NAREL. Notice that a negative bar on the Figure 2 graph represents a smaller $PM_{2.5}$ capture value determined at NAREL. The 3-sigma advisory limits were derived from all of the gravimetric PE studies administered by NAREL during the past year.

Figure 2



The raw data reported from all laboratories have been tabulated for easy viewing. At the end of this report, Table 9 contains the tare weight, the final loaded weight, and the calculated $PM_{2.5}$ capture for each sample. Table 9 also contains the calculated inter-laboratory difference for measuring the $PM_{2.5}$ capture which is graphed in Figure 2. RTI reported measurements made by several different analysts, and all of the results are included in Table 9. However, only the results from analyst #1 are presented in Figure 1 and Figure 2. Only one set of measurements from each lab were selected for graphical presentation because usually only one set of measurements are available for a routine sample.

All of the participating labs have an SOP for measuring the gravimetric mass of $PM_{2.5}$ filter samples. Most of the SOP's are currently available on the web for easy viewing (see reference 1 through 5).

IC Analysis

This study included the analysis of selected ions using three slightly different IC methods. Five labs analyzed a set of Nylon® filters using the STN method, two labs analyzed a set of Teflon® filters using the STN method, and finally two labs analyzed a set of Nylon® filters using the IMPROVE method. NAREL provided each lab with a set of six filters for each method tested. Each sample set contained two blank filters and four filters that were loaded with $PM_{2.5}$ collected from the Montgomery air. Co-located Met One SuperSASS air samplers were used to load filters and create replicates in each sample set according to the sampling schedule presented in Table 3.

Table 3. Sampling Schedule for Ion Chromatography PE Filters

Filter ID	Filter Medium	Sample Start	Event Duration	Receiving Lab	Method
N04-11197	Nylon®	24-Nov-04	116-hour	CARB	STN
N04-11198	Nylon®	24-Nov-04	116-hour	CARB	STN
N04-11208	Nylon®	29-Nov-04	159-hour	CARB	STN
N04-11209	Nylon®	29-Nov-04	159-hour	CARB	STN
N04-11199	Nylon®	24-Nov-04	116-hour	DRI	STN
N04-11200	Nylon®	24-Nov-04	116-hour	DRI	STN
N04-11210	Nylon®	29-Nov-04	159-hour	DRI	STN
N04-11211	Nylon®	29-Nov-04	159-hour	DRI	STN
N04-11201	Nylon®	24-Nov-04	116-hour	ODEQ	STN
N04-11202	Nylon®	24-Nov-04	116-hour	ODEQ	STN
N04-11212	Nylon®	29-Nov-04	159-hour	ODEQ	STN
N04-11213	Nylon®	29-Nov-04	159-hour	ODEQ	STN
N04-11203	Nylon®	24-Nov-04	116-hour	RTI	STN
N04-11204	Nylon®	24-Nov-04	116-hour	RTI	STN
N04-11214	Nylon®	29-Nov-04	159-hour	RTI	STN
N04-11215	Nylon®	29-Nov-04	159-hour	RTI	STN
N04-11205	Nylon®	24-Nov-04	116-hour	NAREL	STN
N04-11206	Nylon®	24-Nov-04	116-hour	NAREL	STN
N04-11216	Nylon®	29-Nov-04	159-hour	NAREL	STN
N04-11217	Nylon®	29-Nov-04	159-hour	NAREL	STN
T05-11333	Teflon®	03-Jan-05	144-hour	DRI	STN
T05-11334	Teflon®	03-Jan-05	144-hour	DRI	STN
T05-11337	Teflon®	04-Jan-05	216-hour	DRI	STN
T05-11338	Teflon®	04-Jan-05	216-hour	DRI	STN

Table 3. Sampling Schedule for Ion Chromatography PE Filters

Filter ID	Filter Medium	Sample Start	Event Duration	Receiving Lab	Method
T05-11335	Teflon®	03-Jan-05	144-hour	NAREL	STN
T05-11336	Teflon®	03-Jan-05	144-hour	NAREL	STN
T05-11339	Teflon®	04-Jan-05	216-hour	NAREL	STN
T05-11340	Teflon®	04-Jan-05	216-hour	NAREL	STN
N04-11229	Nylon®	07-Dec-04	161-hour	RTI	IMPROVE
N04-11230	Nylon®	07-Dec-04	161-hour	RTI	IMPROVE
N04-11233	Nylon®	08-Dec-04	130-hour	RTI	IMPROVE
N04-11234	Nylon®	08-Dec-04	130-hour	RTI	IMPROVE
N04-11231	Nylon®	07-Dec-04	161-hour	NAREL	IMPROVE
N04-11232	Nylon®	07-Dec-04	161-hour	NAREL	IMPROVE
N04-11235	Nylon®	08-Dec-04	130-hour	NAREL	IMPROVE
N04-11236	Nylon®	08-Dec-04	130-hour	NAREL	IMPROVE

Table 3 shows thirty-six filters that were loaded during six separate collection events. A sufficient number of replicates were prepared during each event such that each participating lab was provided with an almost identical set of loaded filters. For example, ten replicates were created during a 116-hour collection event that started on November 24, and two of these replicates were submitted to each lab for analysis. Likewise, ten replicates were created during a 159-hour collection event that started on November 29, and two of these replicates were submitted to each lab for analysis. The collection times used for this study were significantly longer than the normal 24-hours to boost the amount of $PM_{2.5}$ collected and raise the level of most analytes to above the detection threshold. Table 3 does not list the filter blanks that were provided to each participating lab.

A filter set was provided to each participating lab with instructions to use local standard procedures, as closely as possible, for the extraction and the IC analysis. No information was given to the participating labs about the history of the individual filters. The results were reported for each sample based upon the amount of analyte present on the filter (µg/filter).

All of the participating labs have an SOP for analyzing $PM_{2.5}$ filter samples by IC. Most of the SOP's are currently available on the web for easy viewing (see reference 6 through 13).

IC Results

Results from the analysis of Nylon® filters using the STN method are presented as a bar graph in Figure 3 and Figure 4. Ten replicates from the November 24 event are shown on the left side of the graphs, and ten replicates from the November 29 event are shown on the right side of the graphs. Nitrate, sulfate, and ammonium were the most abundant analytes captured from the Montgomery air, and these mid-level ions are plotted together in Figure 3. Sodium and potassium were present in the air at relatively low levels, and these ions are plotted in Figure 4. Since the low-level components are presented in Figure 4, an extra bar was added to this graph that represents the lowest calibration standard analyzed at NAREL. The lowest calibration standard is a good estimate of the practical quantitation limit for the analysis. Each cluster of ten bars in the graph is labeled with the ion reported, but the individual samples within each cluster are not identified. It is important to understand that the ten replicate samples within each cluster were consistently arranged, from left to right, in the same order.

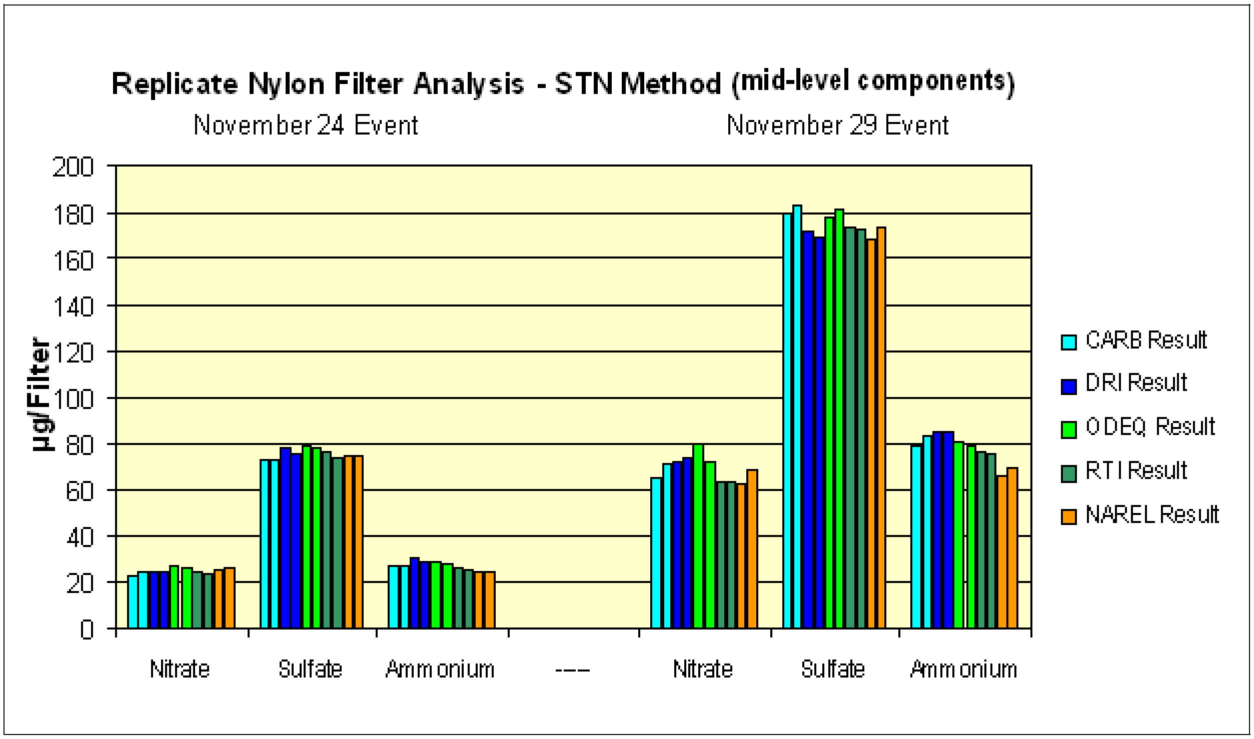
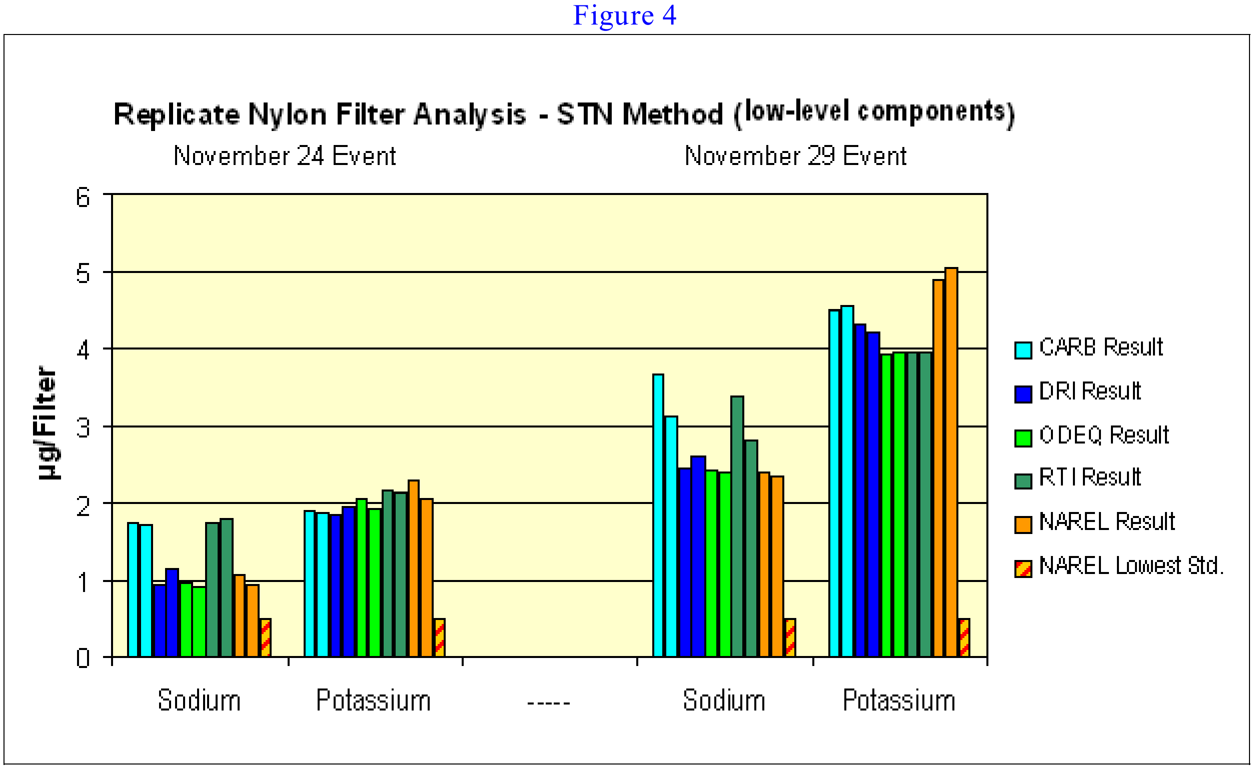


Figure 3

Good precision can be seen in Figure 3 and Figure 4. The inter-laboratory precision is almost as good as the precision within each lab.

Figure 4



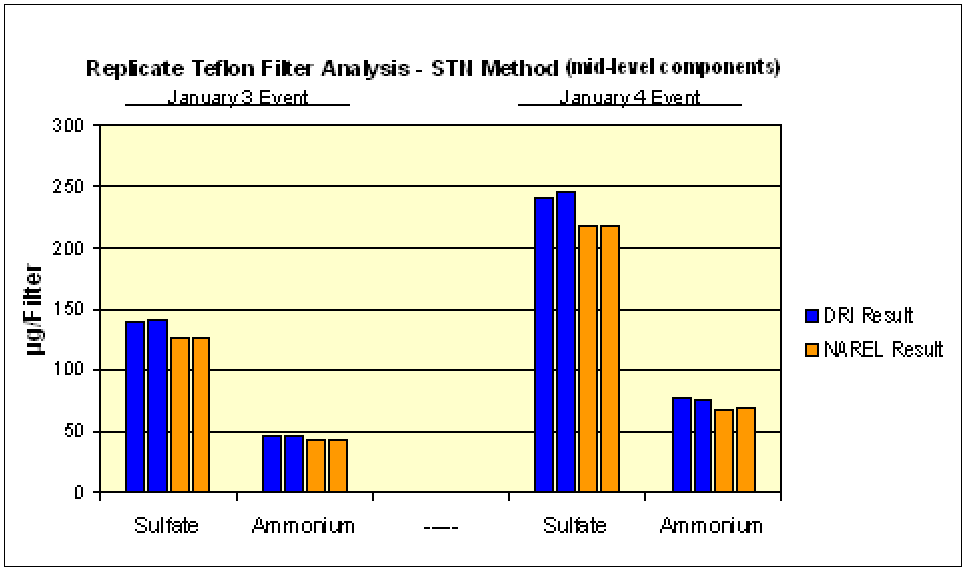


Figure 5

Figure 5 and Figure 6 show the results from replicate Teflon® filter samples that were created on January 3 and January 4. Half of the replicates were submitted to DRI for analysis using the STN method, and half were retained at NAREL for analysis using the same method. Teflon® filter samples are routinely analyzed at DRI as part of their work for the Texas Commission on Environmental Quality (TCEQ). The mid-level and the low-level components are presented again as separate graphs in Figure 5 and Figure 6 respectively. It is worth noting that nitrate was not a mid-level component on the Teflon® filters even though it probably was a mid-level component in the Montgomery air. Excellent precision is observed in Figure 5 for ammonium, especially considering the non-linear response curve that ammonium offers at the IC instrument. A small consistent (eleven percent) inter-laboratory bias is observed for sulfate in Figure 5. Good precision is observed for the low-level components shown in Figure 6.

Figure 6

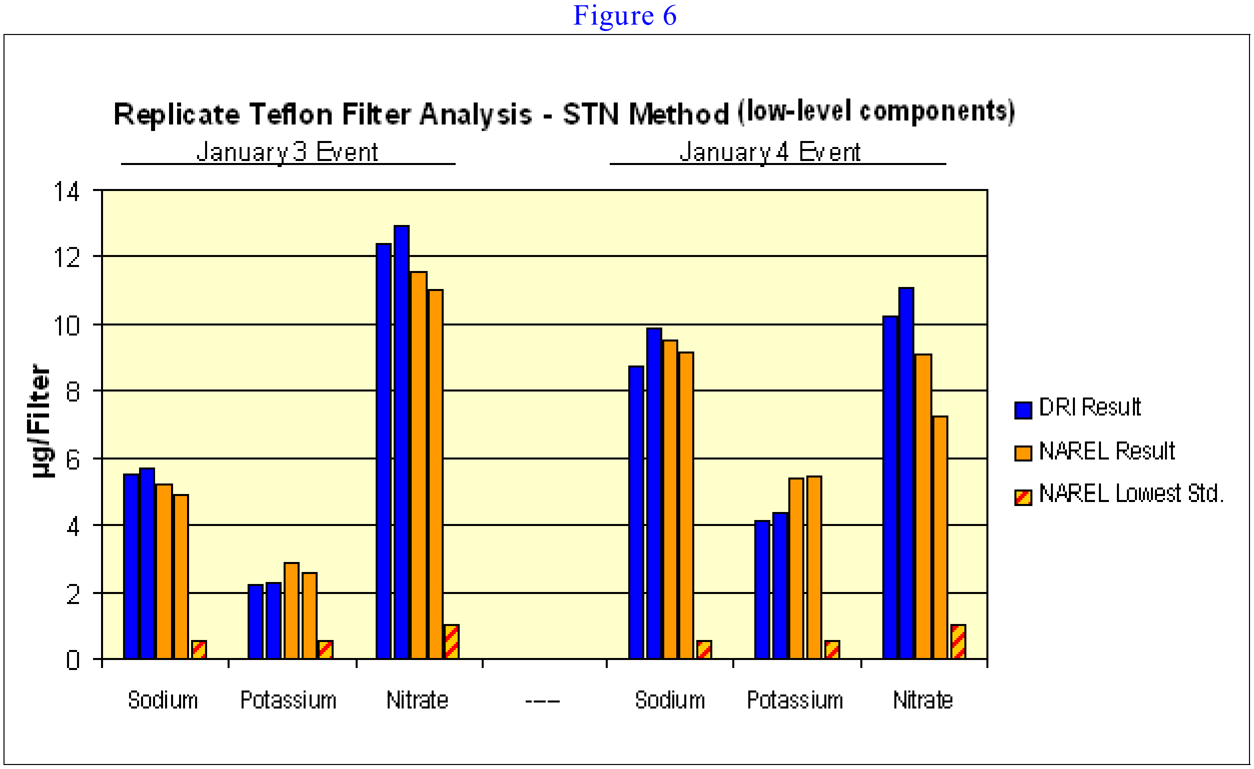
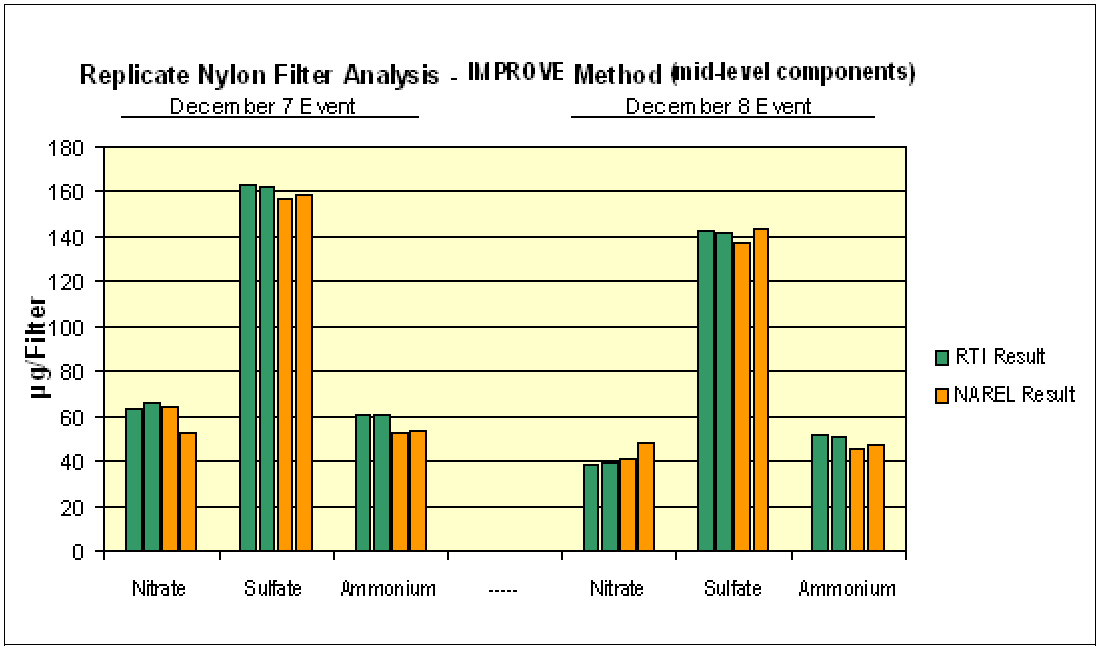
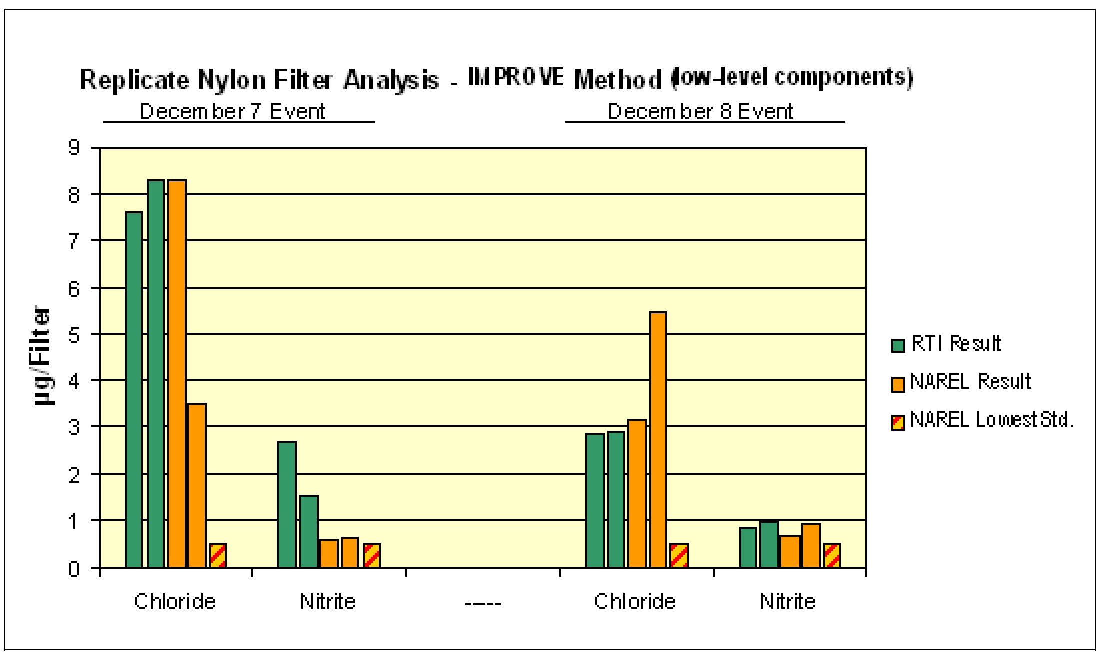


Figure 7



Nylon® filters are routinely analyzed at RTI using the IMPROVE method which is slightly different from the STN method with respect to the extraction procedure and the list of reported ions. Figure 7 shows good precision for all of the mid-level ions, but there is a problem in Figure 8 with the low-level components. Poor precision was reported by NAREL for the chloride analysis. After discovery of the problem, the filter extracts were re-analyzed with similar results. NAREL has not been able to explain the poor precision for chloride observed in Figure 8, but possible reasons include poor filter replication and accidental contamination of the filter extract. The variability observed for nitrite may be due to contamination which is frequently observed in blanks. Blanks were provided to all of the labs for this study even though the blank results are not presented in graphical format. The numerical results for all of the blanks and for all of the loaded filters are available in Table 10 at the end of this report.

Figure 8



Carbon Analysis

This study included the Thermal-Optical Analysis (TOA) of quartz fiber filters to determine the amount of carbon present in captured $PM_{2.5}$. NAREL provided each participating laboratory with a set of six 47-mm filters. Each sample set contained two blank filters and four filters that were loaded with $PM_{2.5}$ collected from the Montgomery air. Co-located Met One SuperSASS air samplers were used to load filters and create replicates in each sample set according to the sampling schedule presented in Table 4.

Table 4. Sampling Schedule for TOA Carbon PE Filters

Filter ID	Filter Medium	Sample Start	Event Duration	Receiving Lab	TOA Method(s)
Q04-11175	quartz	27-Apr-04	287-hr	CARB	STN (modified)
Q04-11176	quartz	27-Apr-04	287-hr	CARB	STN (modified)
Q04-11186	quartz	16-Nov-04	192-hr	CARB	STN (modified)
Q04-11187	quartz	16-Nov-04	192-hr	CARB	STN (modified)
Q04-11177	quartz	27-Apr-04	287-hr	DRI	STN, IMPROVE, and IMPROVEa
Q04-11178	quartz	27-Apr-04	287-hr	DRI	STN, IMPROVE, and IMPROVEa
Q04-11188	quartz	16-Nov-04	192-hr	DRI	STN, IMPROVE, and IMPROVEa
Q04-11189	quartz	16-Nov-04	192-hr	DRI	STN, IMPROVE, and IMPROVEa
Q04-11181	quartz	27-Apr-04	287-hr	RTI	STN and IMPROVE
Q04-11182	quartz	27-Apr-04	287-hr	RTI	STN and IMPROVE
Q04-11192	quartz	16-Nov-04	192-hr	RTI	STN and IMPROVE
Q04-11193	quartz	16-Nov-04	192-hr	RTI	STN and IMPROVE
Q04-11183	quartz	27-Apr-04	287-hr	NAREL	STN, IMPROVE, and IMPROVEa
Q04-11184	quartz	27-Apr-04	287-hr	NAREL	STN, IMPROVE, and IMPROVEa
Q04-11194	quartz	16-Nov-04	192-hr	NAREL	STN, IMPROVE, and IMPROVEa
Q04-11195	quartz	16-Nov-04	192-hr	NAREL	STN, IMPROVE, and IMPROVEa

Table 4 shows sixteen filters that were loaded during two separate collection events. A sufficient number of replicates were prepared during each event such that each participating lab was provided with an almost identical set of loaded filters. Eight replicates were created during the 287-hour springtime event that started on April 27, and two of these replicates were submitted to each lab for analysis. Likewise, eight replicates were created during the 192-hour autumn event that started on November 16, and two of these replicates were submitted to each lab for analysis. The collection times used for this study were significantly longer than the normal 24-hours to boost the amount of elemental carbon deposited on the filter. Table 4 does not list the two filter blanks that were provided to each participating lab.

A filter set was provided to each lab with instructions to use local standard procedures, as closely as possible, for the analysis. No information was given to the participating labs about the history of the individual filters. ODEQ did not participate in this part of the study because their quartz filters are shipped to RTI for analysis. The DRI and RTI labs are set up to analyze a large volume of samples and routinely operate several TOA instruments. Both DRI and RTI were able to analyze each filter several times using more than one instrument and using more than one TOA method. The results were reported for each sample based upon the amount of carbon per square centimeter of the filter deposit($\mu g\ C/cm^2$). Raw data were also supplied to NAREL so that some of the thermograms are included in this report.

This study has provided an excellent opportunity to see replicate filter samples analyzed by a variety of TOA methods. Therefore it is appropriate to ask, "what distinguishes one TOA method from another?" To answer this question we must first identify the critical elements of a TOA method. At least four different TOA methods have been identified in this report based upon the temperature protocol used during the analysis. The following table provides a brief description of each temperature protocol.

Table 5. Comparison of the Temperature Protocols for Four TOA Methods

STN Method TOT Analysis	CARB Method (modified STN) TOT Analysis	IMPROVE Method TOR Analysis	IMPROVE_A Method TOR Analysis	Carrier Gas	Carbon Fraction*
heater off (90s)	heater off (90s)	heater off (90s)	heater off (90s)	He Purge	-----
310°C (60s)	250°C (180s)	120°C (150-580s)	140°C (150-580s)	He	OC1
480°C (60s)	400°C (150s)	250°C (150-580s)	280°C (150-580s)	He	OC2
615°C (60s)	550°C (150s)	450°C (150-580s)	480°C (150-580s)	He	OC3
900°C (90s)	700°C (270s)	550°C (150-580s)	580°C (150-580s)	He	OC4
heater off (40s)**	heater off (60s)**	-----	-----	He	
600°C (35s)	550°C (100s)	550°C (150-580s)	580°C (150-580s)	He/O_2	EC1
675°C (45s)	650°C (100s)	700°C (150-580s)	740°C (150-580s)	He/O_2	EC2
750°C (45s)	750°C (100s)	800°C (150-580s)	840°C (150-580s)	He/O_2	EC3
825°C (45s)	850°C (100s)	-----	-----	He/O_2	
920°C (120s)	900°C (170s)	-----	-----	He/O_2	
heater off (110s)	heater off (200s)	heater off (150s)	heater off (200s)	He/O_2+IS	

The carbon fractions are not consistently defined among the different methods. See text for explanation.
***** These "heater off" times are approximate and may have varied slightly among instruments during this study.***

Beyond the thermal protocols listed in Table 5, each TOA method is further defined by the way optical measurements are made and utilized to calculate carbon fractions. For example, the optical measurements are used to distinguish the elemental carbon (EC) from the organic carbon (OC) present in the sample. In fact as we shall see, all of the carbon fractions have a functional definition that depends upon the method of analysis.

All of the instruments used for this study are equipped with a small tubular quartz oven and a laser/diode system. The sample analysis begins by placing a carefully measured [punched] segment of the filter sample into the oven directly in the path of the laser. A purge gas removes air from the oven and surrounds the sample with a stream of pure helium before the heating and data acquisition begin. Light from the laser will interact with the sample during the analysis. Some of the light will transmit through the sample, and some light will reflect from the surface of the sample. A diode detector can be positioned to measure the light transmitted through the sample, and this configuration is needed for a TOT (thermal optical transmittance) analysis. A diode can also be positioned to measure the reflected light, and this configuration is needed for a TOR (thermal optical reflectance) analysis. As the sample segment is heated and the pure helium phase of the analysis proceeds, some of the carbon may char to form a darker pyrolized carbon (PyrolC). All of the methods in this study use either TOT or TOR to evaluate the PyrolC. Four different instrument configurations were used for this study. The older

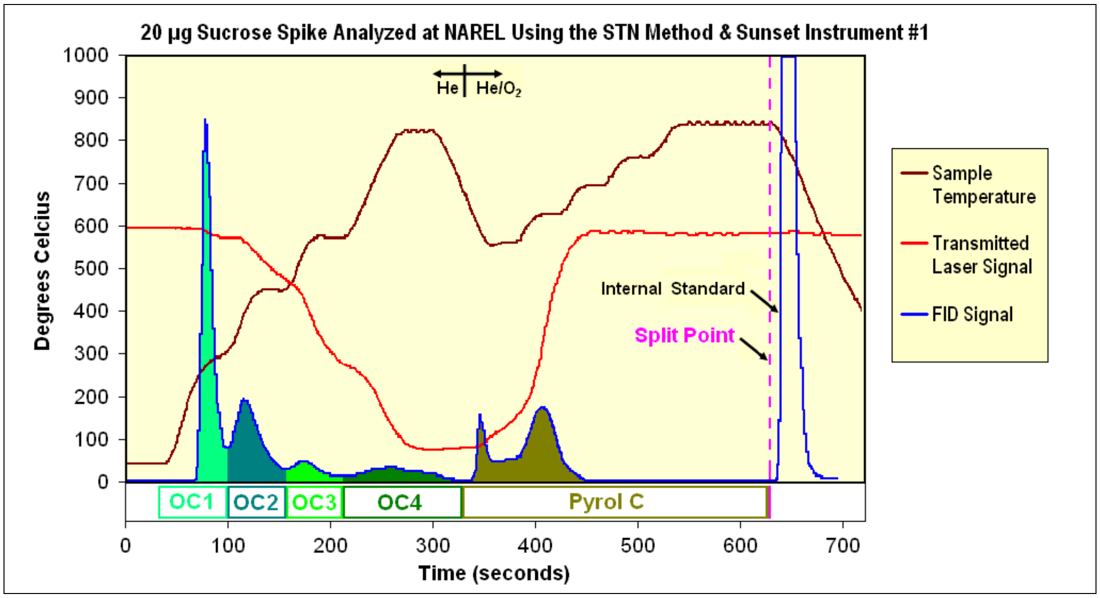
Sunset [single mode] instruments are equipped with only one diode detector and are configured for the TOT analysis. The older DRI/OGC instruments are also equipped with only one diode detector and are configured for the TOR analysis. The DRI Model 2001 instruments and the Sunset Dual Mode instruments are newer designs capable of measuring the transmitted and the reflected light simultaneously. These newer instruments provide more optical information and give the user a choice of the TOT or the TOR analysis. Table 6 shows specifically how the different instruments were used for analyzing the samples in this study.

Table 6. Summary of Report Packages for the TOA Analyses

Temperature Protocol	Optical Analysis	Instrument Model	Specific Instrument Reporting	Parameters Reported	Report Package Count
Modified STN	TOT	DRI Model 2001	CARB Instr. #1	OC, EC, TC	1
STN	TOT	DRI Model 2001	DRI Instr. #7	OC, EC, TC, OCsub, ECsub	2
			DRI Instr. #9	OC, EC, TC, OCsub, ECsub	3
		Sunset	RTI Instr. R	OC, EC, TC, OCsub	4
			RTI Instr. S	OC, EC, TC, OCsub	5
			RTI Instr. T	OC, EC, TC, OCsub	6
			NAREL Instr. #1	OC, EC, TC, OCsub	7
		Sunset (Dual Mode)	RTI Instr. F	OC, EC, TC, OCsub	8
IMPROVE	TOR	DRI/OGC	DRI Instr. #4	OC, EC, TC, OCsub, ECsub	9
			DRI Instr. #5	OC, EC, TC, OCsub, ECsub	10
		Sunset (Dual Mode)	RTI Instr. F	OC, EC, TC, OCsub, ECsub	11
			NAREL Instr. #2	OC, EC, TC, OCsub, ECsub	12
IMPROVE_A	TOR	DRI Model 2001	DRI Instr. #7	OC, EC, TC, OCsub, ECsub	13
			DRI Instr. #9	OC, EC, TC, OCsub, ECsub	14
		Sunset (Dual Mode)	NAREL Instr. #2	OC, EC, TC, OCsub, ECsub	15

All of the instruments in this study operate by heating a punched segment of the sample in the presence of a controlled carrier gas. Any carbonaceous material released from the quartz filter segment is swept through a series of zones that rapidly convert the released carbon to methane which is measured by a Flame Ionization Detector (FID) positioned at the end of the sample train. During the first [non-oxidizing] stage of the analysis, the carrier gas is pure helium. Oxygen is added to the carrier during the second stage of the analysis which is designed to remove any remaining carbonaceous material from the quartz residue. Most of the OC is released during the first stage of the analysis, but the EC and any PyrolC that may have formed are more difficult to volatilize, and they are expected to release during the second stage of the analysis. A known mass of methane is injected through the oven at the end of the analysis to serve as an Internal Standard (IS). Signals from the FID and from the laser may be plotted along a time axis to construct a thermogram. An example of a thermogram is shown in Figure 9. This is a thermogram of a sucrose spike which was analyzed at NAREL as a routine calibration check sample. The sucrose spike contains no EC but has a strong tendency to char and form PyrolC.

Figure 9



After the raw data acquisition is complete, the thermogram is evaluated to determine the amount of OC and the amount of EC that were present in the original sample. All of the participating labs report the Total Carbon (TC) as the sum of the OC and the EC fractions: TC = OC + EC. Other carbon fractions may be calculated such as the OC subfractions: OC = OC1 + OC2 + OC3 + OC4 + PyrolC. Figure 9 shows an example of OC subfractions that were calculated by a Sunset instrument. EC subfractions may be calculated as well. For example, three EC subfractions are calculated for IMPROVE samples: EC = EC1 + EC2 + EC3. Unfortunately the rules [and consequently the software programs] used to determine these carbon fractions are not the same for all of the instruments. For example, we will see later that some of the instruments reported a negative PyrolC, but other instruments have adopted different rules that do not allow a negative PyrolC.

A "split point" must be established in each thermogram that separates the OC and the EC. The laser signal must be examined as part of determining the split point. If any of the original OC chars during the first stage of the analysis, the laser signal will decrease from its initial value, and will not recover until later in the run. The point at which the recovering laser signal reaches its initial value is usually the split point. Some samples do not form char, however, and the laser signal does not decrease and fall below its initial value. In this case, the split point is usually assigned when the oxygen valve opens for the second phase of the analysis to begin. All of the instruments follow these general rules, but there is a specific case that is controversial, and it occurs when the laser signal indicates an "early" split point. The split point is considered "early" if it is assigned during the first phase of the analysis before the oxygen valve opens. Most of the instruments were programmed to allow an early split point if the laser signal supports that assignment, but the DRI/OGC instruments did not allow early split points.

As we examine the results from all of the participating labs, it is important to understand the methods that were used, so that valid comparisons can be made. All of the results presented in this report have been identified with the instrument that performed the analysis as well as the thermal protocol and optical configuration that was used. All of the participating labs have an SOP for the TOA method(s) used at their laboratory. Most of the SOP's are currently available on the web for easy viewing (see reference 14 through 18).

Carbon Results

Results from the analysis of replicate quartz filters using the STN method are presented below as a bar graph. Notice that each bar in the graph is labeled with the instrument number, the lab, and the last three digits of the sample number. Figure 10 shows results from replicates that were created on April 27, and Figure 11 shows the results from replicates created on November 16. The bar segments show the OC and EC components of the total carbon but do not show the more detailed fractions. The results are presented again in Figure 12 and Figure 13 with more detail.

Figure 10

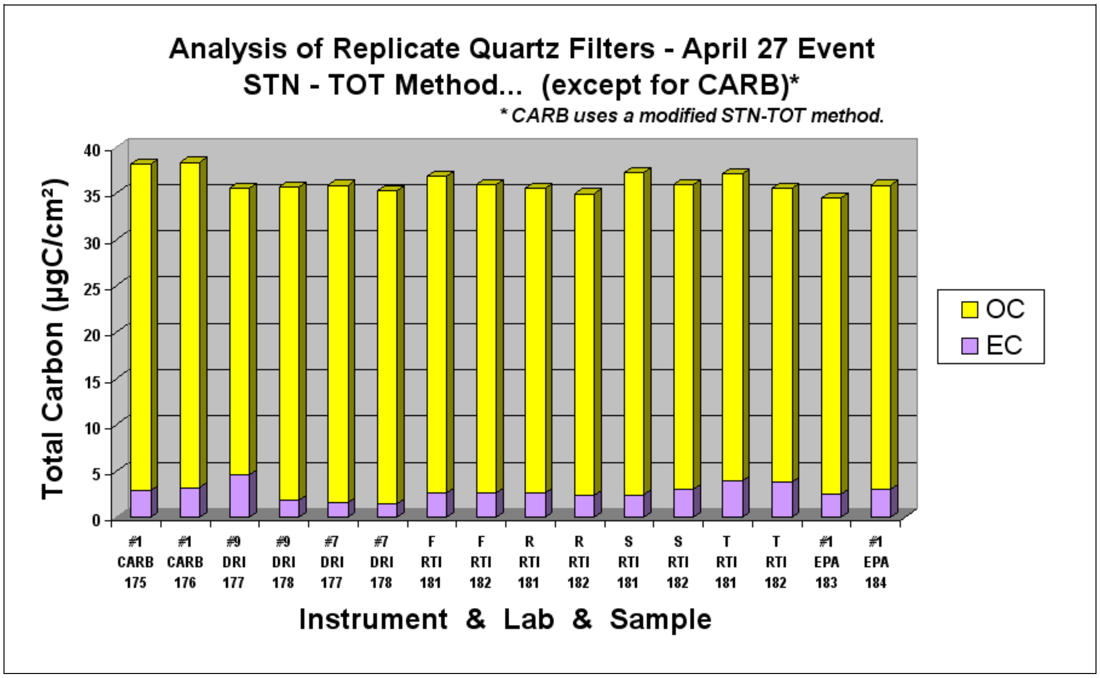
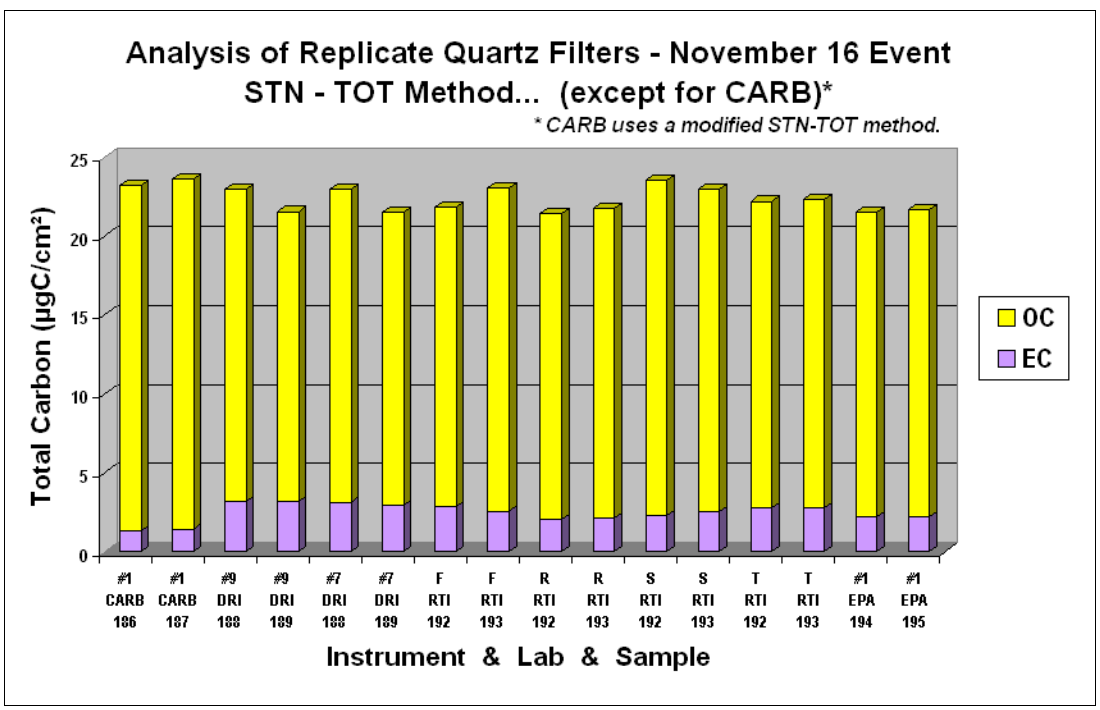


Figure 11



This time in Figure 12 and Figure 13, the OC subfractions are revealed. The subfractions from CARB are not presented since CARB does not use the STN temperature protocol. As shown previously in Figure 9, some of the subfractions are directly related to the temperature set points. PyrolC, on the other hand, is related to the split point. Notice that PyrolC was negative for some of the DRI results, and the reported OC4 result was "adjusted" to maintain proper size of the stacked bar whose height represents the TC. The adjustment was performed by adding the reported OC4 value and the [negative] PyrolC value. The adjustment was performed strictly for graphical purposes.

Figure 12

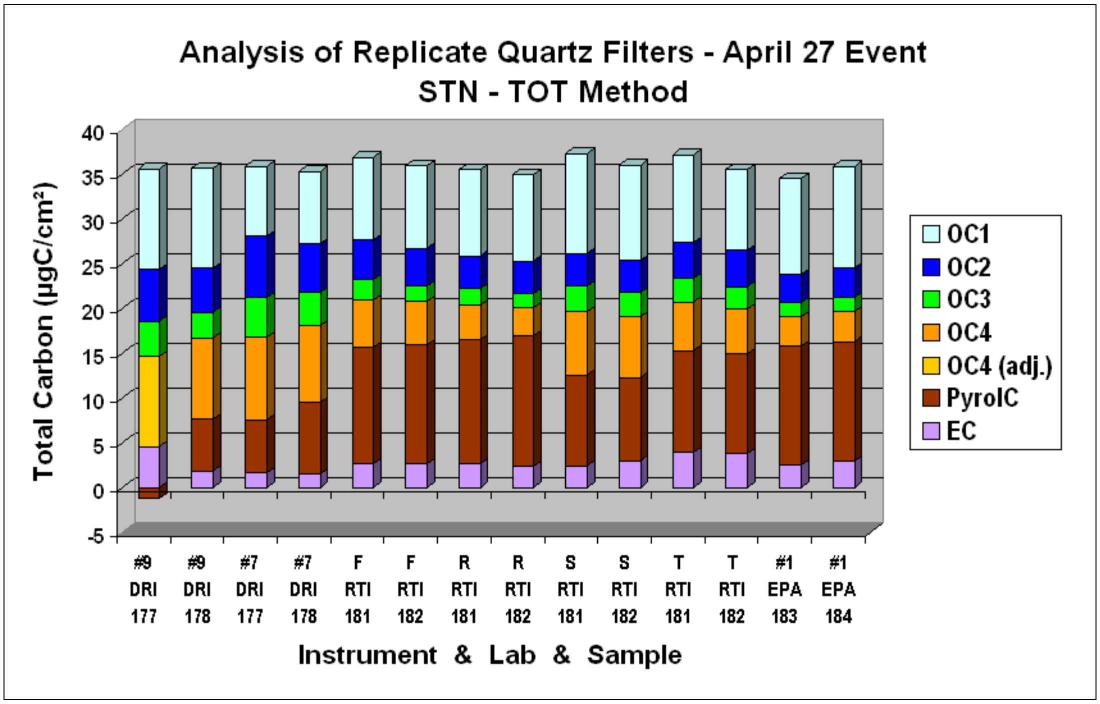
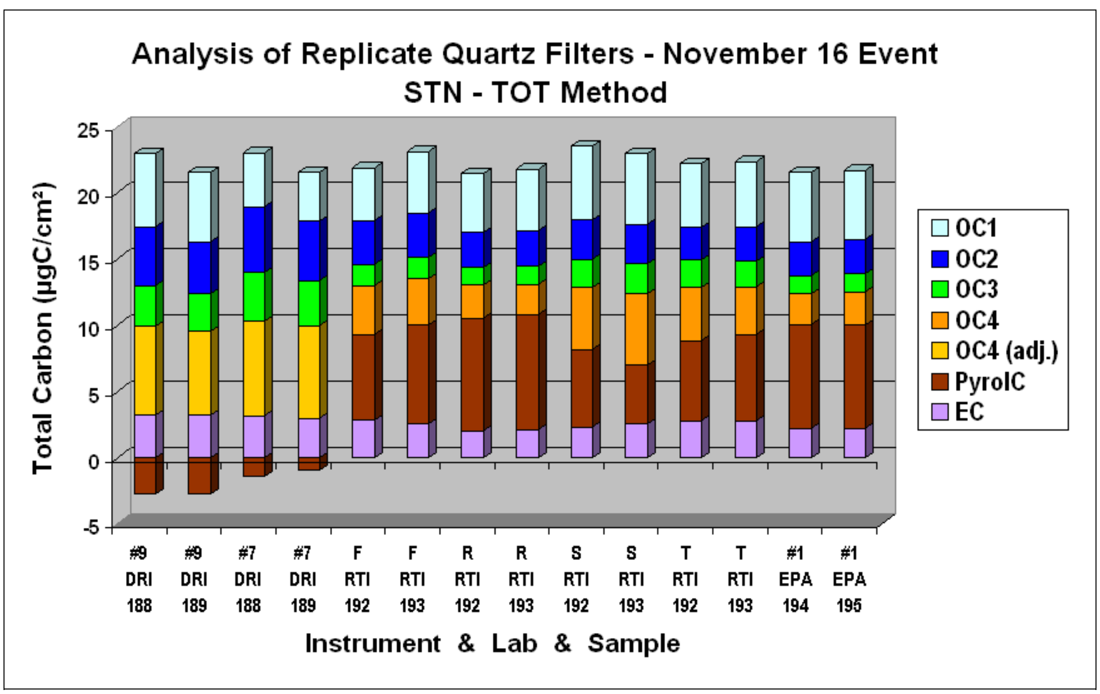


Figure 13



Some of the labs were able to analyze the PE samples using the IMPROVE and the IMPROVE_A methods. The results in Figure 14 and Figure 15 show the OC and EC components of the total carbon but do not show the more detailed fractions. It can be seen in these plots that the two methods agree quite well. The IMPROVE steering committee had just approved the new IMPROVE_A method earlier this year when these PE samples were analyzed. The new IMPROVE_A method was designed to maintain as much consistency as possible with years of old data produced by the DRI/OGC instrument using the IMPROVE method. The previous results for the STN method agree quite well for TC but show EC values that are significantly smaller than those shown here.

Figure 14

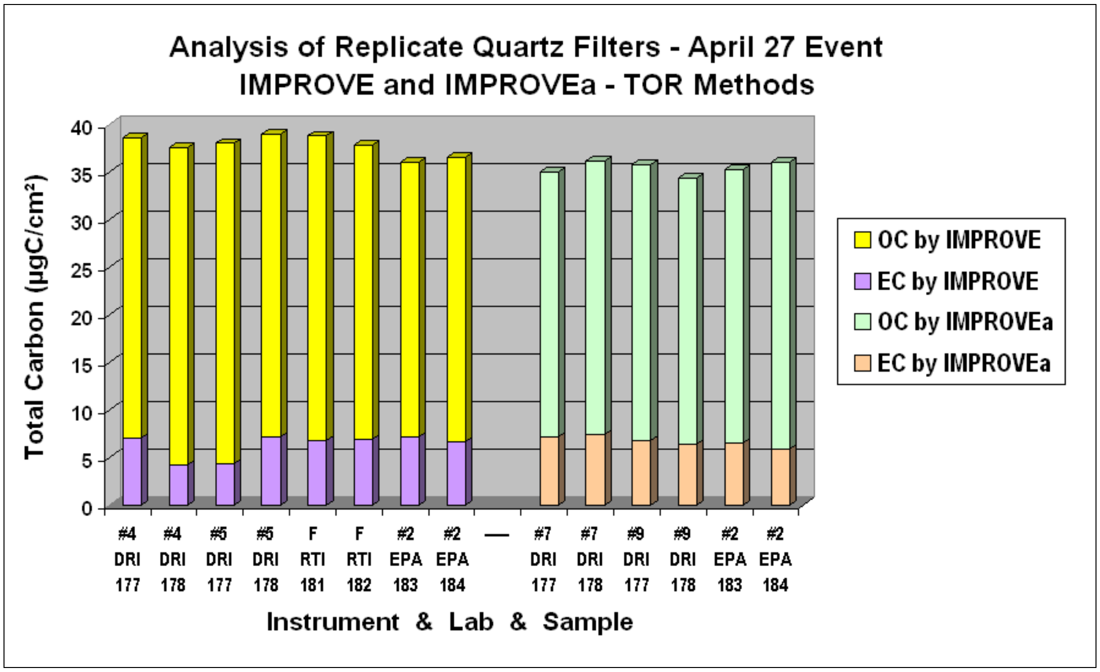


Figure 15

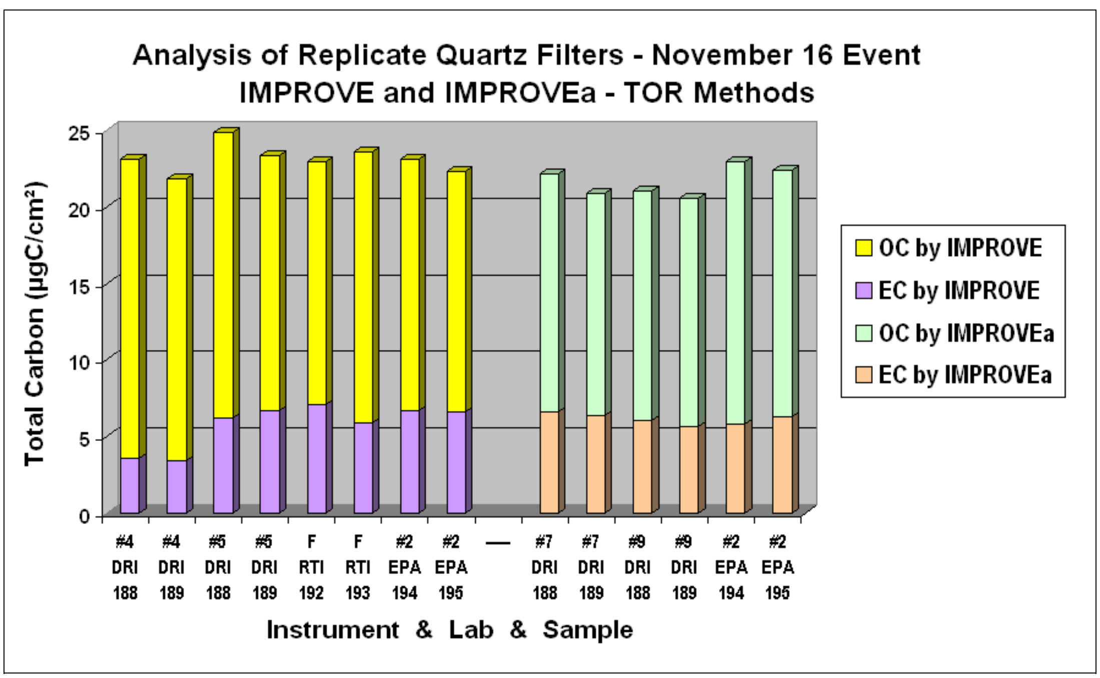


Figure 16 and Figure 17 show the IMPROVE and the IMPROVE_A results again with more detail. Good agreement can be seen for OC subfractions when the IMPROVE_A method was used. Worse precision can be seen among the instruments when the IMPROVE method was used. The DRI/OGC instruments #4 and #5 reported consistently low values for the IMPROVE PyrolC, and this may be related to trace oxygen contamination during the first stage of the analysis. The two Sunset Dual Mode instruments (RTI F and EPA #2) reported consistently low values for the IMPROVE OC1 fraction. This may be explained by a difference in the accuracy of temperature measurements inside the sample oven. The OC1 fraction is very sensitive to the 120°C set point specified by the IMPROVE method.

Figure 16

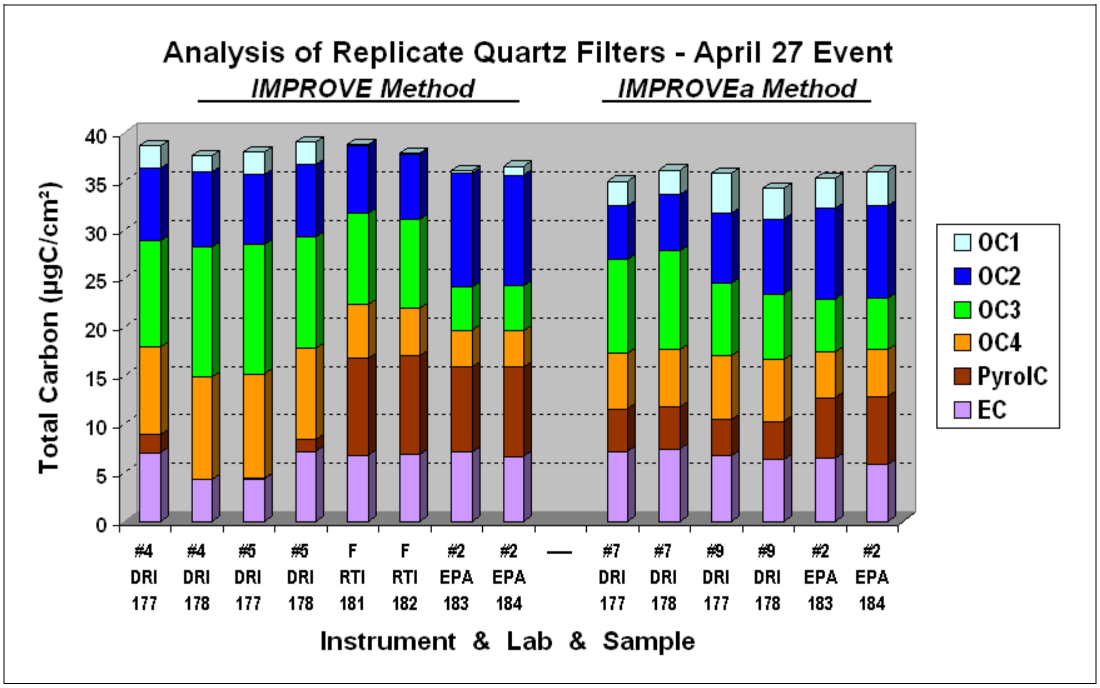
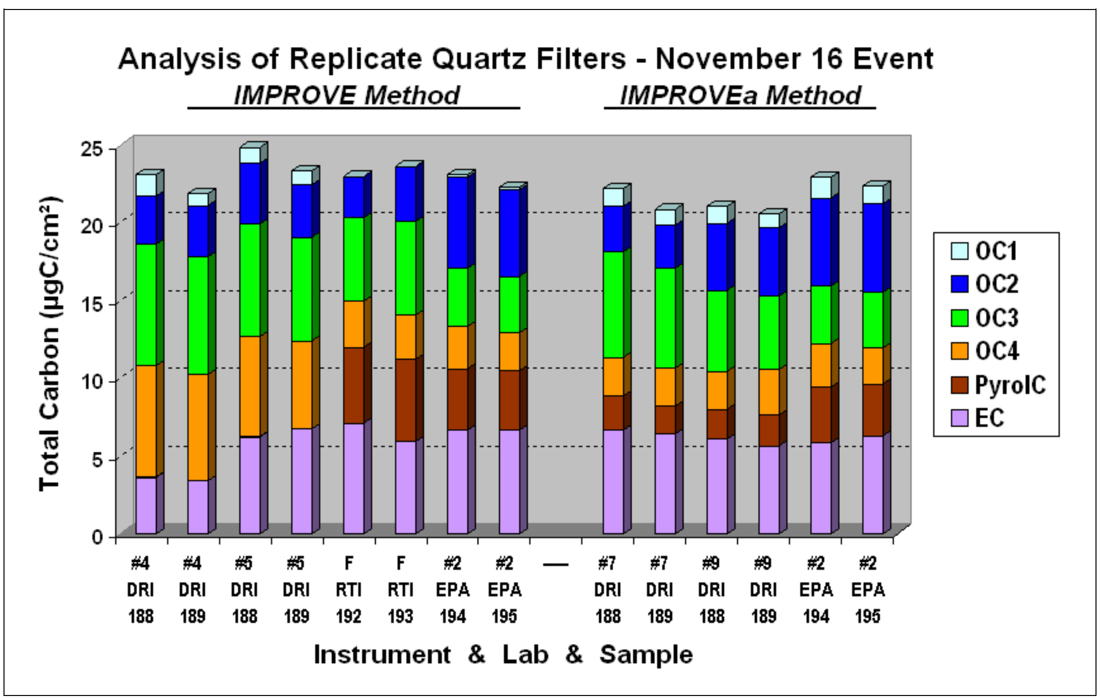


Figure 17



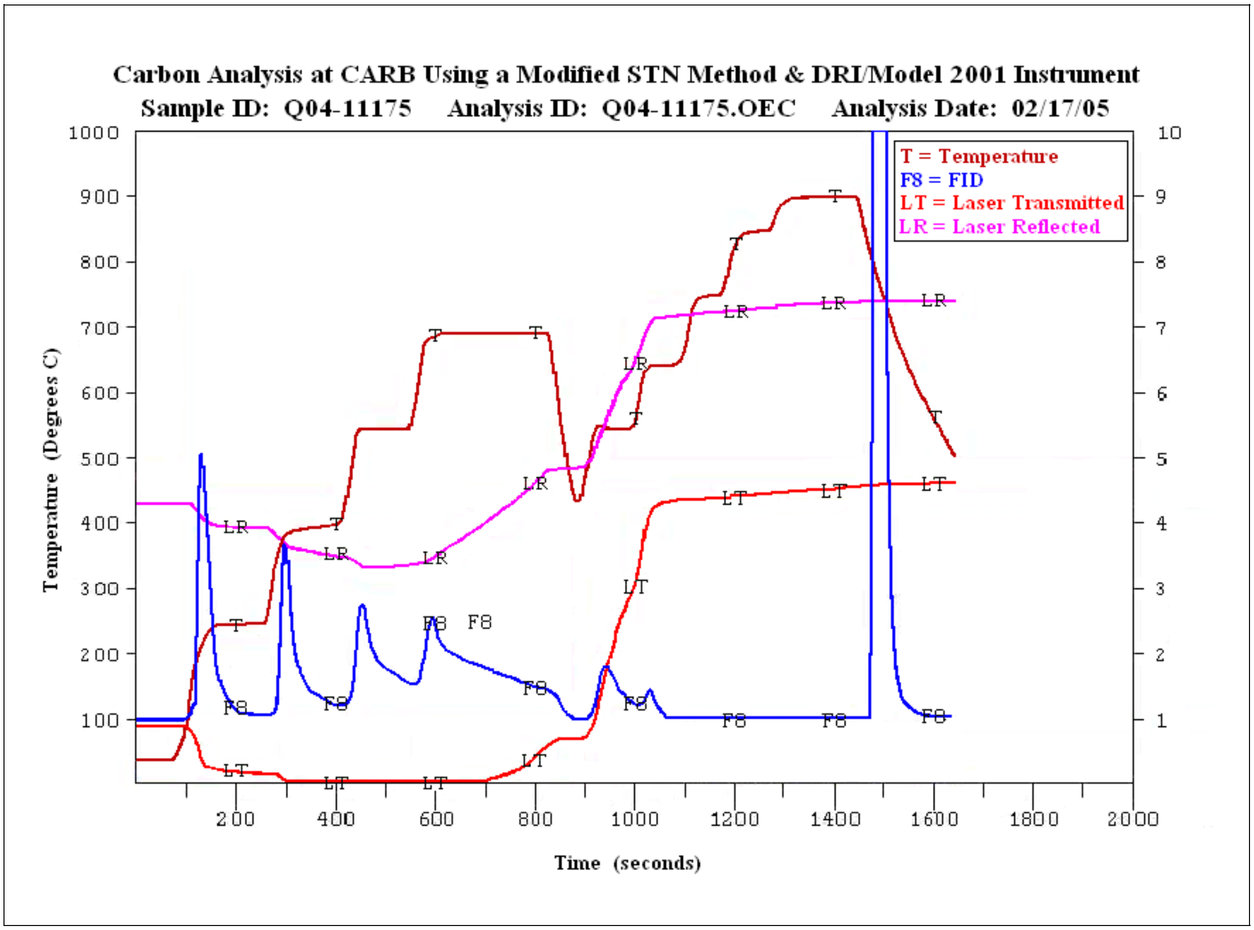
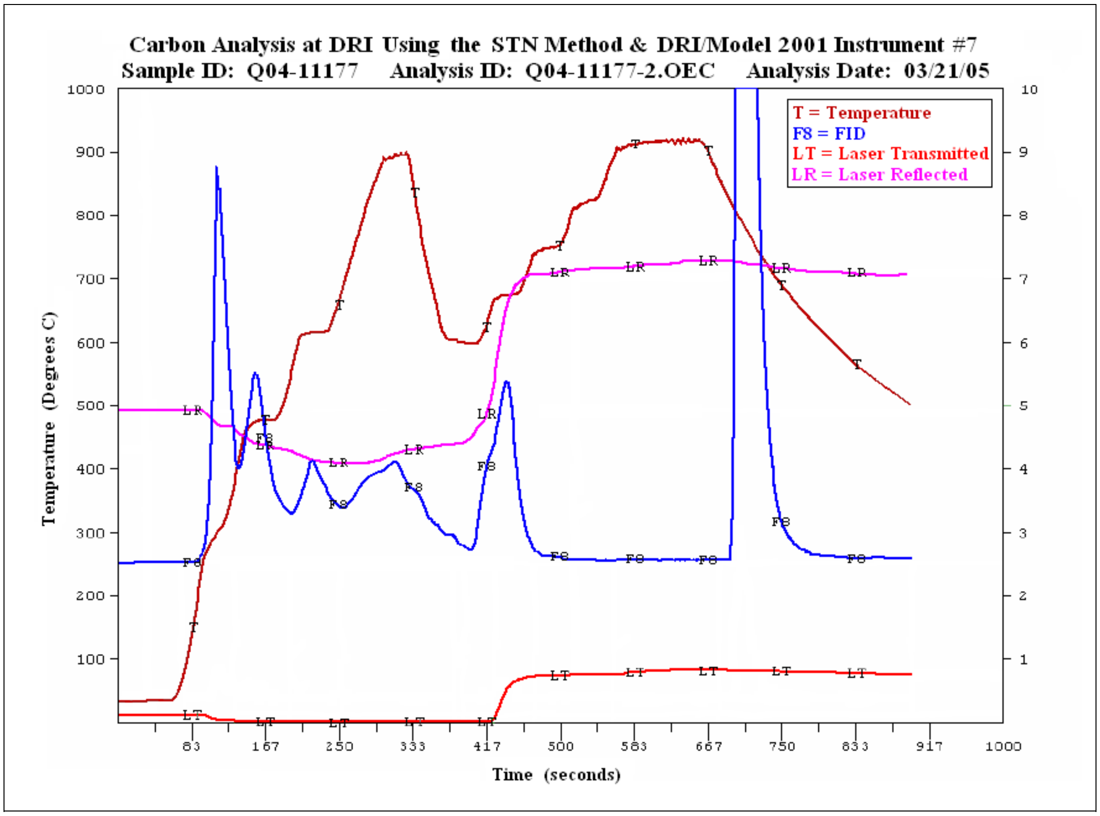


Figure 18

This report includes several thermograms from all of the instruments that were used for this study, and each thermogram was derived from the analysis of a replicate PE sample that was loaded during the collection event which started on April 27, 2004. Figure 18 shows the first thermogram submitted by CARB using their modified STN method and DRI/Model 2001 #1 instrument. CARB has adopted a modified temperature protocol because about three years ago they observed symptoms of trace oxygen contamination during the first [non-oxidizing] stage of their analysis using the STN method. Experiments were performed to learn more about the problem (see reference 19). Their experiments included changes to the temperature protocol. During their experiments, CARB observed the leak symptoms to become less severe as the first stage maximum temperature was reduced from the STN method value of 900°C. The thermogram shows that CARB's method currently uses a 700°C maximum temperature for the first stage of the analysis. The laser signals in Figure 18 still show some evidence of a possible small intrusive ambient air leak. Both laser signals decrease normally from their initial values as char forms. Unfortunately, both signals increase significantly before the oxygen valve opens at approximately 850 seconds into the run. It could be argued that the sample itself contains oxidizing compounds that cause the char to oxidize prematurely. If this were the case, we should see the same symptoms in the thermograms that follow Figure 18.

Figures 19 through 22 show individual thermograms from various instruments using the STN method.

Figure 19



Figures 19 and 20 were produced at DRI using the STN method and DRI/Model 2001 instruments.

Figure 20

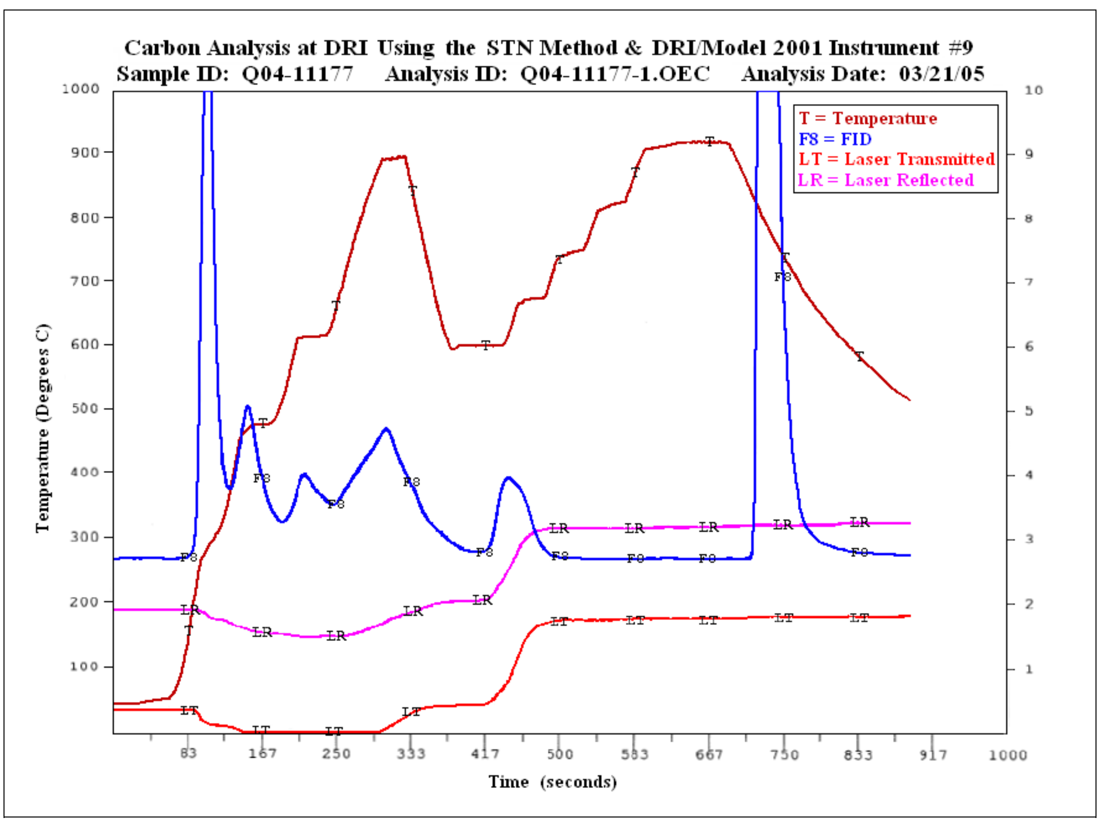


Figure 21

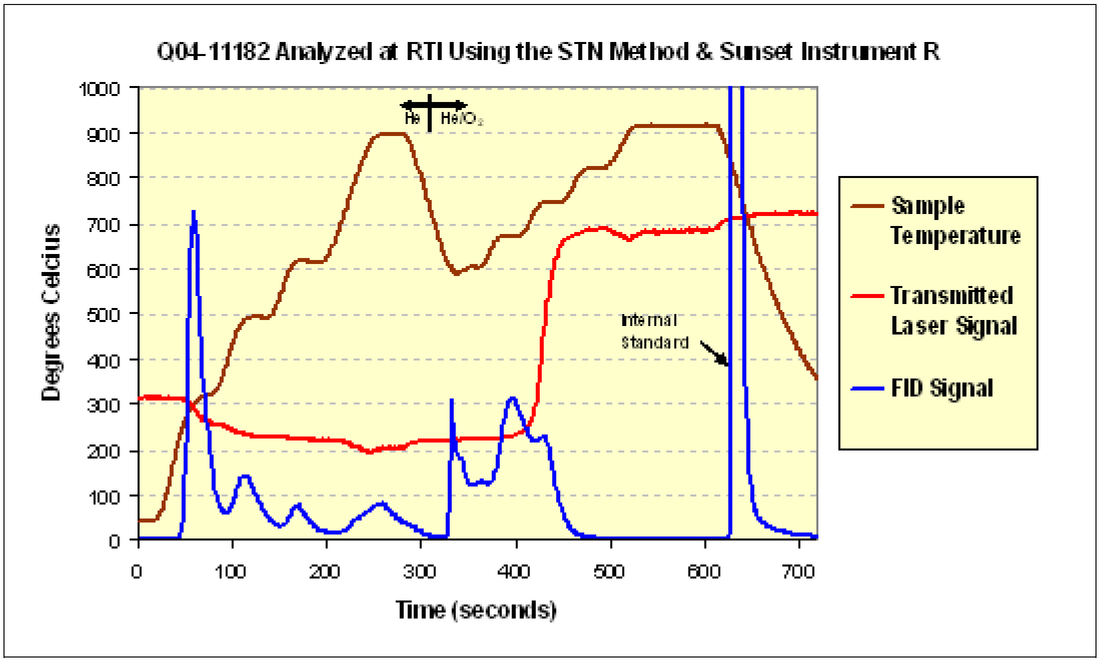


Figure 21 is a thermogram produced at RTI using the STN method and their Sunset instrument R. Figure 22 is a thermogram produced at NAREL using the STN method and their Sunset instrument #1. Both thermograms were produced by an older model Sunset [single mode] instrument, as indicated by a single laser signal, configured to perform the TOT analysis. It should be explained that all of the Sunset thermograms were produced at NAREL from the information inside the raw data files, and the laser signal(s) presented here were not processed using the Sunset software to correct for temperature dependence of the laser/diode system.

Figure 22

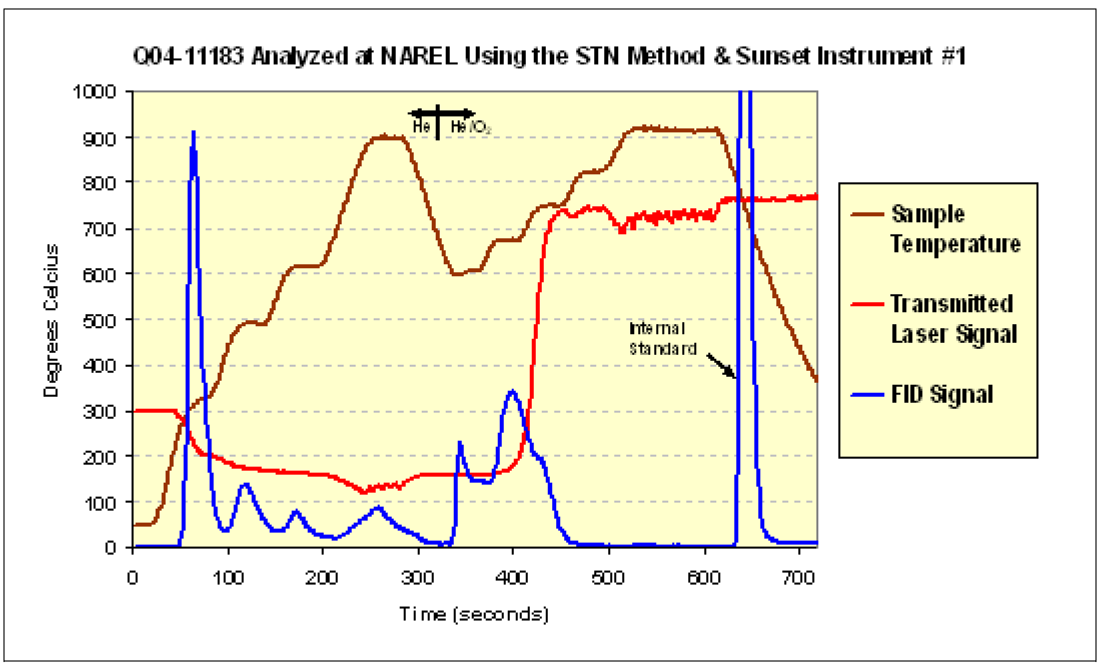


Figure 23

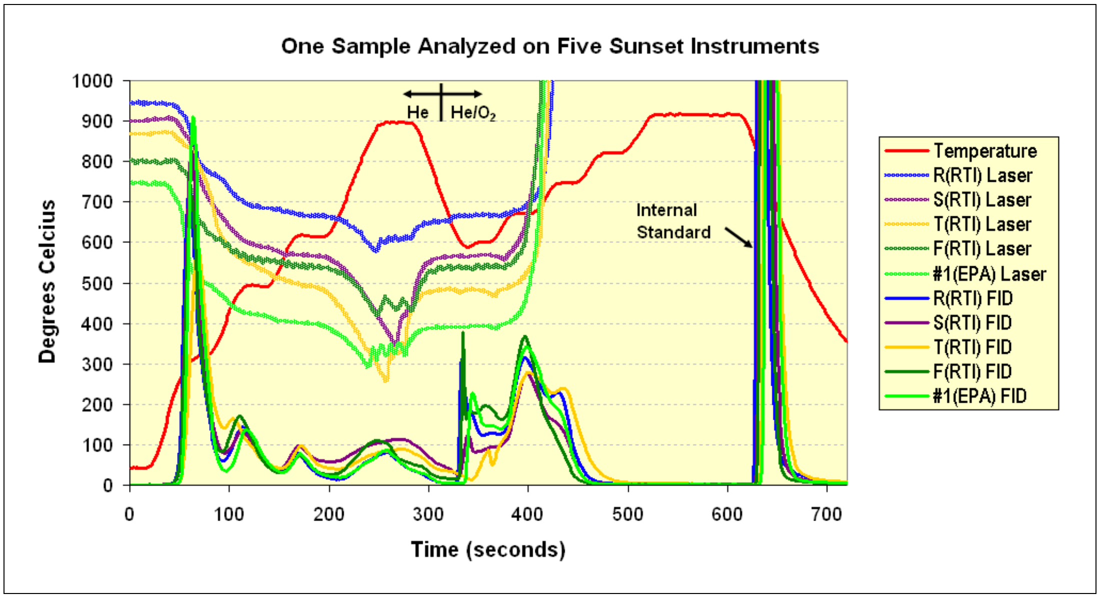


Figure 23 is a composite of five thermograms. Two of the analyses were presented earlier as individual thermograms in Figure 21 and Figure 22. The single temperature trace was taken from the first analysis using the "R" instrument. All of the laser signals have been amplified and allowed to go off-scale during the later part of the thermogram so that critical features of each laser trace may be seen more clearly.

Figure 24 is the first IMPROVE thermogram produced at DRI using the DRI/OGC instrument #4.

Figure 24

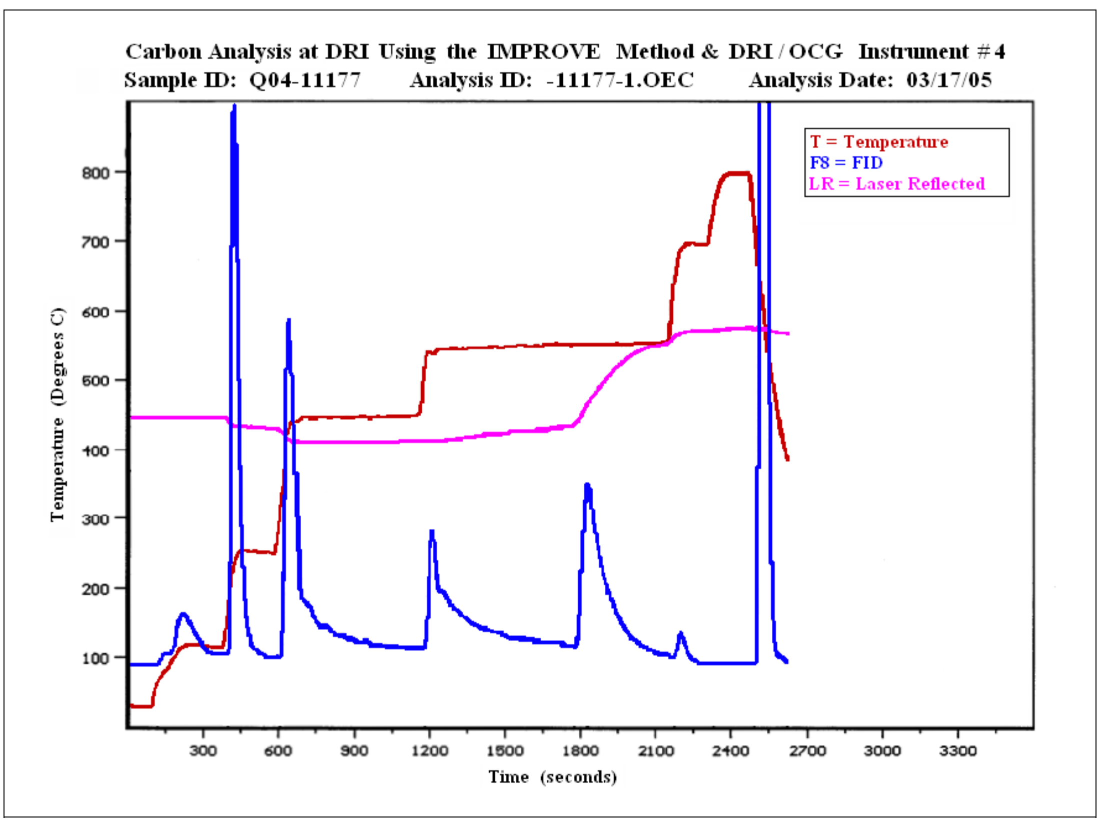


Figure 25

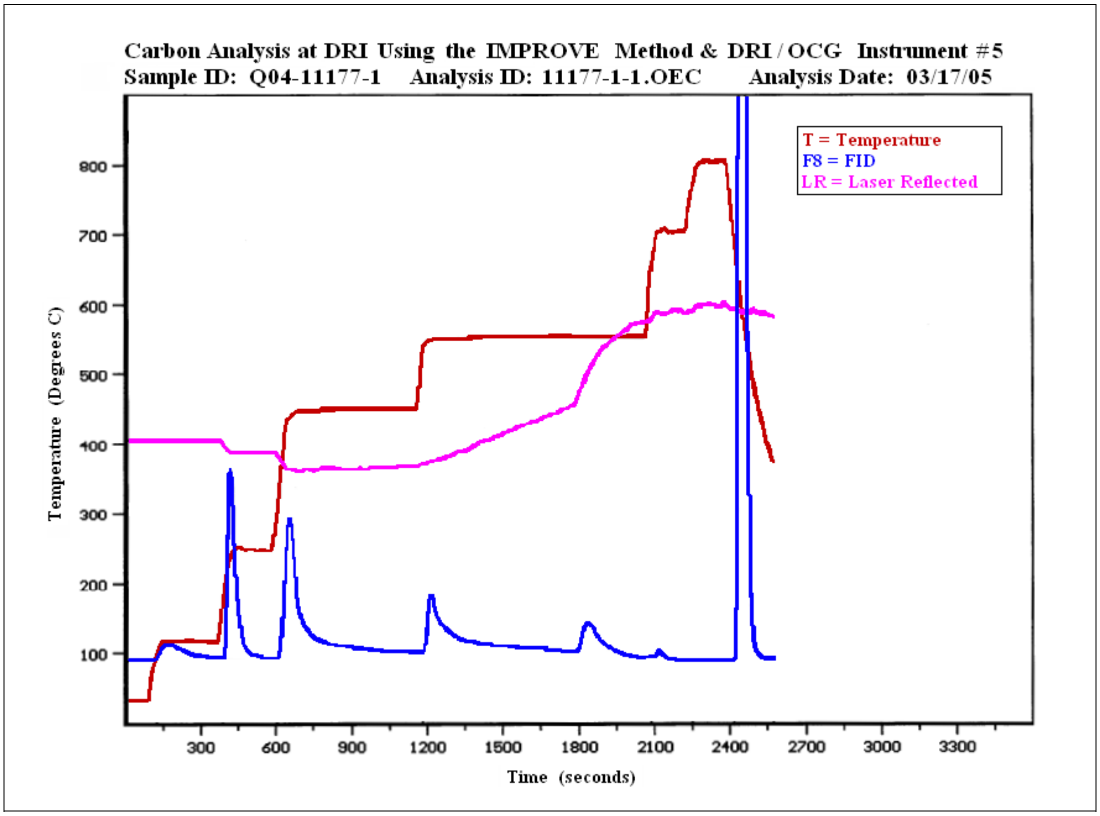


Figure 25 is another IMPROVE thermogram produced at DRI using their DRI/OGC instrument #5. This thermogram shows some evidence of an air leak during the first stage of analysis as indicated by the premature rise of the laser signal before the oxygen valve opens at approximately 1800 seconds. Much less premature rise of the laser signal can be observed in the other IMPROVE thermograms presented in Figures 24, 26, and 27.

Figure 26

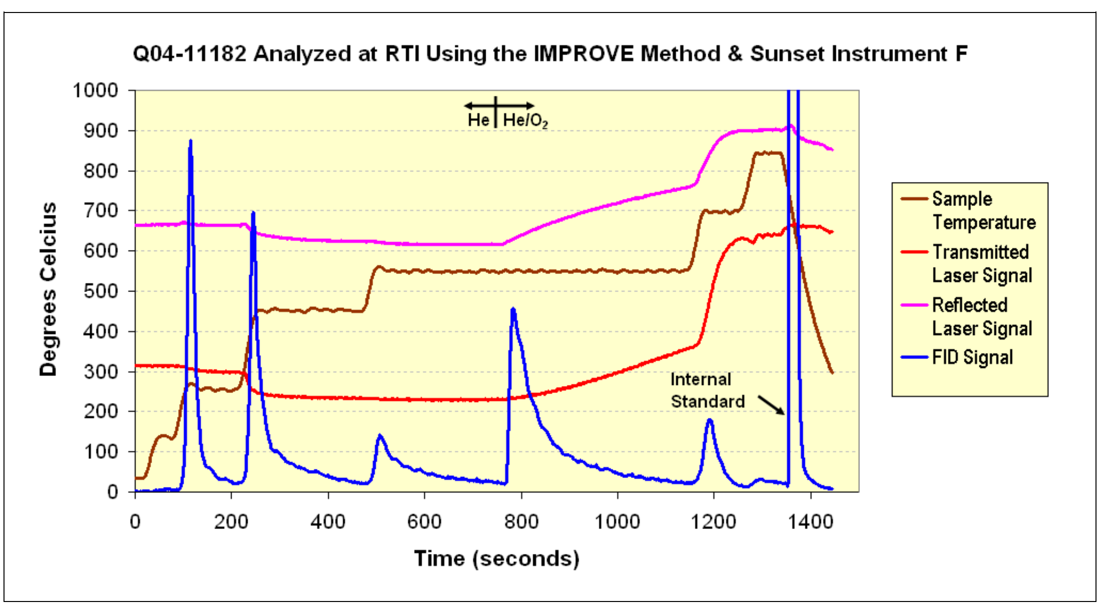


Figure 27

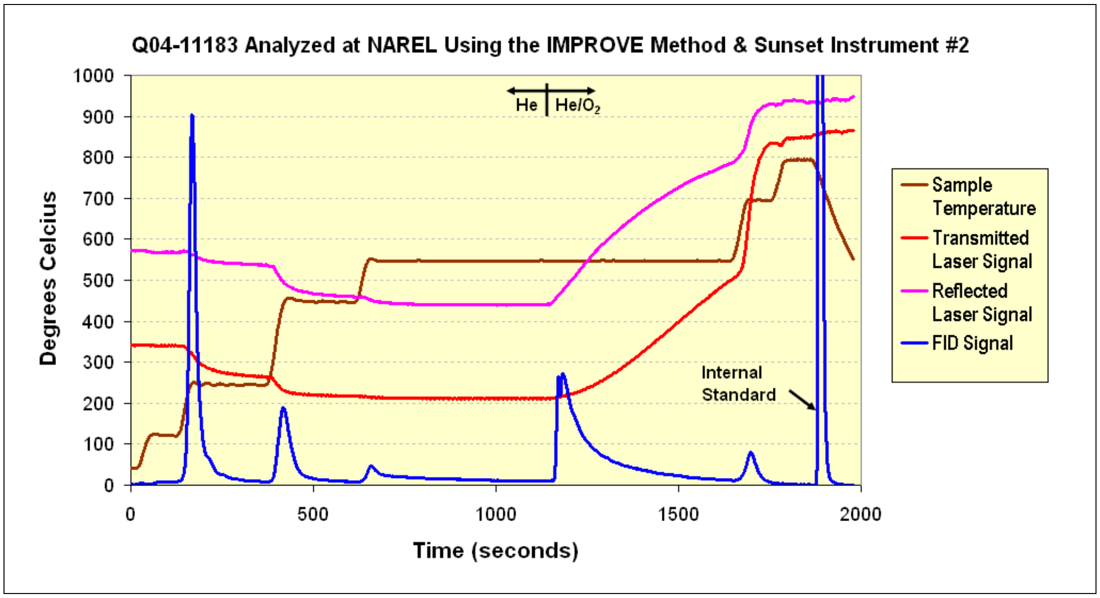


Figure 27 is the last of the IMPROVE thermograms, and Figure 28 is the first of three IMPROVE_A thermograms. Figure 28 was produced at DRI using their DRI/Model 2001 instrument #7. It is easy to interpret from this thermogram that the oxygen valve opened at approximately 1300 seconds and the split point was assigned shortly thereafter at approximately 1350 seconds. Notice that the transmitted laser signal usually supports a split point that is slightly later than the split point supported by the reflected laser signal. In this thermogram, the transmitted laser signals support a split point at approximately 1400 seconds.

Figure 28

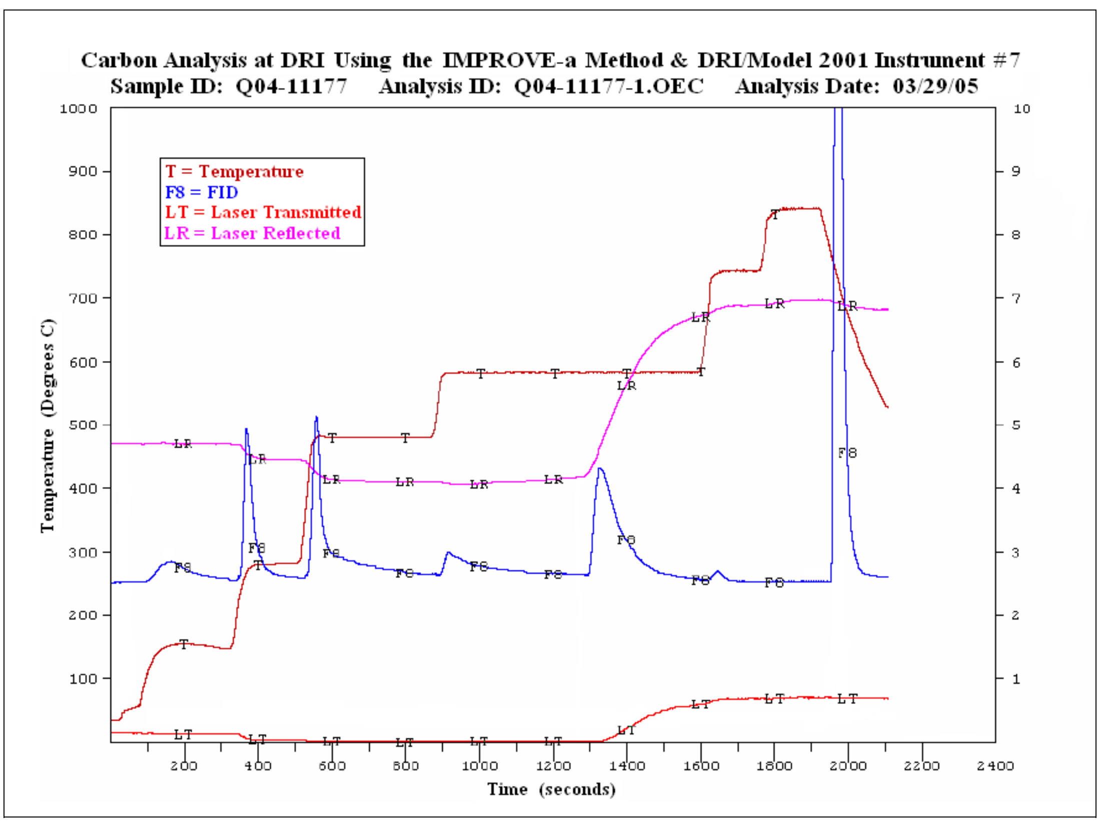


Figure 29

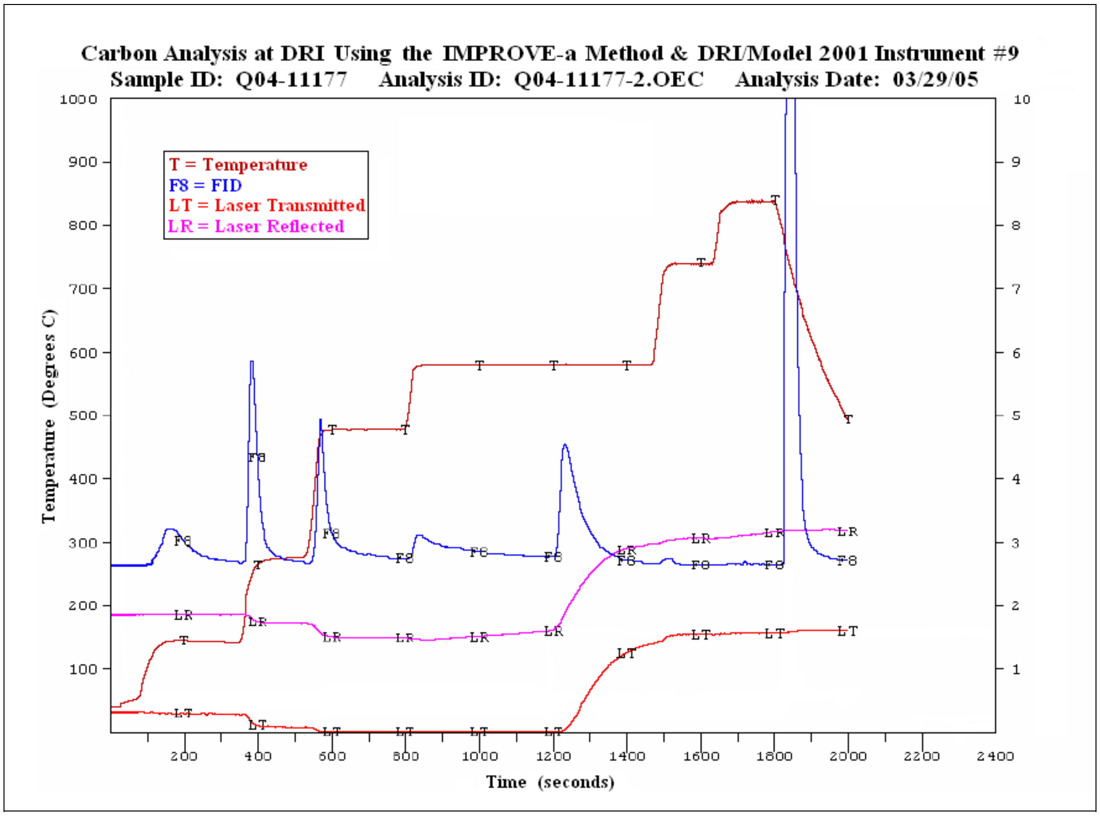
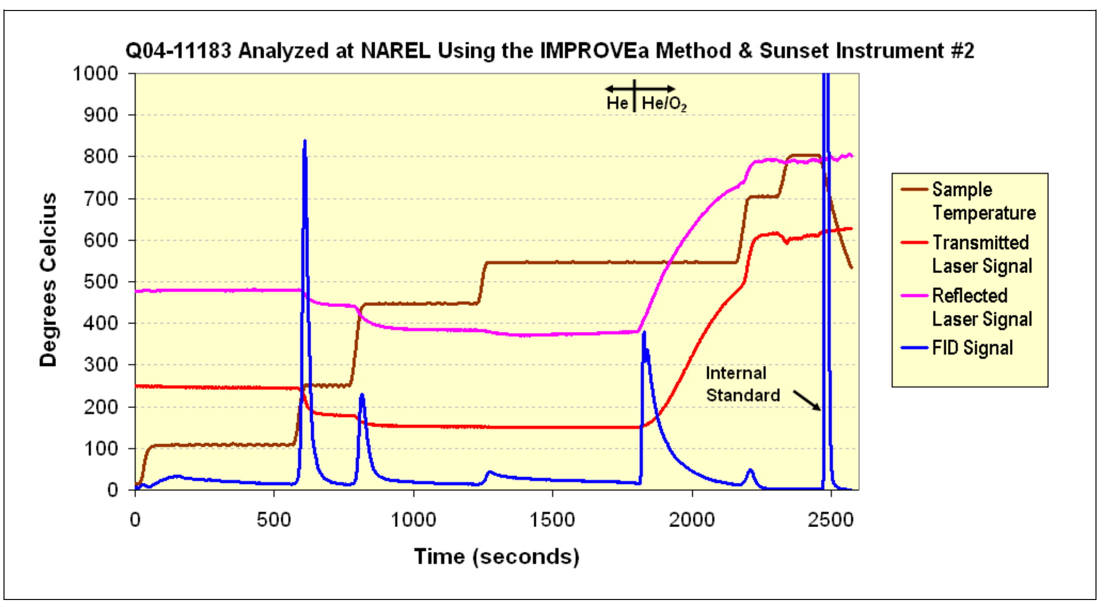


Figure 29 was produced at DRI using the IMPROVE_A method and the DRI/Model 2001 instrument #9. Figure 30 is the last thermogram presented in this report, and it was produced at NAREL using their Sunset (Dual Mode) instrument which was optimized to run the IMPROVE_A method. Thirteen thermograms have been presented, and each one represents the analysis of a stable residue that was loaded onto the filter during a single collection event. Results from all of the quartz filters are presented in Table 11 at the end of this report. This table includes the uncertainty of measurement when it was available. Table 11 also contains results from the blank filters that were part of each set of PE samples.

Figure 30



XRF Analysis

NAREL provided each participating laboratory with a set of six 47-mm filters for elemental analysis using energy dispersive XRF. Each sample set contained two blank filters and four filters that were loaded with $PM_{2.5}$ collected from the Montgomery air. Co-located Met One SuperSASS air samplers were used to load filters and create replicates in each sample set according to the sampling schedule presented in Table 7.

Table 7. Sampling Schedule for XRF PE Filters

Filter ID	Serial Number	Sample Start	Event Duration	Receiving Lab
T04-11257	T2017266	16-Dec-04	138-hr	DRI
T04-11258	T2017268	16-Dec-04	138-hr	DRI
T04-11267	T2017278	23-Dec-04	192-hr	DRI
T04-11268	T2017279	23-Dec-04	192-hr	DRI
T04-11259	T2017269	16-Dec-04	138-hr	ODEQ
T04-11260	T2017270	16-Dec-04	138-hr	ODEQ
T04-11269	T2017280	23-Dec-04	192-hr	ODEQ
T04-11270	T2017281	23-Dec-04	192-hr	ODEQ
T04-11261	T2017271	16-Dec-04	138-hr	RTI
T04-11262	T2017272	16-Dec-04	138-hr	RTI
T04-11271	T2017282	23-Dec-04	192-hr	RTI
T04-11272	T2017283	23-Dec-04	192-hr	RTI
T04-11263	T2017273	16-Dec-04	138-hr	EPA - NERL
T04-11264	T2017274	16-Dec-04	138-hr	EPA - NERL
T04-11273	T2017284	23-Dec-04	192-hr	EPA - NERL
T04-11274	T2017285	23-Dec-04	192-hr	EPA - NERL

Hidden replicate filters were present within each sample set. Table 7 shows that two of the loaded filters in each set were replicates of the same collection event. The results were reported to NAREL as mass of the element per square centimeter of deposit ($\mu g/cm^2$), and a one-sigma uncertainty was provided for each analytical result. Those results were multiplied by the total area of a filter deposit, 11.3 cm^2, to produce final results in units of micrograms of the element per filter (μg/filter).

A request was made for each lab to provide specific information that will help us better understand how the analytical results were produced. A questionnaire was prepared and distributed to each lab. The questionnaire was designed to document those instrument conditions that were used to produce the XRF spectra. The information provided by each lab may be viewed in Tables 13 through 17 at the end of this report.

A second request was made for each lab to provide two specific XRF spectra. As requested, each lab provided the primary spectrum from which aluminum was determined for two samples. One spectrum was created during the analysis of a replicate PE sample collected on December 16, 2004 (see Table 7). The second spectrum was created during the analysis of a PE filter blank. These spectra are included in this report to serve as an example of the raw data produced at each lab.

XRF Results

A large number of XRF results were reported for this study. Forty-eight elements are routinely reported for each sample, and twenty-four samples were reported.

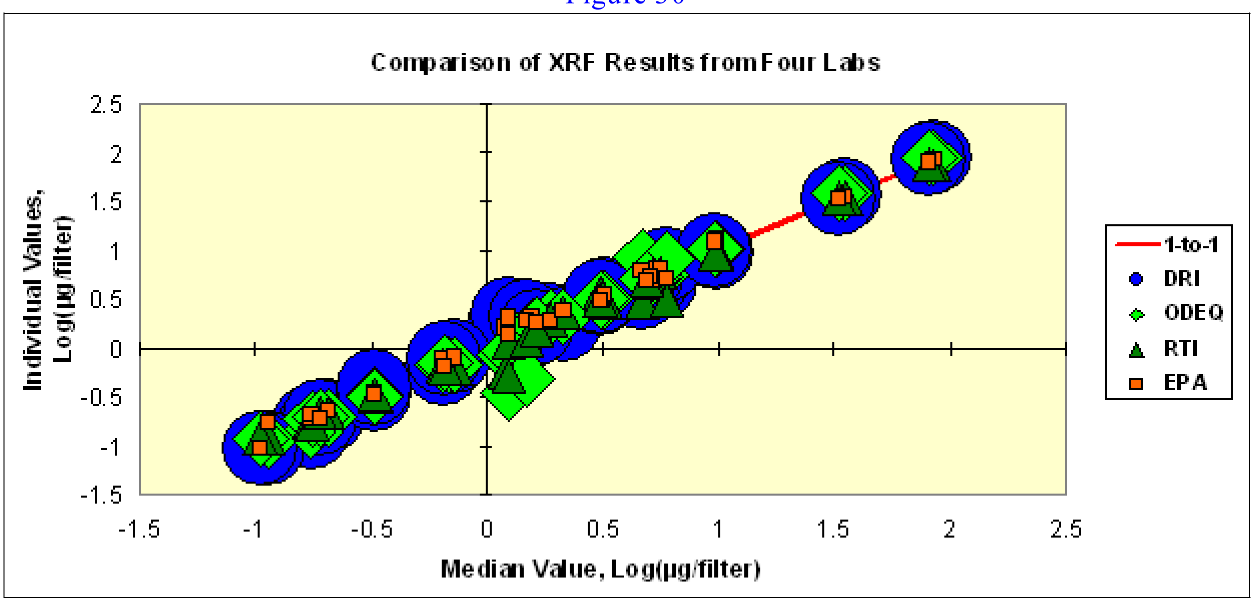
(48 elements/analysis) x (24 analyses) = 1152 results

CARB did not participate in this part of the study because the XRF lab was temporarily out of service due to the purchase of a new instrument. The results from all reporting laboratories are included in Table 12 at the end of this report. Table 12 also contains a median value calculated for some of the elements. A median value was calculated only when all of the reporting labs determined a concentration greater than three times the expressed uncertainty. Six of the heavy elements (Sm, Eu, Tb, Hf, Ta, and Ir) were not included in EPA's analysis, and therefore these EPA results are missing from the table of results.

All of the results have been compared to the median values by constructing a scatter plot shown in Figure 30. A log-log plot was constructed with the median values forming a straight line of unity slope. The corresponding results from all of the labs were superimposed on the median line. Most of the results were very near the median indicating good agreement among the participating labs. Even though Figure 30 gives a quick visual impression of many results that cover a wide range of concentrations, this scatter plot does not identify the element plotted nor the sample.

The more significant XRF results are presented again as stacked bar graphs in Figures 31 and 32. Each bar segment represents an individual value reported by one of the labs. Elements are identified along the horizontal axis, and the elements are arranged from left to right in order of decreasing concentration. The vertical axis of each bar graph is a linear scale, and each bar is normalized to the sum of results reported by all instruments identified in the legend. Each bar segment is color coded to identify the laboratory and labeled to show the reported concentration value. Again, the only results shown in the graphs are those that are significantly above the reported uncertainty. Those significant results can be identified in Table 12 by looking for a calculated median.

Figure 30



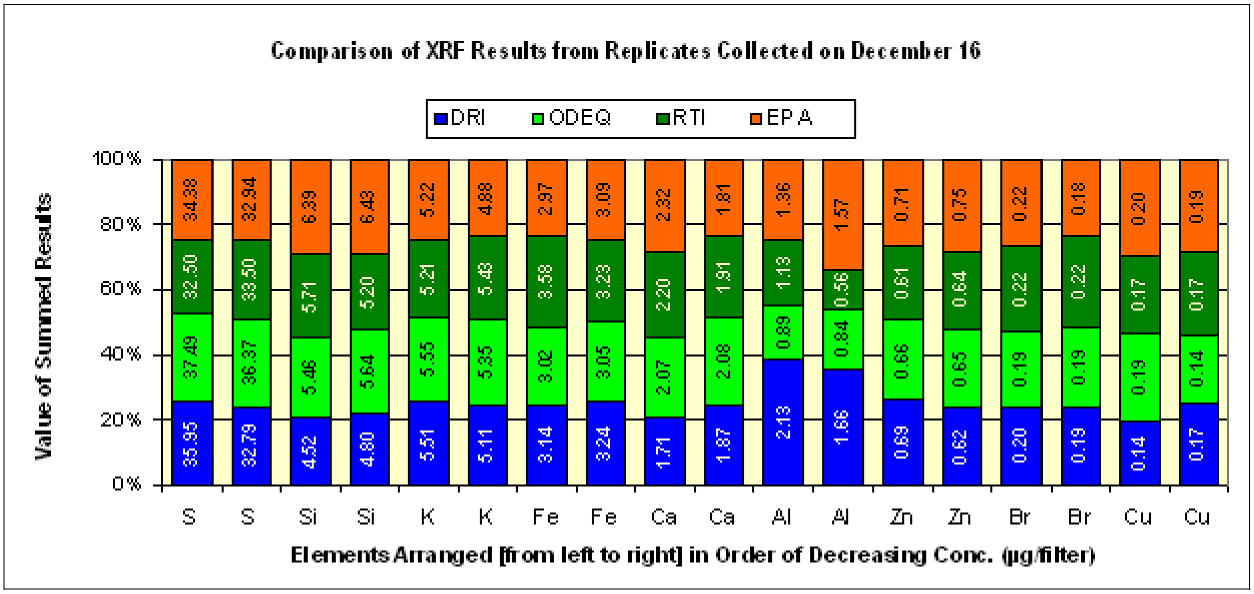


Figure 31

Figure 31 shows results from eight filter replicates created on December 16, 2004, and identified as samples T04-11257 through T04-11264 in Table 12. Two of these replicates were analyzed at each of the four participating laboratories. The most inconsistently reported element in Figure 31 was aluminum with values ranging from 0.56 to 2.13 µg/filter. It is worth noting that aluminum was a very small signal in the raw data spectra produced at all of the labs.

Figure 32 shows results from eight more filter replicates created on December 23, 2004, and identified as samples T04-11267 through T04-11274 in Table 12. The most inconsistent results observed in Figure 32 are for Al and Na, and both of these elements are observed as very small signals within the spectra produced at all of the labs.

Figure 32

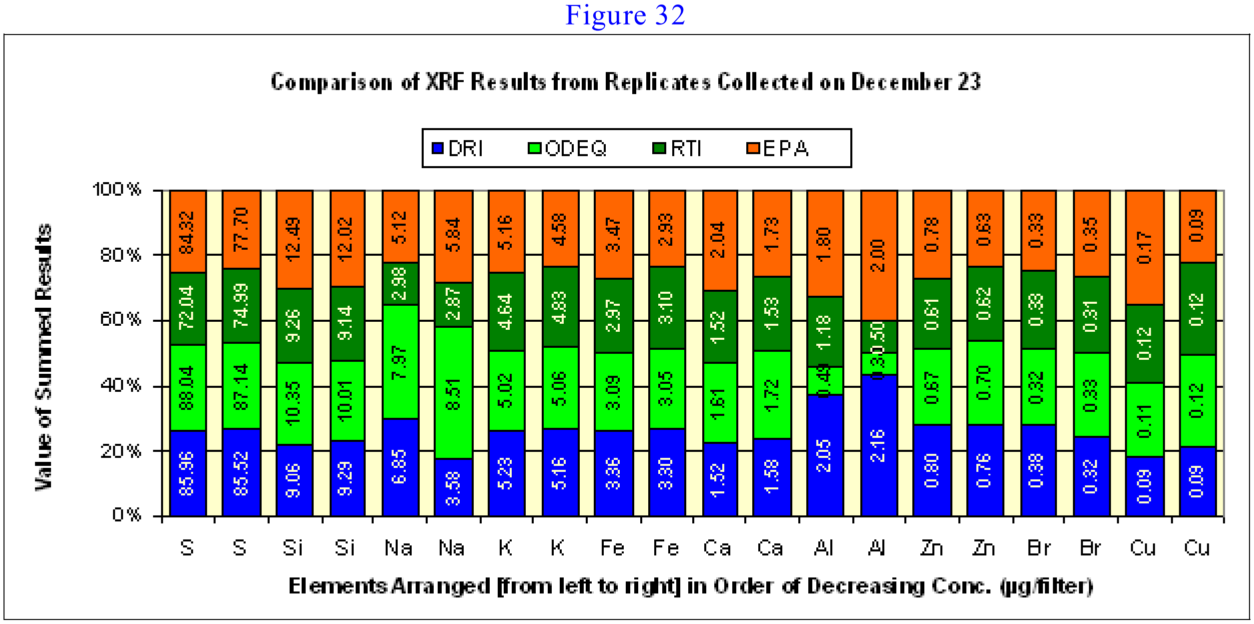
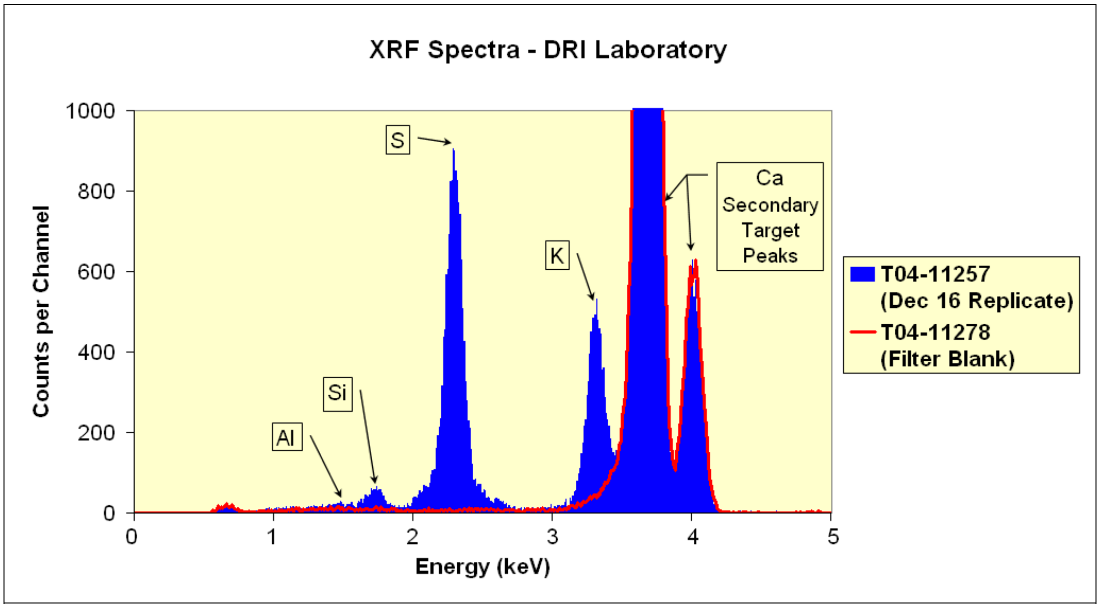


Figure 33



A few spectra have been included in this report to give us an example of the raw data produced at each lab. Figure 33 shows two superimposed spectra that were produced at DRI. The conditions that produced these spectra are listed in column #1 of Table 13 at the end of this report. Al, Si, S, and K were detected above background in sample T04-11257 based upon these spectra.

Figure 34 shows two superimposed spectra that were produced at ODEQ. The conditions that produced these spectra are listed in column #1 of Table 14 at the end of this report. Al, Si, S, and K were detected above background in sample T04-11259 based upon these spectra. It is especially interesting to look at the signal for Al in all of the sepctra, since all of the labs reported Al present [above background] in the December 16 replicates.

Figure 34

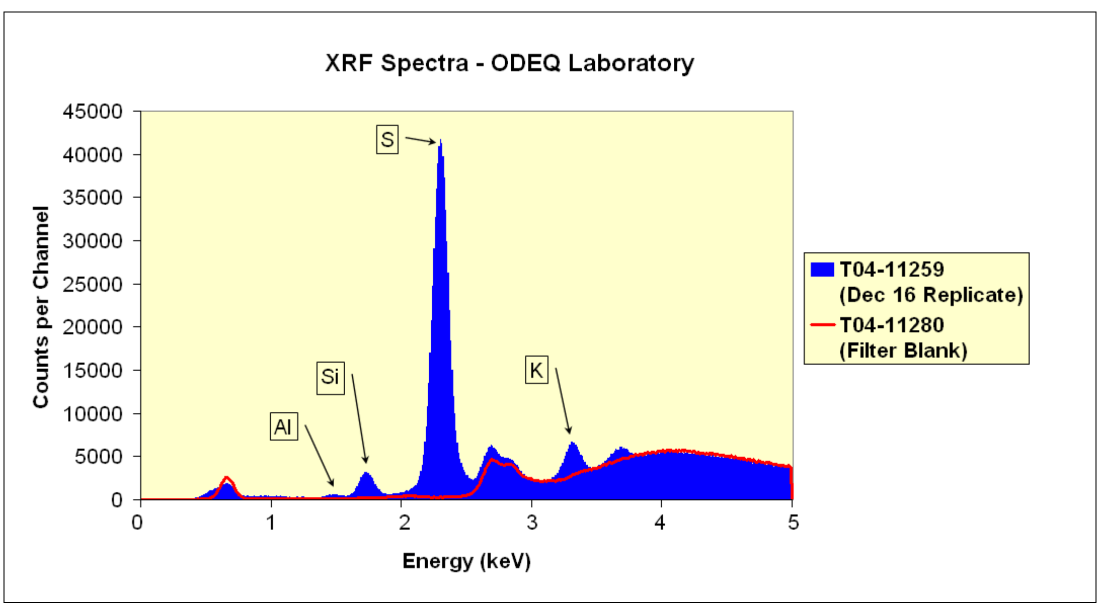


Figure 35

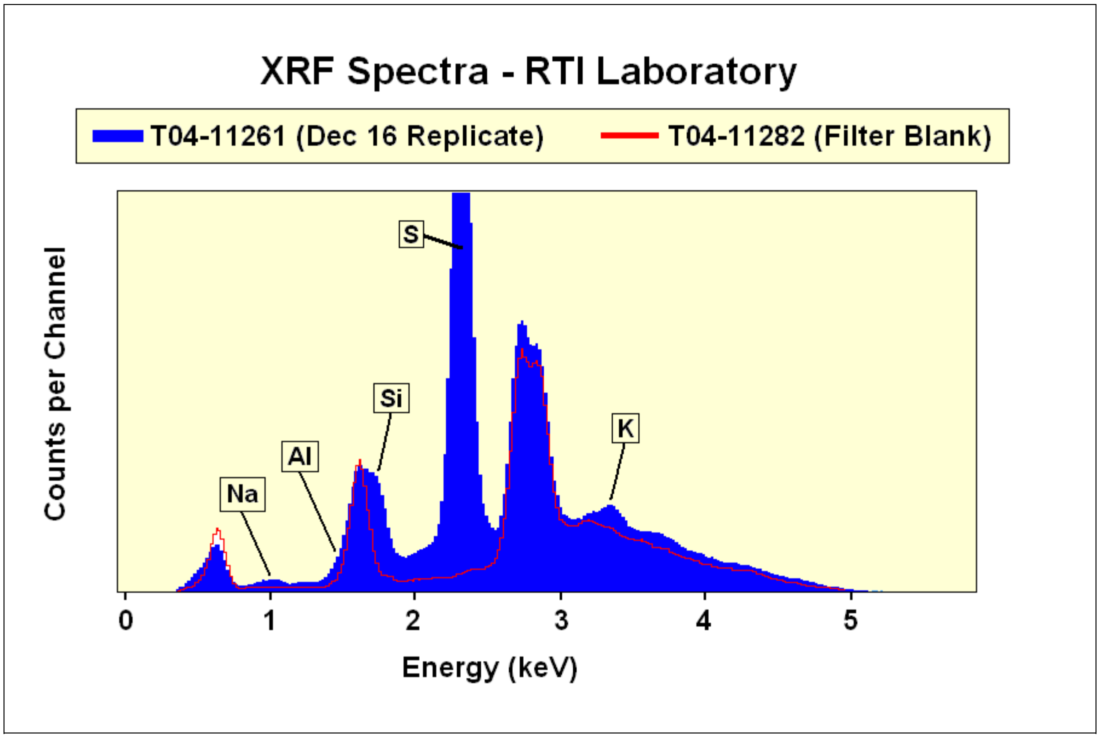
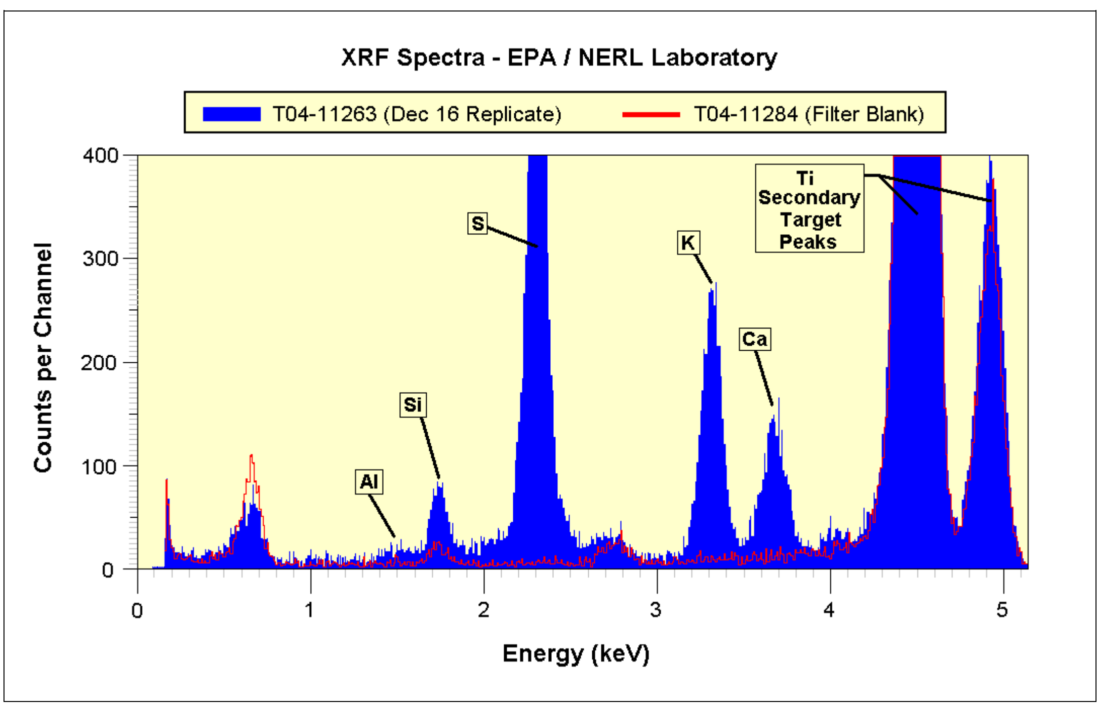


Figure 35 shows spectra that were produced at RTI using the conditions listed in column #1 of Table 16. Our last spectra shown in Figure 36 were produced at EPA's NERL facility using the conditions listed in column #5 of Table 17. We appreciate the effort that our participating labs made to provide us with the raw data presented here.

Figure 36



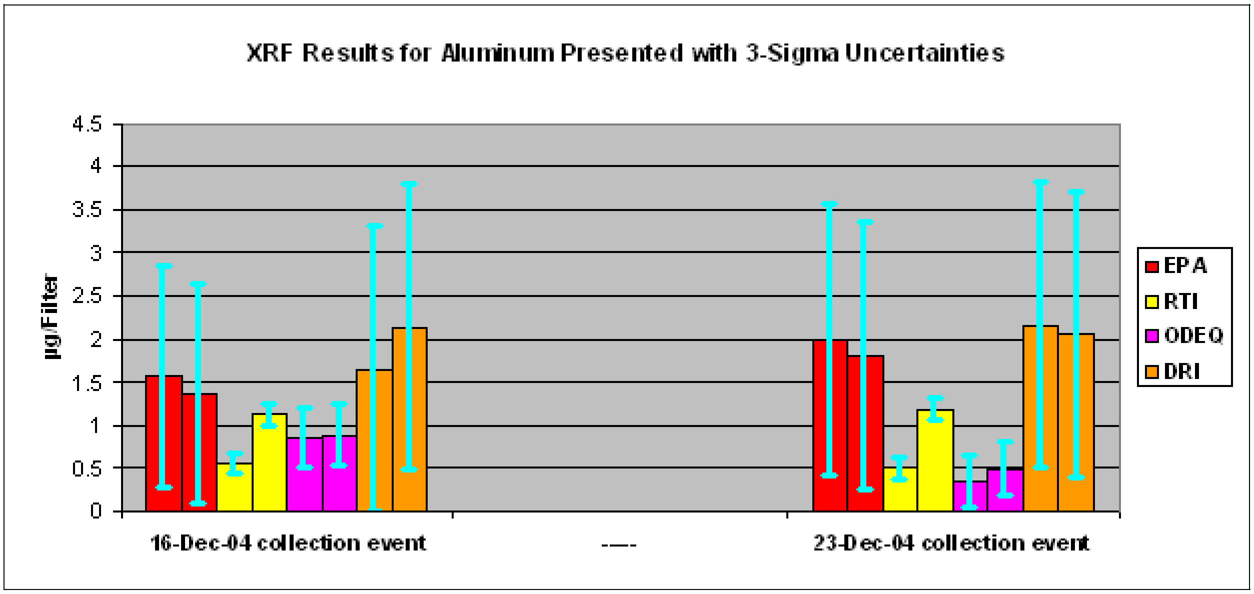


Figure 37

Figure 37 presents another view of the XRF results for aluminum which allows us to examine the uncertainty reported by each lab. Notice that the error bars represent a 3-sigma uncertainty which was used to select those results presented previously in Figures 30 through 32. Figure 37 shows results from eight filter replicates that were collected on December 16 and eight filter replicates that were collected on December 23. It is a worthy exercise to compare the spectra presented earlier with the uncertainties presented here. It is surprising that RTI consistently reported the smallest uncertainty for both collection events since RTI's spectra [in Figure 35] contain a significant interference very near aluminum.

Figure 38 presents a similar view of the XRF results for silicon. RTI reported substantially smaller uncertainties for silicon even though the spectrum shows silicon as a shoulder on the interference peak. All four of the labs actually determined silicon and aluminum from the spectra presented in this report.

Figure 38

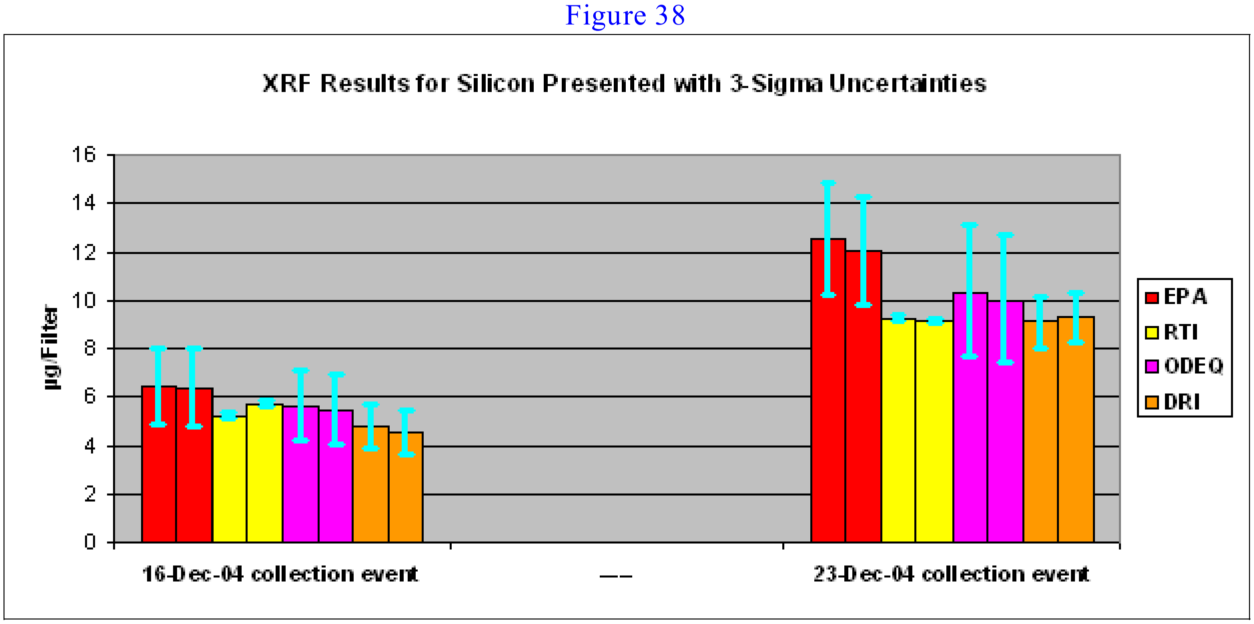


Table 8. Summary of XRF Results and Uncertainties (µg/filter)	EPA Results	EPA Uncert.	RTI Results	RTI Uncert.	ODEQ Results	ODEQ Uncert.	DRI Results	DRI Uncert.
Replicates from Dec 16								
Mean	1.475	0.141	1.169	0.034	1.164	0.261	1.272	0.194
Max	34.381	1.011	33.505	0.158	37.487	3.020	35.945	0.951
Min	-0.659	0.014	0.000	0.004	-1.153	0.008	0.000	0.006
Std. Dev.	5.266	0.208	4.823	0.035	5.399	0.591	5.025	0.253
Count	84	84	96	96	96	96	96	96
Replicates from Dec 23								
Mean	2.787	0.183	2.069	0.037	2.452	0.376	2.532	0.204
Max	84.316	2.287	74.987	0.237	88.042	7.077	85.959	0.993
Min	-0.064	0.015	0.000	0.004	-0.921	0.009	0.000	0.006
Std. Dev.	12.489	0.370	10.593	0.046	12.646	1.091	12.328	0.265
Count	84	84	96	96	96	96	96	96
Blank Filters								
Mean	0.062	0.076	0.001	0.023	-0.064	0.163	0.048	0.184
Max	1.037	0.554	0.023	0.131	0.042	2.258	1.401	0.942
Min	-0.462	0.014	0.000	0.002	-1.449	0.007	0.000	0.001
Std. Dev.	0.223	0.104	0.004	0.025	0.216	0.433	0.163	0.248
Count	84	84	96	96	96	96	96	96

Table 8 is a summary of the XRF results and the uncertainties grouped by sample type. For each sample type, two filters were analyzed at each lab. Each lab reported 96 results for each sample type, except for the EPA lab. We should remember that six of the heavy elements (Sm, Eu, Tb, Hf, Ta, and Ir) were not included in EPA's analysis, and this may skew the statistics to some extent. It is appropriate to compare these statistics as long as we fully appreciate the fact that there was no "true value" for any of the results with the possible exception of the blank filters. It is worth noting that for all three sample types, the mean uncertainty reported by RTI is considerably smaller than the mean uncertainty reported by the other labs. This may indicate a real difference in the way uncertainties are calculated at RTI, or it may indicate a real difference in the raw data itself. This report has presented only a small sample of the raw data.

Conclusions

This study was designed to evaluate the analytical performance of several $PM_{2.5}$ speciation labs. The approach was simple. Each lab analyzed an almost identical set of blind PE samples, and the results reported from all of the labs have been compared. The scope of this study included four analytical techniques, and multiple methods were reported for IC, TOA carbon, and XRF. At least one EPA lab was able to report results for most of the methods used during this study.

Four labs analyzed a set of PE samples for gravimetric mass, and all of the labs performed well. Results for all of the samples were inside the 3-sigma advisory limits established by NAREL.

Five different labs reported IC results for at least one set of PE samples, and only one problem was observed in the IC results. NAREL reported poor analytical precision for chloride that was present in two replicates. No other problems were observed in the IC results.

Four labs analyzed a set of quartz PE filters, and all of the labs, except CARB, analyzed each filter multiple times in order to report results from more than one instrument and also report results using more than one TOA method. Ultimately a total of fifteen data packages were used to report TOA results, and we should remember that each data package contained hidden replicates. Good precision was observed for all of the TC values reported, regardless of method and regardless of instrument. As expected, the precision was best for TC followed closely by OC. EC results for the STN method were lower than EC results reported for the IMPROVE and IMPROVE_A methods. The worst precision was observed for the DRI/OGC instruments running the IMPROVE method. There was some evidence in the raw data that trace oxygen contamination may have contributed to the lower precision observed in the carbon subfractions than in total OC or total EC. Raw data from the CARB instrument also contained some evidence of a small intrusive air leak. The thermograms included in this report help show critical information that is difficult to communicate with text.

None of the labs that reported XRF results used the same instrument. Therefore different hardware and different software were used to produce the results. XRF spectra were presented to illustrate the dramatic differences in raw data even though replicate samples were analyzed. Despite these facts, good agreement was observed for most of the elements that were significantly above the reported uncertainty. The largest disagreement in the XRF results was observed for aluminum and sodium. Both of these elements produce poor instrument response [compared to heavier elements], and larger uncertainties are expected for the lighter elements. This study has raised an important question about how uncertainties are calculated. There is no standard method for calculating the uncertainty. Each lab used a custom method to calculate the XRF uncertainty. It would be difficult to predict the outcome of using a single method at all labs since there were significant differences in the raw data.

Special effort has been made to collect information from the participating labs that help us better understand how the analytical results were produced. And that information has been included in this report. The author would like to take this opportunity to thank those individuals who answered questions, responded to the questionnaire, and provided the requested raw data. They have helped make this a better report!

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Table 9. Gravimetric Mass PE Results

Sample ID	Sample Description	Tare Mass		Final Mass		Captured $PM_{2.5}$		Inter-Lab Difference* of Captured $PM_{2.5}$ (mg)	Name of the Test Lab
		Test Lab (mg)	NAREL (mg)	Test Lab (mg)	NAREL (mg)	Test Lab (mg)	NAREL (mg)		
T05-11285	24-hr collection event, 01/20/05	145.839	145.838	146.073	146.074	0.234	0.236	0.002	CARB
T05-11286	24-hr collection event, 01/20/05	145.389	145.389	145.646	145.644	0.257	0.255	-0.002	CARB
T05-11287	48-hr collection event, 01/21/05	143.933	143.935	144.237	144.239	0.304	0.304	0.000	CARB
T05-11288	48-hr collection event, 01/21/05	144.683	144.685	144.982	144.990	0.299	0.305	0.006	CARB
T05-11289	12-hr collection event, 01/23/05	145.799	145.797	145.834	145.833	0.035	0.036	0.001	CARB
T05-11290	12-hr collection event, 01/23/05	141.825	141.822	141.868	141.865	0.043	0.043	0.000	CARB
T05-11291	24-hr collection event, 01/24/05	142.169	142.169	142.269	142.265	0.100	0.096	-0.004	CARB
T05-11292	filter blank	141.304	141.302	141.310	141.306	0.006	0.004	-0.002	CARB
T05-11293	filter blank	141.055	141.054	141.058	141.056	0.003	0.002	-0.001	CARB
T05-11294	filter blank	142.774	142.773	142.781	142.777	0.007	0.004	-0.003	CARB
MW05-11325	metallic transfer weight	94.833	94.834	94.831	94.834	-0.002	0.000	0.002	DRI
MW05-11326	metallic transfer weight	190.521	190.521	190.520	190.522	-0.001	0.001	0.002	DRI
T05-11295	24-hr collection event, 01/20/05	143.964	143.952	144.191	144.182	0.227	0.230	0.003	DRI
T05-11296	24-hr collection event, 01/20/05	144.544	144.531	144.778	144.768	0.234	0.237	0.003	DRI
T05-11297	48-hr collection event, 01/21/05	143.429	143.415	143.724	143.716	0.295	0.301	0.006	DRI
T05-11298	48-hr collection event, 01/21/05	141.519	141.506	141.817	141.806	0.298	0.300	0.002	DRI
T05-11299	12-hr collection event, 01/23/05	140.397	140.383	140.435	140.424	0.038	0.041	0.003	DRI
T05-11300	12-hr collection event, 01/23/05	141.449	141.436	141.488	141.476	0.039	0.040	0.001	DRI
T05-11301	24-hr collection event, 01/24/05	142.167	142.155	142.263	142.252	0.096	0.097	0.001	DRI
T05-11302	filter blank	143.707	143.694	143.710	143.696	0.003	0.002	-0.001	DRI
T05-11303	filter blank	139.756	139.744	139.759	139.745	0.003	0.001	-0.002	DRI
T05-11304	filter blank	143.332	143.318	143.333	143.320	0.001	0.002	0.001	DRI
MW05-11327	metallic transfer weight	97.351	97.356	97.350	97.356	-0.001	0.000	0.001	DRI
MW05-11328	metallic transfer weight	196.224	196.235	196.223	196.235	-0.001	0.000	0.001	DRI

Table 9. Gravimetric Mass PE Results

Sample ID	Sample Description	Tare Mass		Final Mass		Captured $PM_{2.5}$		Inter-Lab Difference* of Captured $PM_{2.5}$ (mg)	Name of the Test Lab
		Test Lab (mg)	NAREL (mg)	Test Lab (mg)	NAREL (mg)	Test Lab (mg)	NAREL (mg)		
T05-11305	24-hr collection event, 01/20/05	144.336	144.337	144.559	144.566	0.223	0.229	0.006	ODEQ
T05-11306	24-hr collection event, 01/20/05	142.974	142.972	143.197	143.205	0.223	0.233	0.010	ODEQ
T05-11307	48-hr collection event, 01/21/05	139.657	139.657	139.951	139.961	0.294	0.304	0.010	ODEQ
T05-11308	48-hr collection event, 01/21/05	141.301	141.301	141.587	141.594	0.286	0.293	0.007	ODEQ
T05-11309	12-hr collection event, 01/23/05	142.031	142.029	142.062	142.072	0.031	0.043	0.012	ODEQ
T05-11310	12-hr collection event, 01/23/05	141.468	141.468	141.500	141.505	0.032	0.037	0.005	ODEQ
T05-11311	24-hr collection event, 01/24/05	142.483	142.484	142.575	142.584	0.092	0.100	0.008	ODEQ
T05-11312	filter blank	141.487	141.487	141.489	141.490	0.002	0.003	0.001	ODEQ
T05-11313	filter blank	142.208	142.208	142.209	142.211	0.001	0.003	0.002	ODEQ
T05-11314	filter blank	140.697	140.698	140.698	140.703	0.001	0.005	0.004	ODEQ
MW05-11329	metallic transfer weight	93.775	93.776	93.775	93.776	0.000	0.000	0.000	ODEQ
MW05-11330	metallic transfer weight	188.879	188.880	188.878	188.880	-0.001	0.000	0.001	ODEQ
T05-11315	24-hr collection event, 01/20/05	139.752	139.751	139.972	139.978	0.220	0.227	0.007	RTI analyst 1
T05-11316	24-hr collection event, 01/20/05	139.527	139.527	139.749	139.765	0.222	0.238	0.016	RTI analyst 1
T05-11317	48-hr collection event, 01/21/05	142.196	142.196	142.483	142.491	0.287	0.295	0.008	RTI analyst 1
T05-11318	48-hr collection event, 01/21/05	142.533	142.531	142.829	142.838	0.296	0.307	0.011	RTI analyst 1
T05-11319	12-hr collection event, 01/23/05	141.306	141.306	141.336	141.344	0.030	0.038	0.008	RTI analyst 1
T05-11320	12-hr collection event, 01/23/05	140.549	140.549	140.584	140.593	0.035	0.044	0.009	RTI analyst 1
T05-11321	24-hr collection event, 01/24/05	140.300	140.297	140.389	140.400	0.089	0.103	0.014	RTI analyst 1
T05-11322	filter blank	141.646	141.648	141.648	141.651	0.002	0.003	0.001	RTI analyst 1
T05-11323	filter blank	145.693	145.692	145.692	145.696	-0.001	0.004	0.005	RTI analyst 1
T05-11324	filter blank	141.573	141.574	141.573	141.578	0.000	0.004	0.004	RTI analyst 1
MW05-11331	metallic transfer weight	97.545	97.546	97.545	97.546	0.000	0.000	0.000	RTI analyst 1
MW05-11332	metallic transfer weight	192.421	192.422	192.422	192.421	0.001	-0.001	-0.002	RTI analyst 1

Table 10. Ion Chromatography PE Results

Sample ID	Filter Medium	Sample Description	Lab	Method	Concentration (µg/filter) Chloride	Nitrate	Nitrite	Sulfate	Ammonium	Potassium	Sodium
N04-11197	Nylon®	116-hr event, 11/24/04	CARB	STN	-----	22.484	-----	72.523	27.236	1.898	1.737
N04-11198	Nylon®	116-hr event, 11/24/04	CARB	STN	-----	24.106	-----	72.282	26.203	1.877	1.712
N04-11199	Nylon®	116-hr event, 11/24/04	DRI	STN	-----	24.039	-----	77.679	29.991	1.865	0.948
N04-11200	Nylon®	116-hr event, 11/24/04	DRI	STN	-----	23.931	-----	75.704	28.340	1.943	1.166
N04-11201	Nylon®	116-hr event, 11/24/04	ODEQ	STN	-----	26.700	-----	79.100	28.600	2.070	<3.6
N04-11202	Nylon®	116-hr event, 11/24/04	ODEQ	STN	-----	25.300	-----	77.600	27.600	1.920	<3.6
N04-11203	Nylon®	116-hr event, 11/24/04	RTI	STN	-----	24.496	-----	76.586	25.559	2.147	1.744
N04-11204	Nylon®	116-hr event, 11/24/04	RTI	STN	-----	23.129	-----	73.608	25.117	2.126	1.796
N04-11205	Nylon®	116-hr event, 11/24/04	NAREL	STN	-----	24.977	-----	74.782	23.975	2.289	1.061
N04-11206	Nylon®	116-hr event, 11/24/04	NAREL	STN	-----	25.489	-----	74.382	24.138	2.051	0.941
N04-11208	Nylon®	159-hr event, 11/29/04	CARB	STN	-----	64.668	-----	179.290	79.350	4.506	3.679
N04-11209	Nylon®	159-hr event, 11/29/04	CARB	STN	-----	71.148	-----	182.763	83.395	4.547	3.130
N04-11210	Nylon®	159-hr event, 11/29/04	DRI	STN	-----	71.388	-----	172.308	84.330	4.320	2.445
N04-11211	Nylon®	159-hr event, 11/29/04	DRI	STN	-----	73.851	-----	169.050	84.293	4.205	2.610
N04-11212	Nylon®	159-hr event, 11/29/04	ODEQ	STN	-----	79.700	-----	178.000	80.700	3.940	<3.6
N04-11213	Nylon®	159-hr event, 11/29/04	ODEQ	STN	-----	71.400	-----	181.000	78.300	3.970	<3.6
N04-11214	Nylon®	159-hr event, 11/29/04	RTI	STN	-----	63.602	-----	173.368	75.905	3.960	3.397
N04-11215	Nylon®	159-hr event, 11/29/04	RTI	STN	-----	63.719	-----	172.912	75.583	3.967	2.798
N04-11216	Nylon®	159-hr event, 11/29/04	NAREL	STN	-----	62.957	-----	168.679	65.752	4.888	2.411
N04-11217	Nylon®	159-hr event, 11/29/04	NAREL	STN	-----	68.779	-----	173.945	69.657	5.044	2.330
N04-11219	Nylon®	filter blank	CARB	STN	-----	BMDL*	-----	BMDL*	BMDL*	BMDL*	BMDL*
N04-11220	Nylon®	filter blank	CARB	STN	-----	3.323	-----	BMDL*	BMDL*	BMDL*	BMDL*
N04-11221	Nylon®	filter blank	DRI	STN	-----	0.000	-----	0.000	0.189	0.000	0.081
N04-11222	Nylon®	filter blank	DRI	STN	-----	0.000	-----	0.000	0.114	0.000	0.000
N04-11223	Nylon®	filter blank	ODEQ	STN	-----	<1.4	-----	<1.4	<0.72	<1.1	<3.6
N04-11224	Nylon®	filter blank	ODEQ	STN	-----	<1.4	-----	<1.4	<0.72	<1.1	<3.6
N04-11225	Nylon®	filter blank	RTI	STN	-----	1.537	-----	BMDL*	BMDL*	BMDL*	0.050
N04-11226	Nylon®	filter blank	RTI	STN	-----	0.878	-----	BMDL*	BMDL*	BMDL*	0.030

Table 10. Ion Chromatography PE Results

Sample ID	Filter Medium	Sample Description	Lab	Method	Concentration (µg/filter) Chloride	Nitrate	Nitrite	Sulfate	Ammonium	Potassium	Sodium
N04-11227	Nylon®	filter blank	NAREL	STN	-----	BMDL*	-----	BMDL*	BMDL*	BMDL*	BMDL*
N04-11228	Nylon®	filter blank	NAREL	STN	-----	BMDL*	-----	BMDL*	BMDL*	BMDL*	BMDL*
N04-11229	Nylon®	161-hr event, 12/07/04	RTI	IMPROVE	7.641	63.645	2.698	163.338	60.791	-----	-----
N04-11230	Nylon®	161-hr event, 12/07/04	RTI	IMPROVE	8.273	65.815	1.533	161.422	60.242	-----	-----
N04-11231	Nylon®	161-hr event, 12/07/04	NAREL	IMPROVE	8.285	64.306	0.602	156.938	53.281	-----	-----
N04-11232	Nylon®	161-hr event, 12/07/04	NAREL	IMPROVE	3.506	53.172	0.633	158.214	53.945	-----	-----
N04-11233	Nylon®	161-hr event, 12/07/04	RTI	IMPROVE	2.836	39.038	0.855	142.790	51.997	-----	-----
N04-11234	Nylon®	161-hr event, 12/07/04	RTI	IMPROVE	2.926	39.349	0.976	141.670	50.925	-----	-----
N04-11235	Nylon®	161-hr event, 12/07/04	NAREL	IMPROVE	3.133	41.645	0.676	137.541	45.648	-----	-----
N04-11236	Nylon®	161-hr event, 12/07/04	NAREL	IMPROVE	5.474	48.054	0.948	143.390	47.280	-----	-----
N04-11237	Nylon®	filter blank	RTI	IMPROVE	0.083	BMDL*	0.716	BMDL*	BMDL*	-----	-----
N04-11238	Nylon®	filter blank	RTI	IMPROVE	0.062	BMDL*	1.048	BMDL*	BMDL*	-----	-----
N04-11239	Nylon®	filter blank	NAREL	IMPROVE	BMDL*	BMDL*	0.440	BMDL*	BMDL*	-----	-----
N04-11240	Nylon®	filter blank	NAREL	IMPROVE	BMDL*	BMDL*	BMDL*	BMDL*	BMDL*	-----	-----
T05-11333	Teflon®	144-hr event, 01/03/05	DRI	STN	-----	12.370	-----	139.584	46.423	2.202	5.493
T05-11334	Teflon®	144-hr event, 01/03/05	DRI	STN	-----	12.889	-----	141.185	46.128	2.289	5.657
T05-11335	Teflon®	144-hr event, 01/03/05	NAREL	STN	-----	11.555	-----	125.824	42.733	2.882	5.204
T05-11336	Teflon®	144-hr event, 01/03/05	NAREL	STN	-----	10.988	-----	126.785	43.562	2.546	4.885
T05-11337	Teflon®	216-hr event, 01/04/05	DRI	STN	-----	10.274	-----	241.056	75.974	4.119	8.731
T05-11338	Teflon®	216-hr event, 01/04/05	DRI	STN	-----	11.050	-----	245.164	75.126	4.385	9.891
T05-11339	Teflon®	216-hr event, 01/04/05	NAREL	STN	-----	9.125	-----	217.998	67.936	5.356	9.503
T05-11340	Teflon®	216-hr event, 01/04/05	NAREL	STN	-----	7.224	-----	217.855	69.121	5.431	9.136
T05-11341	Teflon®	filter blank	DRI	STN	-----	BMDL*	-----	BMDL*	BMDL*	BMDL*	BMDL*
T05-11342	Teflon®	filter blank	DRI	STN	-----	BMDL*	-----	BMDL*	BMDL*	BMDL*	BMDL*
T05-11343	Teflon®	filter blank	NAREL	STN	-----	BMDL*	-----	BMDL*	BMDL*	BMDL*	0.180
T05-11344	Teflon®	filter blank	NAREL	STN	-----	0.533	-----	BMDL*	BMDL*	BMDL*	0.204

BMDL = Below Method Detection Limit

Table 11. TOA Carbon PE Results

Sample ID	Sample Description	Lab	Instrument (see text)*	Method	Concentration (µg C/cm²)							
					EC	OC	TC	OC1	OC2	OC3	OC4	Pyrol C
Q04-11175	287-hr event, 04/27/04	CARB	#1	STN (mod.)	2.91	35.24	38.14	-----	-----	-----	-----	-----
Q04-11176	287-hr event, 04/27/04	CARB	#1	STN (mod.)	3.22	35.11	38.33	-----	-----	-----	-----	-----
Q04-11177	287-hr event, 04/27/04	DRI	#9	STN	4.6 ± 1.5	30.9 ± 3.7	35.5 ± 3.7	11.2 ± 4.8	5.8 ± 1.2	4.0 ± 0.9	11.2 ± 1.4	-1.2 ± 1.0
Q04-11177	287-hr event, 04/27/04	DRI	#7	STN	1.6 ± 0.5	34.2 ± 4.1	35.9 ± 3.7	7.8 ± 3.3	6.8 ± 1.4	4.5 ± 1.0	9.2 ± 1.1	5.9 ± 4.9
Q04-11178	287-hr event, 04/27/04	DRI	#9	STN	1.9 ± 0.6	33.8 ± 4.1	35.7 ± 3.7	11.2 ± 4.8	4.9 ± 1.0	2.8 ± 0.7	9.0 ± 1.1	5.8 ± 4.8
Q04-11178	287-hr event, 04/27/04	DRI	#7	STN	1.5 ± 0.5	33.8 ± 4.1	35.3 ± 3.7	8.1 ± 3.4	5.5 ± 1.2	3.7 ± 0.9	8.5 ± 1.0	8.0 ± 6.6
Q04-11181	287-hr event, 04/27/04	RTI	R	STN	2.7 ± 0.3	32.9 ± 1.8	35.5 ± 2.1	9.68	3.68	1.82	3.89	13.80
Q04-11181	287-hr event, 04/27/04	RTI	R	STN	2.6 ± 0.3	32.7 ± 1.8	35.3 ± 2.1	9.66	3.66	1.67	3.12	14.59
Q04-11181	287-hr event, 04/27/04	RTI	S	STN	2.5 ± 0.3	34.8 ± 1.9	37.3 ± 2.2	11.15	3.67	2.82	7.06	10.13
Q04-11181	287-hr event, 04/27/04	RTI	T	STN	3.9 ± 0.4	33.2 ± 1.9	37.1 ± 2.2	9.80	3.98	2.67	5.40	11.34
Q04-11181	287-hr event, 04/27/04	RTI	F	STN	2.6 ± 0.3	34.2 ± 1.9	36.9 ± 2.1	9.22	4.41	2.35	5.28	12.96
Q04-11182	287-hr event, 04/27/04	RTI	R	STN	2.4 ± 0.3	32.6 ± 1.8	34.9 ± 2.0	9.66	3.59	1.64	3.12	14.55
Q04-11182	287-hr event, 04/27/04	RTI	S	STN	3.0 ± 0.4	33.0 ± 1.8	36.0 ± 2.1	10.60	3.58	2.73	6.77	9.29
Q04-11182	287-hr event, 04/27/04	RTI	T	STN	3.8 ± 0.4	31.6 ± 1.8	35.5 ± 2.1	9.03	4.04	2.46	5.01	11.11
Q04-11182	287-hr event, 04/27/04	RTI	T	STN	3.9 ± 0.4	32.3 ± 1.8	36.2 ± 2.1	9.40	3.93	2.39	4.58	11.96
Q04-11182	287-hr event, 04/27/04	RTI	F	STN	2.7 ± 0.3	33.2 ± 1.9	35.9 ± 2.1	9.20	4.19	1.76	4.81	13.25
Q04-11183	287-hr event, 04/27/04	NAREL	#1	STN	2.5 ± 0.3	32.0 ± 1.8	34.4 ± 2.0	10.68	3.09	1.65	3.21	13.32
Q04-11184	287-hr event, 04/27/04	NAREL	#1	STN	3.0 ± 0.3	32.9 ± 1.8	35.9 ± 2.1	11.32	3.29	1.59	3.34	13.32
Q04-11186	192-hr event, 11/16/04	CARB	#1	STN (mod.)	1.32	21.89	23.21	-----	-----	-----	-----	-----
Q04-11187	192-hr event, 11/16/04	CARB	#1	STN (mod.)	1.44	22.15	23.59	-----	-----	-----	-----	-----
Q04-11188	192-hr event, 11/16/04	DRI	#9	STN	3.2 ± 1.0	19.7 ± 2.4	22.9 ± 2.4	5.5 ± 2.4	4.4 ± 0.9	3.1 ± 0.7	9.5 ± 1.2	-2.8 ± 2.3
Q04-11188	192-hr event, 11/16/04	DRI	#7	STN	3.1 ± 1.0	19.8 ± 2.4	23.0 ± 2.4	4.0 ± 1.7	5.0 ± 1.1	3.7 ± 0.9	8.6 ± 1.1	-1.4 ± 1.2
Q04-11189	192-hr event, 11/16/04	DRI	#9	STN	3.2 ± 1.0	18.3 ± 2.2	21.5 ± 2.3	5.3 ± 2.2	3.9 ± 0.8	2.8 ± 0.7	9.1 ± 1.1	-2.8 ± 2.3
Q04-11189	192-hr event, 11/16/04	DRI	#7	STN	3.0 ± 0.9	18.6 ± 2.2	21.5 ± 2.3	3.7 ± 1.6	4.5 ± 1.0	3.4 ± 0.8	8.0 ± 1.0	-1.0 ± 0.8
Q04-11192	192-hr event, 11/16/04	RTI	R	STN	2.0 ± 0.3	19.4 ± 1.2	21.4 ± 1.4	4.44	2.65	1.33	2.51	8.48
Q04-11192	192-hr event, 11/16/04	RTI	S	STN	2.3 ± 0.3	21.2 ± 1.3	23.5 ± 1.5	5.55	3.00	2.11	4.65	5.88

Table 11. TOA Carbon PE Results

Sample ID	Sample Description	Lab	Instrument (see text)*	Method	Concentration (µg C/cm^2)							
					EC	OC	TC	OC1	OC2	OC3	OC4	Pyrol C
Q04-11192	192-hr event, 11/16/04	RTI	T	STN	2.8 ± 0.3	19.4 ± 1.2	22.2 ± 1.4	4.79	2.50	2.05	4.02	6.02
Q04-11192	192-hr event, 11/16/04	RTI	F	STN	2.8 ± 0.3	19.0 ± 1.2	21.9 ± 1.4	3.99	3.29	1.59	3.68	6.46
Q04-11192	192-hr event, 11/16/04	RTI	F	STN	2.8 ± 0.3	19.0 ± 1.1	21.8 ± 1.4	4.03	3.25	1.55	3.72	6.43
Q04-11193	192-hr event, 11/16/04	RTI	R	STN	2.1 ± 0.3	19.7 ± 1.2	21.8 ± 1.4	4.62	2.73	1.33	2.30	8.68
Q04-11193	192-hr event, 11/16/04	RTI	S	STN	2.5 ± 0.3	20.4 ± 1.2	23.0 ± 1.4	5.37	2.94	2.25	5.39	4.47
Q04-11193	192-hr event, 11/16/04	RTI	S	STN	2.6 ± 0.3	19.8 ± 1.2	22.4 ± 1.4	5.24	2.79	2.36	6.01	3.39
Q04-11193	192-hr event, 11/16/04	RTI	T	STN	2.8 ± 0.3	19.5 ± 1.2	22.3 ± 1.4	4.91	2.57	1.96	3.58	6.52
Q04-11193	192-hr event, 11/16/04	RTI	F	STN	2.6 ± 0.3	20.5 ± 1.2	23.1 ± 1.5	4.62	3.34	1.63	3.46	7.46
Q04-11194	192-hr event, 11/16/04	NAREL	#1	STN	2.2 ± 0.3	19.3 ± 1.2	21.5 ± 1.4	5.21	2.57	1.38	2.31	7.85
Q04-11195	192-hr event, 11/16/04	NAREL	#1	STN	2.2 ± 0.3	19.4 ± 1.2	21.7 ± 1.4	5.19	2.58	1.41	2.50	7.75
Q04-11241	filter blank	CARB	#1	STN (mod.)	<0.8	<0.8	<0.8	-----	-----	-----	-----	-----
Q04-11242	filter blank	CARB	#1	STN (mod.)	<0.8	<0.8	<0.8	-----	-----	-----	-----	-----
Q04-11243	filter blank	DRI	#9	STN	0.0 ± 0.1	0.5 ± 0.3	0.5 ± 0.3	0.2 ± 0.1	0.3 ± 0.1	0.0 ± 0.2	0.0 ± 0.1	0.0 ± 0.1
Q04-11243	filter blank	DRI	#7	STN	0.0 ± 0.1	0.4 ± 0.3	0.4 ± 0.3	0.2 ± 0.1	0.2 ± 0.1	0.0 ± 0.2	0.0 ± 0.1	0.0 ± 0.1
Q04-11244	filter blank	DRI	#9	STN	0.0 ± 0.1	0.3 ± 0.3	0.3 ± 0.3	0.1 ± 0.0	0.2 ± 0.1	0.1 ± 0.2	0.0 ± 0.1	0.0 ± 0.1
Q04-11244	filter blank	DRI	#7	STN	0.0 ± 0.1	0.5 ± 0.3	0.5 ± 0.3	0.3 ± 0.1	0.2 ± 0.1	0.0 ± 0.2	0.0 ± 0.1	0.0 ± 0.1
Q04-11247	filter blank	RTI	R	STN	0.0 ± 0.2	0.1 ± 0.2	0.1 ± 0.3	0.06	0.04	0.01	0.00	0.00
Q04-11247	filter blank	RTI	R	STN	0.1 ± 0.2	0.4 ± 0.2	0.5 ± 0.3	0.06	0.20	0.12	0.07	0.00
Q04-11247	filter blank	RTI	S	STN	0.0 ± 0.2	0.2 ± 0.2	0.2 ± 0.3	0.03	0.12	0.04	0.00	0.00
Q04-11247	filter blank	RTI	T	STN	0.0 ± 0.2	0.1 ± 0.2	0.1 ± 0.3	0.02	0.05	0.05	0.00	0.00
Q04-11247	filter blank	RTI	F	STN	0.0 ± 0.2	0.3 ± 0.2	0.3 ± 0.3	0.06	0.10	0.04	0.04	0.02
Q04-11248	filter blank	RTI	R	STN	0.0 ± 0.2	0.2 ± 0.2	0.2 ± 0.3	0.05	0.08	0.03	0.01	0.00
Q04-11248	filter blank	RTI	S	STN	0.0 ± 0.2	0.3 ± 0.2	0.3 ± 0.3	0.03	0.15	0.05	0.05	0.01
Q04-11248	filter blank	RTI	T	STN	0.0 ± 0.2	0.2 ± 0.2	0.2 ± 0.3	0.03	0.04	0.05	0.03	0.00
Q04-11248	filter blank	RTI	T	STN	0.0 ± 0.2	0.1 ± 0.2	0.1 ± 0.3	0.02	0.04	0.05	0.01	0.00
Q04-11248	filter blank	RTI	F	STN	0.0 ± 0.2	0.0 ± 0.2	0.0 ± 0.3	0.00	0.00	0.00	0.00	0.00

Table 11. TOA Carbon PE Results

Sample ID	Sample Description	Lab	Instrument (see text)*	Method	Concentration (µg C/cm²)							
					EC	OC	TC	OC1	OC2	OC3	OC4	Pyrol C
Q04-11249	filter blank	NAREL	#1	STN	0.0 ± 0.2	0.5 ± 0.2	0.5 ± 0.3	0.06	0.22	0.09	0.07	0.03
Q04-11250	filter blank	NAREL	#1	STN	0.0 ± 0.2	0.4 ± 0.2	0.4 ± 0.3	0.06	0.19	0.08	0.06	-0.02
Q04-11177	287-hr event, 04/27/04	DRI	#4	IMPROVE	7.1 ± 3.8	31.5 ± 2.1	38.6 ± 1.9	2.3 ± 0.4	7.5 ± 0.6	11.0 ± 2.8	9.0 ± 1.8	1.8 ± 2.2
Q04-11177	287-hr event, 04/27/04	DRI	#5	IMPROVE	4.4 ± 2.4	33.6 ± 2.2	37.9 ± 1.8	2.3 ± 0.4	7.2 ± 0.6	13.3 ± 3.4	10.8 ± 2.1	0.0 ± 0.1
Q04-11178	287-hr event, 04/27/04	DRI	#4	IMPROVE	4.3 ± 2.3	33.3 ± 2.2	37.6 ± 1.8	1.7 ± 0.3	7.7 ± 0.6	13.4 ± 3.4	10.5 ± 2.1	0.0 ± 0.1
Q04-11178	287-hr event, 04/27/04	DRI	#5	IMPROVE	7.2 ± 3.9	31.8 ± 2.1	39.0 ± 1.9	2.3 ± 0.4	7.5 ± 0.6	11.4 ± 2.9	9.4 ± 1.8	1.3 ± 1.5
Q04-11181	287-hr event, 04/27/04	RTI	F	IMPROVE	6.8 ± 0.5	31.9 ± 1.8	38.8 ± 2.2	0.05	7.00	9.42	5.48	9.97
Q04-11182	287-hr event, 04/27/04	RTI	F	IMPROVE	6.9 ± 0.5	31.0 ± 1.7	37.8 ± 2.2	0.06	6.69	9.19	4.83	10.18
Q04-11183	287-hr event, 04/27/04	NAREL	#2	IMPROVE	7.2 ± 0.6	28.9 ± 1.6	36.1 ± 2.1	0.24	11.69	4.45	3.77	8.73
Q04-11184	287-hr event, 04/27/04	NAREL	#2	IMPROVE	6.7 ± 0.5	29.8 ± 1.7	36.5 ± 2.1	0.88	11.39	4.65	3.69	9.21
Q04-11188	192-hr event, 11/16/04	DRI	#4	IMPROVE	3.6 ± 1.9	19.5 ± 1.3	23.0 ± 1.1	1.4 ± 0.3	3.1 ± 0.3	7.8 ± 2.0	7.2 ± 1.4	0.0 ± 0.1
Q04-11188	192-hr event, 11/16/04	DRI	#5	IMPROVE	6.2 ± 3.3	18.6 ± 1.2	24.8 ± 1.2	1.0 ± 0.2	3.9 ± 0.3	7.2 ± 1.8	6.5 ± 1.3	0.0 ± 0.1
Q04-11189	192-hr event, 11/16/04	DRI	#4	IMPROVE	3.4 ± 1.8	18.4 ± 1.2	21.9 ± 1.1	0.8 ± 0.1	3.3 ± 0.3	7.6 ± 1.9	6.8 ± 1.3	0.0 ± 0.1
Q04-11189	192-hr event, 11/16/04	DRI	#5	IMPROVE	6.7 ± 3.6	16.6 ± 1.1	23.3 ± 1.2	0.9 ± 0.2	3.4 ± 0.3	6.7 ± 1.7	5.7 ± 1.1	0.0 ± 0.1
Q04-11192	192-hr event, 11/16/04	RTI	F	IMPROVE	7.1 ± 0.6	15.9 ± 1.0	23.0 ± 1.4	0.01	2.61	5.40	2.97	4.87
Q04-11193	192-hr event, 11/16/04	RTI	F	IMPROVE	5.9 ± 0.5	17.7 ± 1.1	23.6 ± 1.5	0.05	3.50	6.02	2.80	5.34
Q04-11194	192-hr event, 11/16/04	NAREL	#2	IMPROVE	6.7 ± 0.5	16.4 ± 1.0	23.1 ± 1.5	0.19	5.85	3.71	2.74	3.93
Q04-11195	192-hr event, 11/16/04	NAREL	#2	IMPROVE	6.6 ± 0.5	15.7 ± 1.0	22.3 ± 1.4	0.17	5.58	3.62	2.44	3.83
Q04-11243	filter blank	DRI	#4	IMPROVE	0.0 ± 0.1	0.4 ± 0.4	0.4 ± 0.4	0.0 ± 0.0	0.0 ± 0.1	0.3 ± 0.2	0.0 ± 0.1	0.0 ± 0.1
Q04-11243	filter blank	DRI	#5	IMPROVE	0.0 ± 0.1	0.3 ± 0.3	0.3 ± 0.4	0.0 ± 0.0	0.0 ± 0.1	0.3 ± 0.2	0.0 ± 0.1	0.0 ± 0.1
Q04-11244	filter blank	DRI	#4	IMPROVE	0.0 ± 0.1	0.2 ± 0.3	0.2 ± 0.3	0.0 ± 0.0	0.0 ± 0.1	0.2 ± 0.2	0.0 ± 0.1	0.0 ± 0.1
Q04-11244	filter blank	DRI	#5	IMPROVE	0.0 ± 0.1	0.5 ± 0.4	0.5 ± 0.4	0.0 ± 0.0	0.0 ± 0.1	0.4 ± 0.2	0.1 ± 0.1	0.0 ± 0.1
Q04-11247	filter blank	RTI	F	IMPROVE	0.1 ± 0.2	0.5 ± 0.2	0.5 ± 0.3	0.03	0.06	0.18	0.12	0.07
Q04-11248	filter blank	RTI	F	IMPROVE	0.0 ± 0.2	0.2 ± 0.2	0.2 ± 0.3	0.00	0.00	0.07	0.07	0.07
Q04-11249	filter blank	NAREL	#2	IMPROVE	0.0 ± 0.2	0.3 ± 0.2	0.3 ± 0.3	0.04	0.06	0.20	0.02	0.01
Q04-11250	filter blank	NAREL	#2	IMPROVE	0.0 ± 0.2	0.4 ± 0.2	0.4 ± 0.3	0.04	0.06	0.19	0.06	0.08

Table 11. TOA Carbon PE Results

Sample ID	Sample Description	Lab	Instrument (see text)*	Method	Concentration (µg C/cm²)							
					EC	OC	TC	OC1	OC2	OC3	OC4	Pyrol C
Q04-11177	287-hr event, 04/27/04	DRI	#7	IMPROVE_A	7.2 ± 0.8	27.8 ± 1.0	35.0 ± 1.3	2.5 ± 0.3	5.6 ± 1.6	9.6 ± 4.0	5.7 ± 0.6	4.4 ± 0.6
Q04-11177	287-hr event, 04/27/04	DRI	#9	IMPROVE_A	6.8 ± 0.7	29.0 ± 1.1	35.8 ± 1.3	4.2 ± 0.5	7.2 ± 2.0	7.4 ± 3.1	6.6 ± 0.7	3.7 ± 0.5
Q04-11178	287-hr event, 04/27/04	DRI	#7	IMPROVE_A	7.5 ± 0.8	28.6 ± 1.0	36.1 ± 1.3	2.5 ± 0.3	5.8 ± 1.6	10.2 ± 4.2	6.0 ± 0.6	4.3 ± 0.5
Q04-11178	287-hr event, 04/27/04	DRI	#9	IMPROVE_A	6.4 ± 0.7	27.9 ± 1.0	34.3 ± 1.2	3.2 ± 0.4	7.7 ± 2.2	6.7 ± 2.8	6.3 ± 0.6	3.9 ± 0.5
Q04-11183	287-hr event, 04/27/04	NAREL	#2	IMPROVE_A	6.5 ± 0.5	28.7 ± 1.6	35.3 ± 2.1	3.07	9.33	5.43	4.72	6.19
Q04-11184	287-hr event, 04/27/04	NAREL	#2	IMPROVE_A	5.9 ± 0.5	30.1 ± 1.7	36.0 ± 2.1	3.49	9.50	5.30	4.82	7.02
Q04-11188	192-hr event, 11/16/04	DRI	#7	IMPROVE_A	6.6 ± 0.7	15.5 ± 0.6	22.2 ± 0.8	1.1 ± 0.1	3.0 ± 0.8	6.8 ± 2.8	2.5 ± 0.3	2.2 ± 0.3
Q04-11188	192-hr event, 11/16/04	DRI	#9	IMPROVE_A	6.1 ± 0.7	14.9 ± 0.6	21.0 ± 0.8	1.1 ± 0.1	4.3 ± 1.2	5.2 ± 2.2	2.4 ± 0.3	1.9 ± 0.2
Q04-11189	192-hr event, 11/16/04	DRI	#7	IMPROVE_A	6.4 ± 0.7	14.5 ± 0.6	20.8 ± 0.8	1.0 ± 0.1	2.8 ± 0.8	6.4 ± 2.7	2.5 ± 0.3	1.8 ± 0.2
Q04-11189	192-hr event, 11/16/04	DRI	#9	IMPROVE_A	5.6 ± 0.6	14.9 ± 0.6	20.6 ± 0.8	0.9 ± 0.1	4.4 ± 1.2	4.8 ± 2.0	2.9 ± 0.3	2.0 ± 0.3
Q04-11194	192-hr event, 11/16/04	NAREL	#2	IMPROVE_A	5.8 ± 0.5	17.1 ± 1.1	22.9 ± 1.5	1.36	5.63	3.71	2.83	3.56
Q04-11195	192-hr event, 11/16/04	NAREL	#2	IMPROVE_A	6.3 ± 0.5	16.1 ± 1.0	22.4 ± 1.4	1.17	5.66	3.58	2.33	3.33
Q04-11243	filter blank	DRI	#7	IMPROVE_A	0.0 ± 0.1	0.5 ± 0.5	0.5 ± 0.5	0.1 ± 0.0	0.1 ± 0.1	0.3 ± 0.2	0.0 ± 0.1	0.0 ± 0.1
Q04-11243	filter blank	DRI	#9	IMPROVE_A	0.0 ± 0.1	0.3 ± 0.4	0.3 ± 0.4	0.0 ± 0.0	0.1 ± 0.1	0.3 ± 0.2	0.0 ± 0.1	0.0 ± 0.1
Q04-11244	filter blank	DRI	#7	IMPROVE_A	0.0 ± 0.1	0.6 ± 0.6	0.6 ± 0.6	0.1 ± 0.0	0.1 ± 0.1	0.4 ± 0.3	0.1 ± 0.1	0.0 ± 0.1
Q04-11244	filter blank	DRI	#9	IMPROVE_A	0.0 ± 0.1	0.1 ± 0.3	0.1 ± 0.3	0.0 ± 0.0	0.0 ± 0.1	0.1 ± 0.2	0.0 ± 0.1	0.0 ± 0.1
Q04-11249	filter blank	NAREL	#2	IMPROVE_A	-----	-----	-----	-----	-----	-----	-----	-----
Q04-11250	filter blank	NAREL	#2	IMPROVE_A	-----	-----	-----	-----	-----	-----	-----	-----

** Instruments identified as CARB #1, DRI #7, and DRI #9 are DRI/Model 2001 instruments capable of the TOR and the TOT analysis. The DRI #4 and #5 instruments are older DRI/OGC instruments set up for the TOR analysis. RTI instruments identified as R, S, T, and the NAREL #1 instrument are early model Sunset instruments set up for the TOT analysis. The instruments identified as RTI F and NAREL #2 are newer Sunset Dual Mode instruments capable of the TOR and the TOT analysis.*

Table 12. XRF PE Results

Element	Z	Sample Description	DRI Sample ID	DRI (µg/filter)	ODEQ Sample ID	ODEQ (µg/filter)	RTI Sample ID	RTI (µg/filter)	EPA-NERL Sample ID	EPA-NERL (µg/filter)	Median* (µg/filter)
Na	11	138-hr event	T04-11257	4.676 ± 0.859	T04-11259	2.536 ± 2.291	T04-11261	2.091 ± 0.124	T04-11263	4.609 ± 0.805	-----
Mg	12	138-hr event	T04-11257	0.599 ± 0.817	T04-11259	-0.022 ± 0.405	T04-11261	0.025 ± 0.043	T04-11263	1.514 ± 0.426	-----
Al	13	138-hr event	T04-11257	1.659 ± 0.550	T04-11259	0.839 ± 0.115	T04-11261	0.558 ± 0.041	T04-11263	1.570 ± 0.428	1.20
Si	14	138-hr event	T04-11257	4.800 ± 0.299	T04-11259	5.637 ± 0.495	T04-11261	5.196 ± 0.035	T04-11263	6.428 ± 0.534	5.42
P	15	138-hr event	T04-11257	1.370 ± 0.054	T04-11259	-0.209 ± 0.085	T04-11261	0.000 ± 0.130	T04-11263	0.492 ± 0.242	-----
S	16	138-hr event	T04-11257	35.945 ± 0.295	T04-11259	37.487 ± 3.020	T04-11261	32.499 ± 0.158	T04-11263	34.381 ± 1.011	35.16
Cl	17	138-hr event	T04-11257	0.411 ± 0.038	T04-11259	0.059 ± 0.270	T04-11261	0.622 ± 0.037	T04-11263	0.576 ± 0.091	-----
K	19	138-hr event	T04-11257	5.512 ± 0.006	T04-11259	5.546 ± 0.449	T04-11261	5.206 ± 0.044	T04-11263	5.219 ± 0.159	5.37
Ca	20	138-hr event	T04-11257	1.867 ± 0.047	T04-11259	2.082 ± 0.174	T04-11261	1.914 ± 0.029	T04-11263	1.808 ± 0.065	1.89
Sc	21	138-hr event	T04-11257	0.000 ± 0.028	T04-11259	0.002 ± 0.025	T04-11261	0.000 ± 0.041	T04-11263	0.016 ± 0.022	-----
Ti	22	138-hr event	T04-11257	0.072 ± 0.026	T04-11259	0.198 ± 0.049	T04-11261	0.000 ± 0.025	T04-11263	0.143 ± 0.045	-----
V	23	138-hr event	T04-11257	0.009 ± 0.009	T04-11259	0.029 ± 0.017	T04-11261	0.078 ± 0.012	T04-11263	0.013 ± 0.016	-----
Cr	24	138-hr event	T04-11257	0.005 ± 0.040	T04-11259	0.007 ± 0.008	T04-11261	0.000 ± 0.010	T04-11263	0.060 ± 0.015	-----
Mn	25	138-hr event	T04-11257	0.133 ± 0.114	T04-11259	0.090 ± 0.016	T04-11261	0.097 ± 0.008	T04-11263	0.132 ± 0.031	-----
Fe	26	138-hr event	T04-11257	3.239 ± 0.180	T04-11259	3.045 ± 0.246	T04-11261	3.225 ± 0.025	T04-11263	3.086 ± 0.107	3.16
Co	27	138-hr event	T04-11257	0.009 ± 0.019	T04-11259	-0.018 ± 0.019	T04-11261	0.000 ± 0.009	T04-11263	-0.054 ± 0.026	-----
Ni	28	138-hr event	T04-11257	0.000 ± 0.031	T04-11259	0.001 ± 0.008	T04-11261	0.096 ± 0.005	T04-11263	0.030 ± 0.018	-----
Cu	29	138-hr event	T04-11257	0.170 ± 0.024	T04-11259	0.141 ± 0.015	T04-11261	0.172 ± 0.006	T04-11263	0.193 ± 0.020	0.17
Zn	30	138-hr event	T04-11257	0.689 ± 0.034	T04-11259	0.663 ± 0.054	T04-11261	0.613 ± 0.009	T04-11263	0.708 ± 0.055	0.68
Ga	31	138-hr event	T04-11257	0.041 ± 0.097	T04-11259	-0.015 ± 0.054	T04-11261	0.003 ± 0.004	T04-11263	0.009 ± 0.028	-----
As	33	138-hr event	T04-11257	0.066 ± 0.026	T04-11259	0.079 ± 0.018	T04-11261	0.124 ± 0.006	T04-11263	0.065 ± 0.041	-----
Se	34	138-hr event	T04-11257	0.000 ± 0.023	T04-11259	0.048 ± 0.011	T04-11261	0.067 ± 0.006	T04-11263	0.119 ± 0.025	-----
Br	35	138-hr event	T04-11257	0.199 ± 0.026	T04-11259	0.188 ± 0.018	T04-11261	0.216 ± 0.007	T04-11263	0.220 ± 0.029	0.21
Rb	37	138-hr event	T04-11257	0.000 ± 0.024	T04-11259	-0.005 ± 0.009	T04-11261	0.007 ± 0.008	T04-11263	0.030 ± 0.024	-----
Sr	38	138-hr event	T04-11257	0.007 ± 0.057	T04-11259	0.007 ± 0.010	T04-11261	0.008 ± 0.009	T04-11263	0.021 ± 0.057	-----
Y	39	138-hr event	T04-11257	0.066 ± 0.037	T04-11259	-0.006 ± 0.011	T04-11261	0.014 ± 0.010	T04-11263	-0.010 ± 0.059	-----
Zr	40	138-hr event	T04-11257	0.104 ± 0.078	T04-11259	-0.002 ± 0.012	T04-11261	0.000 ± 0.011	T04-11263	0.079 ± 0.053	-----

Table 12. XRF PE Results

Element	Z	Sample Description	DRI Sample ID	DRI (µg/filter)	ODEQ Sample ID	ODEQ (µg/filter)	RTI Sample ID	RTI (µg/filter)	EPA-NERL Sample ID	EPA-NERL (µg/filter)	Median* (µg/filter)
Nb	41	138-hr event	T04-11257	0.000 ± 0.062	T04-11259	-0.009 ± 0.014	T04-11261	0.000 ± 0.009	T04-11263	-0.026 ± 0.055	-----
Mo	42	138-hr event	T04-11257	0.016 ± 0.081	T04-11259	0.005 ± 0.016	T04-11261	0.000 ± 0.010	T04-11263	0.003 ± 0.053	-----
Ag	47	138-hr event	T04-11257	0.032 ± 0.085	T04-11259	-0.005 ± 0.034	T04-11261	0.000 ± 0.039	T04-11263	0.101 ± 0.236	-----
Cd	48	138-hr event	T04-11257	0.000 ± 0.094	T04-11259	0.009 ± 0.035	T04-11261	0.000 ± 0.045	T04-11263	0.046 ± 0.135	-----
In	49	138-hr event	T04-11257	0.014 ± 0.092	T04-11259	-0.012 ± 0.036	T04-11261	0.114 ± 0.061	T04-11263	0.106 ± 0.245	-----
Sn	50	138-hr event	T04-11257	0.000 ± 0.108	T04-11259	0.040 ± 0.040	T04-11261	0.000 ± 0.062	T04-11263	0.047 ± 0.128	-----
Sb	51	138-hr event	T04-11257	0.226 ± 0.098	T04-11259	0.012 ± 0.044	T04-11261	0.701 ± 0.136	T04-11263	0.209 ± 0.095	-----
Cs	55	138-hr event	T04-11257	0.099 ± 0.225	T04-11259	-0.052 ± 0.073	T04-11261	0.000 ± 0.043	T04-11263	0.125 ± 0.054	-----
Ba	56	138-hr event	T04-11257	0.145 ± 0.243	T04-11259	0.008 ± 0.101	T04-11261	0.000 ± 0.055	T04-11263	0.207 ± 0.091	-----
La	57	138-hr event	T04-11257	0.000 ± 0.496	T04-11259	-0.075 ± 0.125	T04-11261	0.000 ± 0.038	T04-11263	0.318 ± 0.068	-----
Ce	58	138-hr event	T04-11257	0.203 ± 0.412	T04-11259	-0.049 ± 0.155	T04-11261	0.000 ± 0.043	T04-11263	0.043 ± 0.051	-----
Sm	62	138-hr event	T04-11257	0.000 ± 0.683	T04-11259	-0.223 ± 0.558	T04-11261	0.000 ± 0.021	T04-11263	not reported	-----
Eu	63	138-hr event	T04-11257	0.735 ± 0.871	T04-11259	-1.153 ± 0.843	T04-11261	0.000 ± 0.026	T04-11263	not reported	-----
Tb	65	138-hr event	T04-11257	0.052 ± 0.945	T04-11259	-1.086 ± 1.823	T04-11261	0.147 ± 0.062	T04-11263	not reported	-----
Hf	72	138-hr event	T04-11257	0.000 ± 0.229	T04-11259	-0.047 ± 0.204	T04-11261	0.049 ± 0.024	T04-11263	not reported	-----
Ta	73	138-hr event	T04-11257	0.000 ± 0.122	T04-11259	-0.100 ± 0.227	T04-11261	0.000 ± 0.018	T04-11263	not reported	-----
W	74	138-hr event	T04-11257	0.000 ± 0.292	T04-11259	-0.079 ± 0.058	T04-11261	0.000 ± 0.011	T04-11263	0.056 ± 0.078	-----
Ir	77	138-hr event	T04-11257	0.000 ± 0.105	T04-11259	-0.014 ± 0.034	T04-11261	0.000 ± 0.008	T04-11263	not reported	-----
Au	79	138-hr event	T04-11257	0.000 ± 0.111	T04-11259	-0.046 ± 0.026	T04-11261	0.023 ± 0.009	T04-11263	-0.091 ± 0.044	-----
Hg	80	138-hr event	T04-11257	0.000 ± 0.042	T04-11259	-0.011 ± 0.022	T04-11261	0.133 ± 0.011	T04-11263	-0.073 ± 0.042	-----
Pb	82	138-hr event	T04-11257	0.084 ± 0.081	T04-11259	0.199 ± 0.034	T04-11261	0.255 ± 0.020	T04-11263	0.352 ± 0.077	-----
Na	11	138-hr event	T04-11258	5.015 ± 0.866	T04-11260	3.153 ± 2.302	T04-11262	1.774 ± 0.124	T04-11264	4.488 ± 0.794	-----
Mg	12	138-hr event	T04-11258	0.260 ± 0.814	T04-11260	-0.095 ± 0.406	T04-11262	0.000 ± 0.057	T04-11264	2.330 ± 0.460	-----
Al	13	138-hr event	T04-11258	2.133 ± 0.553	T04-11260	0.890 ± 0.119	T04-11262	1.125 ± 0.042	T04-11264	1.361 ± 0.424	1.24
Si	14	138-hr event	T04-11258	4.518 ± 0.296	T04-11260	5.464 ± 0.480	T04-11262	5.708 ± 0.036	T04-11264	6.391 ± 0.536	5.59
P	15	138-hr event	T04-11258	1.268 ± 0.054	T04-11260	-0.213 ± 0.083	T04-11262	0.000 ± 0.132	T04-11264	0.015 ± 0.239	-----
S	16	138-hr event	T04-11258	32.793 ± 0.270	T04-11260	36.366 ± 2.930	T04-11262	33.505 ± 0.158	T04-11264	32.938 ± 0.977	33.22

Table 12. XRF PE Results

Element	Z	Sample Description	DRI Sample ID	DRI (µg/filter)	ODEQ Sample ID	ODEQ (µg/filter)	RTI Sample ID	RTI (µg/filter)	EPA-NERL Sample ID	EPA-NERL (µg/filter)	Median* (µg/filter)
Cl	17	138-hr event	T04-11258	0.423 ± 0.038	T04-11260	0.092 ± 0.263	T04-11262	0.703 ± 0.038	T04-11264	0.659 ± 0.095	-----
K	19	138-hr event	T04-11258	5.105 ± 0.006	T04-11260	5.353 ± 0.433	T04-11262	5.429 ± 0.045	T04-11264	4.876 ± 0.153	5.23
Ca	20	138-hr event	T04-11258	1.709 ± 0.047	T04-11260	2.070 ± 0.173	T04-11262	2.204 ± 0.029	T04-11264	2.318 ± 0.075	2.14
Sc	21	138-hr event	T04-11258	0.000 ± 0.028	T04-11260	-0.054 ± 0.026	T04-11262	0.000 ± 0.040	T04-11264	-0.006 ± 0.024	-----
Ti	22	138-hr event	T04-11258	0.140 ± 0.026	T04-11260	0.098 ± 0.051	T04-11262	0.000 ± 0.025	T04-11264	0.236 ± 0.045	-----
V	23	138-hr event	T04-11258	0.000 ± 0.009	T04-11260	0.007 ± 0.018	T04-11262	0.086 ± 0.012	T04-11264	-0.004 ± 0.016	-----
Cr	24	138-hr event	T04-11258	0.005 ± 0.040	T04-11260	0.036 ± 0.009	T04-11262	0.000 ± 0.010	T04-11264	0.020 ± 0.014	-----
Mn	25	138-hr event	T04-11258	0.111 ± 0.114	T04-11260	0.084 ± 0.015	T04-11262	0.081 ± 0.008	T04-11264	0.175 ± 0.033	-----
Fe	26	138-hr event	T04-11258	3.137 ± 0.180	T04-11260	3.023 ± 0.244	T04-11262	3.578 ± 0.026	T04-11264	2.967 ± 0.105	3.08
Co	27	138-hr event	T04-11258	0.020 ± 0.019	T04-11260	-0.036 ± 0.019	T04-11262	0.000 ± 0.010	T04-11264	-0.047 ± 0.025	-----
Ni	28	138-hr event	T04-11258	0.023 ± 0.031	T04-11260	0.015 ± 0.009	T04-11262	1.597 ± 0.014	T04-11264	0.048 ± 0.019	-----
Cu	29	138-hr event	T04-11258	0.136 ± 0.024	T04-11260	0.185 ± 0.018	T04-11262	0.166 ± 0.007	T04-11264	0.204 ± 0.021	0.18
Zn	30	138-hr event	T04-11258	0.622 ± 0.034	T04-11260	0.654 ± 0.054	T04-11262	0.637 ± 0.009	T04-11264	0.746 ± 0.056	0.65
Ga	31	138-hr event	T04-11258	0.063 ± 0.097	T04-11260	-0.003 ± 0.054	T04-11262	0.006 ± 0.004	T04-11264	-0.032 ± 0.028	-----
As	33	138-hr event	T04-11258	0.000 ± 0.026	T04-11260	0.066 ± 0.019	T04-11262	0.124 ± 0.006	T04-11264	0.059 ± 0.038	-----
Se	34	138-hr event	T04-11258	0.000 ± 0.023	T04-11260	0.045 ± 0.011	T04-11262	0.068 ± 0.006	T04-11264	0.049 ± 0.022	-----
Br	35	138-hr event	T04-11258	0.188 ± 0.026	T04-11260	0.192 ± 0.018	T04-11262	0.217 ± 0.007	T04-11264	0.184 ± 0.031	0.19
Rb	37	138-hr event	T04-11258	0.000 ± 0.024	T04-11260	0.007 ± 0.010	T04-11262	0.003 ± 0.008	T04-11264	0.031 ± 0.024	-----
Sr	38	138-hr event	T04-11258	0.007 ± 0.057	T04-11260	0.021 ± 0.010	T04-11262	0.013 ± 0.009	T04-11264	-0.078 ± 0.053	-----
Y	39	138-hr event	T04-11258	0.020 ± 0.037	T04-11260	-0.001 ± 0.011	T04-11262	0.000 ± 0.007	T04-11264	-0.007 ± 0.060	-----
Zr	40	138-hr event	T04-11258	0.059 ± 0.077	T04-11260	0.002 ± 0.013	T04-11262	0.000 ± 0.011	T04-11264	0.050 ± 0.051	-----
Nb	41	138-hr event	T04-11258	0.099 ± 0.062	T04-11260	0.001 ± 0.015	T04-11262	0.000 ± 0.009	T04-11264	0.133 ± 0.067	-----
Mo	42	138-hr event	T04-11258	0.005 ± 0.081	T04-11260	0.004 ± 0.018	T04-11262	0.000 ± 0.009	T04-11264	0.177 ± 0.066	-----
Ag	47	138-hr event	T04-11258	0.032 ± 0.085	T04-11260	0.026 ± 0.035	T04-11262	0.000 ± 0.040	T04-11264	-0.659 ± 0.246	-----
Cd	48	138-hr event	T04-11258	0.181 ± 0.095	T04-11260	0.069 ± 0.037	T04-11262	0.066 ± 0.063	T04-11264	0.426 ± 0.147	-----
In	49	138-hr event	T04-11258	0.002 ± 0.092	T04-11260	-0.017 ± 0.038	T04-11262	0.158 ± 0.059	T04-11264	0.149 ± 0.244	-----
Sn	50	138-hr event	T04-11258	0.000 ± 0.108	T04-11260	0.075 ± 0.043	T04-11262	0.193 ± 0.081	T04-11264	-0.148 ± 0.124	-----

Table 12. XRF PE Results

Element	Z	Sample Description	DRI Sample ID	DRI (µg/filter)	ODEQ Sample ID	ODEQ (µg/filter)	RTI Sample ID	RTI (µg/filter)	EPA-NERL Sample ID	EPA-NERL (µg/filter)	Median* (µg/filter)
Sb	51	138-hr event	T04-11258	0.090 ± 0.097	T04-11260	0.021 ± 0.046	T04-11262	0.000 ± 0.104	T04-11264	0.224 ± 0.101	-----
Cs	55	138-hr event	T04-11258	0.000 ± 0.224	T04-11260	0.087 ± 0.080	T04-11262	0.000 ± 0.043	T04-11264	0.074 ± 0.054	-----
Ba	56	138-hr event	T04-11258	0.000 ± 0.240	T04-11260	0.095 ± 0.110	T04-11262	0.000 ± 0.055	T04-11264	0.044 ± 0.092	-----
La	57	138-hr event	T04-11258	0.000 ± 0.493	T04-11260	0.010 ± 0.138	T04-11262	0.000 ± 0.037	T04-11264	0.200 ± 0.066	-----
Ce	58	138-hr event	T04-11258	0.000 ± 0.410	T04-11260	-0.029 ± 0.170	T04-11262	0.000 ± 0.043	T04-11264	0.150 ± 0.051	-----
Sm	62	138-hr event	T04-11258	0.000 ± 0.693	T04-11260	-0.301 ± 0.609	T04-11262	0.000 ± 0.021	T04-11264	not reported	-----
Eu	63	138-hr event	T04-11258	0.000 ± 0.852	T04-11260	-1.004 ± 0.922	T04-11262	0.000 ± 0.027	T04-11264	not reported	-----
Tb	65	138-hr event	T04-11258	0.346 ± 0.951	T04-11260	-0.679 ± 2.000	T04-11262	0.090 ± 0.064	T04-11264	not reported	-----
Hf	72	138-hr event	T04-11258	0.154 ± 0.229	T04-11260	0.037 ± 0.204	T04-11262	0.049 ± 0.024	T04-11264	not reported	-----
Ta	73	138-hr event	T04-11258	0.000 ± 0.122	T04-11260	-0.056 ± 0.227	T04-11262	0.000 ± 0.024	T04-11264	not reported	-----
W	74	138-hr event	T04-11258	0.007 ± 0.293	T04-11260	0.011 ± 0.058	T04-11262	0.000 ± 0.013	T04-11264	-0.026 ± 0.078	-----
Ir	77	138-hr event	T04-11258	0.000 ± 0.104	T04-11260	0.016 ± 0.034	T04-11262	0.000 ± 0.008	T04-11264	not reported	-----
Au	79	138-hr event	T04-11258	0.000 ± 0.111	T04-11260	-0.007 ± 0.026	T04-11262	0.015 ± 0.009	T04-11264	0.013 ± 0.046	-----
Hg	80	138-hr event	T04-11258	0.034 ± 0.042	T04-11260	-0.002 ± 0.022	T04-11262	0.136 ± 0.012	T04-11264	0.054 ± 0.055	-----
Pb	82	138-hr event	T04-11258	0.185 ± 0.081	T04-11260	0.230 ± 0.036	T04-11262	0.255 ± 0.020	T04-11264	0.255 ± 0.073	-----
Na	11	192-hr event	T04-11267	3.580 ± 0.835	T04-11269	8.509 ± 2.450	T04-11271	2.870 ± 0.147	T04-11273	5.835 ± 0.918	4.71
Mg	12	192-hr event	T04-11267	0.339 ± 0.815	T04-11269	0.021 ± 0.416	T04-11271	0.071 ± 0.050	T04-11273	1.544 ± 0.450	-----
Al	13	192-hr event	T04-11267	2.156 ± 0.553	T04-11269	0.344 ± 0.100	T04-11271	0.497 ± 0.044	T04-11273	1.998 ± 0.522	1.25
Si	14	192-hr event	T04-11267	9.060 ± 0.350	T04-11269	10.352 ± 0.906	T04-11271	9.260 ± 0.042	T04-11273	12.486 ± 0.769	9.81
P	15	192-hr event	T04-11267	3.607 ± 0.062	T04-11269	-0.500 ± 0.189	T04-11271	0.000 ± 0.175	T04-11273	0.417 ± 0.339	-----
S	16	192-hr event	T04-11267	85.959 ± 0.693	T04-11269	88.042 ± 7.077	T04-11271	72.038 ± 0.226	T04-11273	84.316 ± 2.287	85.14
Cl	17	192-hr event	T04-11267	0.671 ± 0.040	T04-11269	-0.504 ± 0.628	T04-11271	0.977 ± 0.046	T04-11273	0.977 ± 0.112	-----
K	19	192-hr event	T04-11267	5.230 ± 0.006	T04-11269	5.021 ± 0.407	T04-11271	4.642 ± 0.043	T04-11273	5.159 ± 0.159	5.09
Ca	20	192-hr event	T04-11267	1.516 ± 0.046	T04-11269	1.610 ± 0.137	T04-11271	1.523 ± 0.028	T04-11273	2.039 ± 0.070	1.57
Sc	21	192-hr event	T04-11267	0.000 ± 0.028	T04-11269	-0.026 ± 0.023	T04-11271	0.000 ± 0.043	T04-11273	-0.032 ± 0.023	-----
Ti	22	192-hr event	T04-11267	0.174 ± 0.026	T04-11269	0.177 ± 0.055	T04-11271	0.000 ± 0.025	T04-11273	0.060 ± 0.044	-----
V	23	192-hr event	T04-11267	0.020 ± 0.009	T04-11269	0.035 ± 0.019	T04-11271	0.079 ± 0.014	T04-11273	0.047 ± 0.018	-----

Table 12. XRF PE Results

Element	Z	Sample Description	DRI Sample ID	DRI (µg/filter)	ODEQ Sample ID	ODEQ (µg/filter)	RTI Sample ID	RTI (µg/filter)	EPA-NERL Sample ID	EPA-NERL (µg/filter)	Median* (µg/filter)
Cr	24	192-hr event	T04-11267	0.005 ± 0.040	T04-11269	-0.005 ± 0.009	T04-11271	0.000 ± 0.011	T04-11273	0.059 ± 0.015	-----
Mn	25	192-hr event	T04-11267	0.088 ± 0.114	T04-11269	0.105 ± 0.016	T04-11271	0.103 ± 0.008	T04-11273	0.092 ± 0.031	-----
Fe	26	192-hr event	T04-11267	3.363 ± 0.180	T04-11269	3.091 ± 0.249	T04-11271	2.967 ± 0.024	T04-11273	3.475 ± 0.118	3.23
Co	27	192-hr event	T04-11267	0.000 ± 0.019	T04-11269	-0.041 ± 0.019	T04-11271	0.000 ± 0.009	T04-11273	-0.022 ± 0.028	-----
Ni	28	192-hr event	T04-11267	0.011 ± 0.031	T04-11269	0.030 ± 0.010	T04-11271	0.032 ± 0.004	T04-11273	0.483 ± 0.032	-----
Cu	29	192-hr event	T04-11267	0.090 ± 0.024	T04-11269	0.109 ± 0.013	T04-11271	0.119 ± 0.006	T04-11273	0.173 ± 0.020	0.11
Zn	30	192-hr event	T04-11267	0.802 ± 0.034	T04-11269	0.671 ± 0.055	T04-11271	0.611 ± 0.009	T04-11273	0.782 ± 0.058	0.73
Ga	31	192-hr event	T04-11267	0.233 ± 0.098	T04-11269	-0.014 ± 0.054	T04-11271	0.002 ± 0.004	T04-11273	-0.012 ± 0.029	-----
As	33	192-hr event	T04-11267	0.054 ± 0.026	T04-11269	0.082 ± 0.019	T04-11271	0.129 ± 0.006	T04-11273	0.065 ± 0.041	-----
Se	34	192-hr event	T04-11267	0.000 ± 0.023	T04-11269	0.111 ± 0.014	T04-11271	0.116 ± 0.006	T04-11273	0.208 ± 0.030	-----
Br	35	192-hr event	T04-11267	0.323 ± 0.026	T04-11269	0.331 ± 0.029	T04-11271	0.313 ± 0.007	T04-11273	0.345 ± 0.035	0.33
Rb	37	192-hr event	T04-11267	0.000 ± 0.024	T04-11269	0.003 ± 0.011	T04-11271	0.000 ± 0.006	T04-11273	-0.011 ± 0.024	-----
Sr	38	192-hr event	T04-11267	0.029 ± 0.057	T04-11269	0.007 ± 0.011	T04-11271	0.042 ± 0.010	T04-11273	0.143 ± 0.071	-----
Y	39	192-hr event	T04-11267	0.020 ± 0.037	T04-11269	-0.012 ± 0.012	T04-11271	0.024 ± 0.011	T04-11273	0.147 ± 0.069	-----
Zr	40	192-hr event	T04-11267	0.115 ± 0.078	T04-11269	-0.003 ± 0.014	T04-11271	0.000 ± 0.011	T04-11273	0.081 ± 0.054	-----
Nb	41	192-hr event	T04-11267	0.000 ± 0.062	T04-11269	0.014 ± 0.016	T04-11271	0.000 ± 0.010	T04-11273	-0.006 ± 0.053	-----
Mo	42	192-hr event	T04-11267	0.038 ± 0.082	T04-11269	0.008 ± 0.019	T04-11271	0.000 ± 0.010	T04-11273	0.218 ± 0.068	-----
Ag	47	192-hr event	T04-11267	0.000 ± 0.085	T04-11269	0.020 ± 0.037	T04-11271	0.077 ± 0.053	T04-11273	0.001 ± 0.242	-----
Cd	48	192-hr event	T04-11267	0.102 ± 0.094	T04-11269	-0.009 ± 0.038	T04-11271	0.000 ± 0.045	T04-11273	-0.064 ± 0.138	-----
In	49	192-hr event	T04-11267	0.000 ± 0.092	T04-11269	-0.028 ± 0.040	T04-11271	0.063 ± 0.063	T04-11273	0.286 ± 0.250	-----
Sn	50	192-hr event	T04-11267	0.000 ± 0.108	T04-11269	-0.012 ± 0.044	T04-11271	0.193 ± 0.087	T04-11273	-0.019 ± 0.128	-----
Sb	51	192-hr event	T04-11267	0.079 ± 0.097	T04-11269	-0.011 ± 0.049	T04-11271	0.000 ± 0.110	T04-11273	0.151 ± 0.099	-----
Cs	55	192-hr event	T04-11267	0.099 ± 0.225	T04-11269	-0.003 ± 0.085	T04-11271	0.000 ± 0.045	T04-11273	0.069 ± 0.055	-----
Ba	56	192-hr event	T04-11267	0.000 ± 0.242	T04-11269	-0.063 ± 0.118	T04-11271	0.000 ± 0.056	T04-11273	0.432 ± 0.095	-----
La	57	192-hr event	T04-11267	0.000 ± 0.495	T04-11269	-0.042 ± 0.148	T04-11271	0.000 ± 0.038	T04-11273	0.208 ± 0.068	-----
Ce	58	192-hr event	T04-11267	0.000 ± 0.410	T04-11269	-0.128 ± 0.183	T04-11271	0.000 ± 0.045	T04-11273	0.056 ± 0.053	-----
Sm	62	192-hr event	T04-11267	0.000 ± 0.689	T04-11269	-0.487 ± 0.653	T04-11271	0.000 ± 0.021	T04-11273	not reported	-----

Table 12. XRF PE Results

Element	Z	Sample Description	DRI Sample ID	DRI (µg/filter)	ODEQ Sample ID	ODEQ (µg/filter)	RTI Sample ID	RTI (µg/filter)	EPA-NERL Sample ID	EPA-NERL (µg/filter)	Median* (µg/filter)
Eu	63	192-hr event	T04-11267	0.226 ± 0.864	T04-11269	-0.921 ± 0.990	T04-11271	0.000 ± 0.027	T04-11273	not reported	-----
Tb	65	192-hr event	T04-11267	0.000 ± 0.932	T04-11269	1.155 ± 2.159	T04-11271	0.079 ± 0.060	T04-11273	not reported	-----
Hf	72	192-hr event	T04-11267	0.000 ± 0.229	T04-11269	0.146 ± 0.205	T04-11271	0.028 ± 0.024	T04-11273	not reported	-----
Ta	73	192-hr event	T04-11267	0.000 ± 0.122	T04-11269	-0.091 ± 0.227	T04-11271	0.000 ± 0.016	T04-11273	not reported	-----
W	74	192-hr event	T04-11267	0.041 ± 0.293	T04-11269	-0.026 ± 0.059	T04-11271	0.000 ± 0.011	T04-11273	0.080 ± 0.086	-----
Ir	77	192-hr event	T04-11267	0.000 ± 0.105	T04-11269	0.005 ± 0.034	T04-11271	0.000 ± 0.008	T04-11273	not reported	-----
Au	79	192-hr event	T04-11267	0.000 ± 0.111	T04-11269	-0.048 ± 0.027	T04-11271	0.035 ± 0.010	T04-11273	-0.054 ± 0.049	-----
Hg	80	192-hr event	T04-11267	0.068 ± 0.042	T04-11269	-0.002 ± 0.022	T04-11271	0.224 ± 0.012	T04-11273	-0.014 ± 0.053	-----
Pb	82	192-hr event	T04-11267	0.242 ± 0.081	T04-11269	0.207 ± 0.035	T04-11271	0.243 ± 0.020	T04-11273	0.292 ± 0.078	-----
Na	11	192-hr event	T04-11268	6.846 ± 0.906	T04-11270	7.969 ± 2.427	T04-11272	2.983 ± 0.147	T04-11274	5.115 ± 0.844	5.98
Mg	12	192-hr event	T04-11268	1.209 ± 0.825	T04-11270	0.268 ± 0.415	T04-11272	0.381 ± 0.050	T04-11274	0.355 ± 0.418	-----
Al	13	192-hr event	T04-11268	2.054 ± 0.551	T04-11270	0.490 ± 0.104	T04-11272	1.182 ± 0.043	T04-11274	1.800 ± 0.515	1.49
Si	14	192-hr event	T04-11268	9.286 ± 0.353	T04-11270	10.011 ± 0.876	T04-11272	9.137 ± 0.041	T04-11274	12.016 ± 0.743	9.65
P	15	192-hr event	T04-11268	3.437 ± 0.061	T04-11270	-0.587 ± 0.189	T04-11272	0.000 ± 0.178	T04-11274	1.023 ± 0.334	-----
S	16	192-hr event	T04-11268	85.518 ± 0.689	T04-11270	87.139 ± 7.004	T04-11272	74.987 ± 0.237	T04-11274	77.701 ± 2.121	81.61
Cl	17	192-hr event	T04-11268	0.423 ± 0.038	T04-11270	-0.368 ± 0.621	T04-11272	0.932 ± 0.046	T04-11274	0.599 ± 0.104	-----
K	19	192-hr event	T04-11268	5.162 ± 0.006	T04-11270	5.062 ± 0.410	T04-11272	4.833 ± 0.043	T04-11274	4.584 ± 0.149	4.95
Ca	20	192-hr event	T04-11268	1.584 ± 0.046	T04-11270	1.723 ± 0.145	T04-11272	1.533 ± 0.028	T04-11274	1.728 ± 0.064	1.65
Sc	21	192-hr event	T04-11268	0.000 ± 0.028	T04-11270	-0.030 ± 0.024	T04-11272	0.000 ± 0.043	T04-11274	-0.009 ± 0.023	-----
Ti	22	192-hr event	T04-11268	0.106 ± 0.026	T04-11270	0.191 ± 0.055	T04-11272	0.000 ± 0.025	T04-11274	0.121 ± 0.045	-----
V	23	192-hr event	T04-11268	0.000 ± 0.009	T04-11270	0.039 ± 0.019	T04-11272	0.043 ± 0.015	T04-11274	0.049 ± 0.017	-----
Cr	24	192-hr event	T04-11268	0.027 ± 0.040	T04-11270	0.000 ± 0.009	T04-11272	0.000 ± 0.010	T04-11274	0.052 ± 0.015	-----
Mn	25	192-hr event	T04-11268	0.066 ± 0.114	T04-11270	0.129 ± 0.018	T04-11272	0.086 ± 0.008	T04-11274	0.086 ± 0.030	-----
Fe	26	192-hr event	T04-11268	3.295 ± 0.180	T04-11270	3.046 ± 0.246	T04-11272	3.095 ± 0.024	T04-11274	2.926 ± 0.103	3.07
Co	27	192-hr event	T04-11268	0.000 ± 0.019	T04-11270	-0.031 ± 0.019	T04-11272	0.000 ± 0.009	T04-11274	-0.014 ± 0.026	-----
Ni	28	192-hr event	T04-11268	0.113 ± 0.031	T04-11270	0.038 ± 0.010	T04-11272	0.063 ± 0.005	T04-11274	0.027 ± 0.018	-----
Cu	29	192-hr event	T04-11268	0.090 ± 0.024	T04-11270	0.117 ± 0.014	T04-11272	0.118 ± 0.006	T04-11274	0.091 ± 0.018	0.10

Table 12. XRF PE Results

Element	Z	Sample Description	DRI Sample ID	DRI (µg/filter)	ODEQ Sample ID	ODEQ (µg/filter)	RTI Sample ID	RTI (µg/filter)	EPA-NERL Sample ID	EPA-NERL (µg/filter)	Median* (µg/filter)
Zn	30	192-hr event	T04-11268	0.757 ± 0.034	T04-11270	0.695 ± 0.057	T04-11272	0.618 ± 0.009	T04-11274	0.627 ± 0.052	0.66
Ga	31	192-hr event	T04-11268	0.000 ± 0.097	T04-11270	-0.011 ± 0.054	T04-11272	0.012 ± 0.004	T04-11274	-0.035 ± 0.027	-----
As	33	192-hr event	T04-11268	0.043 ± 0.026	T04-11270	0.078 ± 0.019	T04-11272	0.110 ± 0.006	T04-11274	0.130 ± 0.039	-----
Se	34	192-hr event	T04-11268	0.023 ± 0.023	T04-11270	0.103 ± 0.013	T04-11272	0.122 ± 0.006	T04-11274	0.107 ± 0.025	-----
Br	35	192-hr event	T04-11268	0.380 ± 0.027	T04-11270	0.322 ± 0.028	T04-11272	0.325 ± 0.008	T04-11274	0.330 ± 0.035	0.33
Rb	37	192-hr event	T04-11268	0.000 ± 0.024	T04-11270	0.009 ± 0.010	T04-11272	0.000 ± 0.006	T04-11274	0.070 ± 0.025	-----
Sr	38	192-hr event	T04-11268	0.000 ± 0.057	T04-11270	0.016 ± 0.011	T04-11272	0.025 ± 0.010	T04-11274	0.000 ± 0.063	-----
Y	39	192-hr event	T04-11268	0.032 ± 0.037	T04-11270	-0.018 ± 0.012	T04-11272	0.001 ± 0.011	T04-11274	0.116 ± 0.065	-----
Zr	40	192-hr event	T04-11268	0.115 ± 0.078	T04-11270	-0.006 ± 0.014	T04-11272	0.052 ± 0.016	T04-11274	0.154 ± 0.061	-----
Nb	41	192-hr event	T04-11268	0.032 ± 0.062	T04-11270	0.019 ± 0.016	T04-11272	0.000 ± 0.010	T04-11274	0.088 ± 0.062	-----
Mo	42	192-hr event	T04-11268	0.000 ± 0.081	T04-11270	-0.002 ± 0.019	T04-11272	0.000 ± 0.010	T04-11274	0.090 ± 0.062	-----
Ag	47	192-hr event	T04-11268	0.000 ± 0.085	T04-11270	0.041 ± 0.036	T04-11272	0.000 ± 0.040	T04-11274	0.145 ± 0.253	-----
Cd	48	192-hr event	T04-11268	0.023 ± 0.094	T04-11270	0.062 ± 0.038	T04-11272	0.000 ± 0.047	T04-11274	0.108 ± 0.145	-----
In	49	192-hr event	T04-11268	0.000 ± 0.092	T04-11270	0.005 ± 0.040	T04-11272	0.000 ± 0.049	T04-11274	0.167 ± 0.242	-----
Sn	50	192-hr event	T04-11268	0.000 ± 0.108	T04-11270	0.033 ± 0.043	T04-11272	0.000 ± 0.062	T04-11274	0.169 ± 0.124	-----
Sb	51	192-hr event	T04-11268	0.045 ± 0.097	T04-11270	0.078 ± 0.049	T04-11272	0.045 ± 0.147	T04-11274	0.039 ± 0.093	-----
Cs	55	192-hr event	T04-11268	0.000 ± 0.224	T04-11270	-0.014 ± 0.084	T04-11272	0.000 ± 0.045	T04-11274	-0.026 ± 0.053	-----
Ba	56	192-hr event	T04-11268	1.071 ± 0.249	T04-11270	0.040 ± 0.116	T04-11272	0.000 ± 0.054	T04-11274	0.329 ± 0.092	-----
La	57	192-hr event	T04-11268	0.000 ± 0.496	T04-11270	0.021 ± 0.147	T04-11272	0.000 ± 0.038	T04-11274	0.259 ± 0.067	-----
Ce	58	192-hr event	T04-11268	0.147 ± 0.412	T04-11270	-0.063 ± 0.181	T04-11272	0.000 ± 0.044	T04-11274	0.010 ± 0.052	-----
Sm	62	192-hr event	T04-11268	0.312 ± 0.697	T04-11270	0.208 ± 0.643	T04-11272	0.000 ± 0.021	T04-11274	not reported	-----
Eu	63	192-hr event	T04-11268	0.068 ± 0.862	T04-11270	0.482 ± 0.976	T04-11272	0.000 ± 0.026	T04-11274	not reported	-----
Tb	65	192-hr event	T04-11268	1.962 ± 0.993	T04-11270	0.668 ± 2.131	T04-11272	0.064 ± 0.061	T04-11274	not reported	-----
Hf	72	192-hr event	T04-11268	0.000 ± 0.229	T04-11270	0.019 ± 0.204	T04-11272	0.053 ± 0.024	T04-11274	not reported	-----
Ta	73	192-hr event	T04-11268	0.115 ± 0.123	T04-11270	-0.041 ± 0.227	T04-11272	0.000 ± 0.017	T04-11274	not reported	-----
W	74	192-hr event	T04-11268	0.000 ± 0.290	T04-11270	0.017 ± 0.059	T04-11272	0.000 ± 0.011	T04-11274	0.047 ± 0.075	-----
Ir	77	192-hr event	T04-11268	0.000 ± 0.104	T04-11270	0.000 ± 0.035	T04-11272	0.000 ± 0.008	T04-11274	not reported	-----

Table 12. XRF PE Results

Element	Z	Sample Description	DRI Sample ID	DRI (µg/filter)	ODEQ Sample ID	ODEQ (µg/filter)	RTI Sample ID	RTI (µg/filter)	EPA-NERL Sample ID	EPA-NERL (µg/filter)	Median* (µg/filter)
Au	79	192-hr event	T04-11268	0.192 ± 0.111	T04-11270	-0.031 ± 0.027	T04-11272	0.034 ± 0.010	T04-11274	0.074 ± 0.047	-----
Hg	80	192-hr event	T04-11268	0.000 ± 0.042	T04-11270	0.017 ± 0.022	T04-11272	0.217 ± 0.011	T04-11274	0.122 ± 0.053	-----
Pb	82	192-hr event	T04-11268	0.174 ± 0.081	T04-11270	0.215 ± 0.035	T04-11272	0.205 ± 0.020	T04-11274	0.229 ± 0.071	-----
Na	11	blank filter	T04-11277	0.000 ± 0.753	T04-11279	-0.258 ± 2.258	T04-11281	0.000 ± 0.131	T04-11283	0.174 ± 0.554	-----
Mg	12	blank filter	T04-11277	0.181 ± 0.812	T04-11279	-0.030 ± 0.399	T04-11281	0.000 ± 0.038	T04-11283	0.949 ± 0.370	-----
Al	13	blank filter	T04-11277	0.000 ± 0.539	T04-11279	-0.034 ± 0.080	T04-11281	0.000 ± 0.049	T04-11283	-0.075 ± 0.239	-----
Si	14	blank filter	T04-11277	0.111 ± 0.249	T04-11279	-0.012 ± 0.048	T04-11281	0.000 ± 0.033	T04-11283	0.980 ± 0.280	-----
P	15	blank filter	T04-11277	0.000 ± 0.050	T04-11279	-0.023 ± 0.028	T04-11281	0.000 ± 0.058	T04-11283	-0.212 ± 0.098	-----
S	16	blank filter	T04-11277	0.079 ± 0.014	T04-11279	-0.040 ± 0.047	T04-11281	0.000 ± 0.036	T04-11283	0.116 ± 0.077	-----
Cl	17	blank filter	T04-11277	0.005 ± 0.037	T04-11279	-0.001 ± 0.028	T04-11281	0.000 ± 0.030	T04-11283	0.025 ± 0.053	-----
K	19	blank filter	T04-11277	0.156 ± 0.001	T04-11279	0.004 ± 0.017	T04-11281	0.000 ± 0.026	T04-11283	-0.037 ± 0.040	-----
Ca	20	blank filter	T04-11277	0.002 ± 0.043	T04-11279	-0.029 ± 0.014	T04-11281	0.000 ± 0.024	T04-11283	-0.027 ± 0.023	-----
Sc	21	blank filter	T04-11277	0.005 ± 0.028	T04-11279	-0.003 ± 0.014	T04-11281	0.000 ± 0.038	T04-11283	0.032 ± 0.017	-----
Ti	22	blank filter	T04-11277	0.000 ± 0.026	T04-11279	-0.002 ± 0.048	T04-11281	0.008 ± 0.016	T04-11283	-0.056 ± 0.036	-----
V	23	blank filter	T04-11277	0.000 ± 0.009	T04-11279	-0.007 ± 0.017	T04-11281	0.000 ± 0.012	T04-11283	-0.015 ± 0.014	-----
Cr	24	blank filter	T04-11277	0.000 ± 0.040	T04-11279	-0.005 ± 0.008	T04-11281	0.000 ± 0.008	T04-11283	0.040 ± 0.014	-----
Mn	25	blank filter	T04-11277	0.000 ± 0.113	T04-11279	0.008 ± 0.013	T04-11281	0.000 ± 0.006	T04-11283	0.106 ± 0.027	-----
Fe	26	blank filter	T04-11277	0.041 ± 0.170	T04-11279	-0.005 ± 0.011	T04-11281	0.000 ± 0.005	T04-11283	-0.008 ± 0.020	-----
Co	27	blank filter	T04-11277	0.009 ± 0.019	T04-11279	0.015 ± 0.008	T04-11281	0.000 ± 0.004	T04-11283	-0.075 ± 0.017	-----
Ni	28	blank filter	T04-11277	0.000 ± 0.031	T04-11279	-0.001 ± 0.008	T04-11281	0.006 ± 0.003	T04-11283	-0.025 ± 0.015	-----
Cu	29	blank filter	T04-11277	0.000 ± 0.024	T04-11279	0.008 ± 0.008	T04-11281	0.000 ± 0.005	T04-11283	0.011 ± 0.015	-----
Zn	30	blank filter	T04-11277	0.011 ± 0.032	T04-11279	-0.004 ± 0.007	T04-11281	0.000 ± 0.006	T04-11283	-0.110 ± 0.019	-----
Ga	31	blank filter	T04-11277	0.000 ± 0.098	T04-11279	-0.006 ± 0.054	T04-11281	0.000 ± 0.002	T04-11283	-0.002 ± 0.025	-----
As	33	blank filter	T04-11277	0.000 ± 0.026	T04-11279	0.000 ± 0.012	T04-11281	0.001 ± 0.003	T04-11283	-0.006 ± 0.030	-----
Se	34	blank filter	T04-11277	0.000 ± 0.023	T04-11279	-0.005 ± 0.009	T04-11281	0.000 ± 0.003	T04-11283	-0.019 ± 0.018	-----
Br	35	blank filter	T04-11277	0.007 ± 0.026	T04-11279	-0.001 ± 0.009	T04-11281	0.000 ± 0.004	T04-11283	-0.028 ± 0.020	-----
Rb	37	blank filter	T04-11277	0.000 ± 0.024	T04-11279	-0.002 ± 0.009	T04-11281	0.000 ± 0.005	T04-11283	0.032 ± 0.021	-----

Table 12. XRF PE Results

Element	Z	Sample Description	DRI Sample ID	DRI (µg/filter)	ODEQ Sample ID	ODEQ (µg/filter)	RTI Sample ID	RTI (µg/filter)	EPA-NERL Sample ID	EPA-NERL (µg/filter)	Median* (µg/filter)
Sr	38	blank filter	T04-11277	0.000 ± 0.057	T04-11279	0.000 ± 0.010	T04-11281	0.000 ± 0.006	T04-11283	0.080 ± 0.065	-----
Y	39	blank filter	T04-11277	0.009 ± 0.037	T04-11279	-0.011 ± 0.011	T04-11281	0.000 ± 0.007	T04-11283	-0.025 ± 0.054	-----
Zr	40	blank filter	T04-11277	0.000 ± 0.077	T04-11279	0.004 ± 0.013	T04-11281	0.000 ± 0.010	T04-11283	0.023 ± 0.044	-----
Nb	41	blank filter	T04-11277	0.043 ± 0.062	T04-11279	0.004 ± 0.015	T04-11281	0.000 ± 0.009	T04-11283	-0.028 ± 0.052	-----
Mo	42	blank filter	T04-11277	0.000 ± 0.081	T04-11279	-0.013 ± 0.017	T04-11281	0.000 ± 0.009	T04-11283	-0.023 ± 0.048	-----
Ag	47	blank filter	T04-11277	0.000 ± 0.085	T04-11279	0.005 ± 0.034	T04-11281	0.000 ± 0.039	T04-11283	-0.462 ± 0.155	-----
Cd	48	blank filter	T04-11277	0.000 ± 0.094	T04-11279	0.004 ± 0.036	T04-11281	0.000 ± 0.044	T04-11283	0.169 ± 0.085	-----
In	49	blank filter	T04-11277	0.000 ± 0.092	T04-11279	-0.001 ± 0.037	T04-11281	0.000 ± 0.045	T04-11283	0.143 ± 0.097	-----
Sn	50	blank filter	T04-11277	0.057 ± 0.108	T04-11279	-0.019 ± 0.040	T04-11281	0.000 ± 0.054	T04-11283	-0.018 ± 0.050	-----
Sb	51	blank filter	T04-11277	0.124 ± 0.098	T04-11279	-0.002 ± 0.045	T04-11281	0.000 ± 0.103	T04-11283	0.065 ± 0.049	-----
Cs	55	blank filter	T04-11277	0.000 ± 0.224	T04-11279	-0.041 ± 0.077	T04-11281	0.000 ± 0.035	T04-11283	0.012 ± 0.047	-----
Ba	56	blank filter	T04-11277	0.000 ± 0.240	T04-11279	-0.053 ± 0.106	T04-11281	0.000 ± 0.035	T04-11283	0.117 ± 0.080	-----
La	57	blank filter	T04-11277	0.000 ± 0.495	T04-11279	-0.114 ± 0.134	T04-11281	0.000 ± 0.028	T04-11283	0.107 ± 0.059	-----
Ce	58	blank filter	T04-11277	0.000 ± 0.411	T04-11279	-0.187 ± 0.166	T04-11281	0.000 ± 0.033	T04-11283	0.038 ± 0.045	-----
Sm	62	blank filter	T04-11277	0.000 ± 0.684	T04-11279	-0.093 ± 0.591	T04-11281	0.000 ± 0.017	T04-11283	not reported	-----
Eu	63	blank filter	T04-11277	1.401 ± 0.880	T04-11279	-0.760 ± 0.895	T04-11281	0.000 ± 0.015	T04-11283	not reported	-----
Tb	65	blank filter	T04-11277	0.007 ± 0.942	T04-11279	-1.449 ± 1.938	T04-11281	0.000 ± 0.014	T04-11283	not reported	-----
Hf	72	blank filter	T04-11277	0.000 ± 0.229	T04-11279	0.010 ± 0.204	T04-11281	0.000 ± 0.020	T04-11283	not reported	-----
Ta	73	blank filter	T04-11277	0.115 ± 0.123	T04-11279	-0.042 ± 0.226	T04-11281	0.000 ± 0.011	T04-11283	not reported	-----
W	74	blank filter	T04-11277	0.000 ± 0.292	T04-11279	-0.006 ± 0.052	T04-11281	0.011 ± 0.009	T04-11283	0.071 ± 0.070	-----
Ir	77	blank filter	T04-11277	0.000 ± 0.104	T04-11279	0.010 ± 0.033	T04-11281	0.000 ± 0.007	T04-11283	not reported	-----
Au	79	blank filter	T04-11277	0.068 ± 0.111	T04-11279	-0.004 ± 0.025	T04-11281	0.000 ± 0.005	T04-11283	-0.033 ± 0.040	-----
Hg	80	blank filter	T04-11277	0.023 ± 0.042	T04-11279	-0.009 ± 0.022	T04-11281	0.000 ± 0.009	T04-11283	-0.107 ± 0.040	-----
Pb	82	blank filter	T04-11277	0.000 ± 0.081	T04-11279	0.004 ± 0.028	T04-11281	0.012 ± 0.011	T04-11283	0.041 ± 0.061	-----
Na	11	blank filter	T04-11278	0.000 ± 0.759	T04-11280	-0.247 ± 2.258	T04-11282	0.000 ± 0.129	T04-11284	0.846 ± 0.546	-----
Mg	12	blank filter	T04-11278	0.418 ± 0.815	T04-11280	-0.170 ± 0.400	T04-11282	0.000 ± 0.041	T04-11284	-0.145 ± 0.360	-----
Al	13	blank filter	T04-11278	0.179 ± 0.542	T04-11280	-0.090 ± 0.081	T04-11282	0.000 ± 0.051	T04-11284	0.288 ± 0.243	-----

Table 12. XRF PE Results

Element	Z	Sample Description	DRI Sample ID	DRI (µg/filter)	ODEQ Sample ID	ODEQ (µg/filter)	RTI Sample ID	RTI (µg/filter)	EPA-NERL Sample ID	EPA-NERL (µg/filter)	Median* (µg/filter)
Si	14	blank filter	T04-11278	0.145 ± 0.250	T04-11280	-0.019 ± 0.048	T04-11282	0.000 ± 0.034	T04-11284	1.037 ± 0.274	-----
P	15	blank filter	T04-11278	0.000 ± 0.050	T04-11280	-0.011 ± 0.027	T04-11282	0.000 ± 0.057	T04-11284	-0.065 ± 0.104	-----
S	16	blank filter	T04-11278	0.000 ± 0.012	T04-11280	0.042 ± 0.045	T04-11282	0.000 ± 0.033	T04-11284	-0.021 ± 0.077	-----
Cl	17	blank filter	T04-11278	0.000 ± 0.037	T04-11280	0.039 ± 0.024	T04-11282	0.000 ± 0.028	T04-11284	-0.092 ± 0.046	-----
K	19	blank filter	T04-11278	0.066 ± 0.001	T04-11280	-0.002 ± 0.016	T04-11282	0.023 ± 0.018	T04-11284	0.062 ± 0.042	-----
Ca	20	blank filter	T04-11278	0.000 ± 0.043	T04-11280	0.004 ± 0.013	T04-11282	0.000 ± 0.024	T04-11284	-0.059 ± 0.023	-----
Sc	21	blank filter	T04-11278	0.005 ± 0.028	T04-11280	0.017 ± 0.014	T04-11282	0.000 ± 0.036	T04-11284	0.024 ± 0.017	-----
Ti	22	blank filter	T04-11278	0.000 ± 0.026	T04-11280	0.011 ± 0.046	T04-11282	0.021 ± 0.015	T04-11284	0.037 ± 0.037	-----
V	23	blank filter	T04-11278	0.000 ± 0.009	T04-11280	0.001 ± 0.016	T04-11282	0.000 ± 0.012	T04-11284	0.013 ± 0.014	-----
Cr	24	blank filter	T04-11278	0.000 ± 0.040	T04-11280	-0.001 ± 0.008	T04-11282	0.000 ± 0.007	T04-11284	0.044 ± 0.014	-----
Mn	25	blank filter	T04-11278	0.043 ± 0.114	T04-11280	-0.007 ± 0.012	T04-11282	0.000 ± 0.006	T04-11284	0.048 ± 0.025	-----
Fe	26	blank filter	T04-11278	0.063 ± 0.171	T04-11280	-0.006 ± 0.011	T04-11282	0.000 ± 0.005	T04-11284	-0.035 ± 0.018	-----
Co	27	blank filter	T04-11278	0.020 ± 0.019	T04-11280	0.006 ± 0.008	T04-11282	0.000 ± 0.004	T04-11284	-0.031 ± 0.018	-----
Ni	28	blank filter	T04-11278	0.000 ± 0.031	T04-11280	-0.006 ± 0.008	T04-11282	0.000 ± 0.004	T04-11284	0.009 ± 0.016	-----
Cu	29	blank filter	T04-11278	0.000 ± 0.024	T04-11280	-0.014 ± 0.008	T04-11282	0.008 ± 0.004	T04-11284	0.013 ± 0.015	-----
Zn	30	blank filter	T04-11278	0.000 ± 0.032	T04-11280	-0.002 ± 0.007	T04-11282	0.000 ± 0.006	T04-11284	-0.029 ± 0.023	-----
Ga	31	blank filter	T04-11278	0.131 ± 0.098	T04-11280	-0.008 ± 0.054	T04-11282	0.001 ± 0.003	T04-11284	0.013 ± 0.024	-----
As	33	blank filter	T04-11278	0.000 ± 0.026	T04-11280	0.002 ± 0.012	T04-11282	0.000 ± 0.002	T04-11284	-0.005 ± 0.028	-----
Se	34	blank filter	T04-11278	0.000 ± 0.023	T04-11280	-0.004 ± 0.009	T04-11282	0.000 ± 0.003	T04-11284	0.022 ± 0.019	-----
Br	35	blank filter	T04-11278	0.000 ± 0.026	T04-11280	-0.001 ± 0.009	T04-11282	0.000 ± 0.003	T04-11284	0.001 ± 0.019	-----
Rb	37	blank filter	T04-11278	0.020 ± 0.024	T04-11280	-0.002 ± 0.009	T04-11282	0.003 ± 0.007	T04-11284	0.024 ± 0.020	-----
Sr	38	blank filter	T04-11278	0.041 ± 0.057	T04-11280	0.001 ± 0.010	T04-11282	0.000 ± 0.006	T04-11284	0.028 ± 0.054	-----
Y	39	blank filter	T04-11278	0.000 ± 0.037	T04-11280	-0.003 ± 0.011	T04-11282	0.000 ± 0.006	T04-11284	0.018 ± 0.054	-----
Zr	40	blank filter	T04-11278	0.000 ± 0.077	T04-11280	-0.008 ± 0.012	T04-11282	0.000 ± 0.010	T04-11284	0.113 ± 0.050	-----
Nb	41	blank filter	T04-11278	0.000 ± 0.062	T04-11280	-0.011 ± 0.014	T04-11282	0.000 ± 0.008	T04-11284	0.158 ± 0.062	-----
Mo	42	blank filter	T04-11278	0.016 ± 0.081	T04-11280	0.017 ± 0.016	T04-11282	0.000 ± 0.009	T04-11284	0.188 ± 0.061	-----
Ag	47	blank filter	T04-11278	0.000 ± 0.085	T04-11280	0.001 ± 0.034	T04-11282	0.000 ± 0.034	T04-11284	-0.046 ± 0.175	-----

Table 12. XRF PE Results

Element	Z	Sample Description	DRI Sample ID	DRI (µg/filter)	ODEQ Sample ID	ODEQ (µg/filter)	RTI Sample ID	RTI (µg/filter)	EPA-NERL Sample ID	EPA-NERL (µg/filter)	Median* (µg/filter)
Cd	48	blank filter	T04-11278	0.068 ± 0.094	T04-11280	-0.005 ± 0.035	T04-11282	0.000 ± 0.046	T04-11284	0.065 ± 0.096	-----
In	49	blank filter	T04-11278	0.000 ± 0.092	T04-11280	-0.011 ± 0.037	T04-11282	0.000 ± 0.045	T04-11284	0.011 ± 0.099	-----
Sn	50	blank filter	T04-11278	0.057 ± 0.108	T04-11280	0.013 ± 0.039	T04-11282	0.000 ± 0.056	T04-11284	0.138 ± 0.054	-----
Sb	51	blank filter	T04-11278	0.034 ± 0.097	T04-11280	-0.012 ± 0.044	T04-11282	0.000 ± 0.097	T04-11284	0.113 ± 0.048	-----
Cs	55	blank filter	T04-11278	0.077 ± 0.225	T04-11280	-0.021 ± 0.074	T04-11282	0.000 ± 0.032	T04-11284	0.039 ± 0.046	-----
Ba	56	blank filter	T04-11278	0.000 ± 0.241	T04-11280	-0.090 ± 0.101	T04-11282	0.000 ± 0.031	T04-11284	0.067 ± 0.078	-----
La	57	blank filter	T04-11278	0.000 ± 0.495	T04-11280	-0.054 ± 0.129	T04-11282	0.000 ± 0.025	T04-11284	0.143 ± 0.058	-----
Ce	58	blank filter	T04-11278	0.068 ± 0.412	T04-11280	-0.107 ± 0.159	T04-11282	0.000 ± 0.031	T04-11284	0.102 ± 0.045	-----
Sm	62	blank filter	T04-11278	0.000 ± 0.683	T04-11280	-0.578 ± 0.568	T04-11282	0.000 ± 0.016	T04-11284	not reported	-----
Eu	63	blank filter	T04-11278	0.622 ± 0.869	T04-11280	-1.191 ± 0.861	T04-11282	0.006 ± 0.012	T04-11284	not reported	-----
Tb	65	blank filter	T04-11278	0.000 ± 0.940	T04-11280	-0.333 ± 1.864	T04-11282	0.000 ± 0.014	T04-11284	not reported	-----
Hf	72	blank filter	T04-11278	0.000 ± 0.229	T04-11280	-0.025 ± 0.204	T04-11282	0.008 ± 0.016	T04-11284	not reported	-----
Ta	73	blank filter	T04-11278	0.000 ± 0.122	T04-11280	-0.020 ± 0.227	T04-11282	0.012 ± 0.015	T04-11284	not reported	-----
W	74	blank filter	T04-11278	0.000 ± 0.292	T04-11280	0.001 ± 0.053	T04-11282	0.000 ± 0.007	T04-11284	-0.082 ± 0.066	-----
Ir	77	blank filter	T04-11278	0.047 ± 0.105	T04-11280	0.007 ± 0.034	T04-11282	0.000 ± 0.006	T04-11284	not reported	-----
Au	79	blank filter	T04-11278	0.000 ± 0.111	T04-11280	0.001 ± 0.025	T04-11282	0.008 ± 0.006	T04-11284	0.192 ± 0.045	-----
Hg	80	blank filter	T04-11278	0.000 ± 0.042	T04-11280	0.001 ± 0.022	T04-11282	0.000 ± 0.008	T04-11284	-0.031 ± 0.040	-----
Pb	82	blank filter	T04-11278	0.050 ± 0.081	T04-11280	-0.008 ± 0.028	T04-11282	0.000 ± 0.007	T04-11284	0.059 ± 0.057	-----

***** Median was calculated only when the result from all reporting labs was greater than three times the uncertainty.***

Table 13. XRF Analysis at the DRI Laboratory										
Instrument: PanAnalytical Epsilon 5 Software: E5 Version 1.0B										
	Instrument Conditions for Routine Sample Analysis									
Parameter	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
X-ray tube parameters: Tube voltage (kV)	25	40	40	75	100	100	100	100	100	100
Tube current (mA)	24	15	15	8	6	6	6	6	6	6
Tube anode material	Gd	Gd	Gd	Gd	Gd	Gd	Gd	Gd	Gd	Gd
Direct excitation of sample: Filter Material										
Filter thickness (mm)										
Secondary excitation of sample: Secondary Fluorescor	CaF_2	Ti	Fe	Ge	Zr	Mo	Ag	CsI	BaF_2	Al_2O_3
Filter material										
Filter thickness (mm)										
Acquisition time (seconds)	200	200	200	200	100	100	100	100	100	100
Energy range acquired (keV)	0-20	0-20	0-20	0-20	0-20	0-20	0-40	0-80	0-80	0-80
Number of [MCA] channels	2048	2048	2048	2048	2048	2048	4096	8192	8192	8192
Sample rotation (yes/no)	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Beam spot size, diameter (mm)	20	20	20	20	20	20	20	20	20	20
Atmosphere (vacuum, He, air)	vacuum	vacuum	vacuum	vacuum	vacuum	vacuum	vacuum	vacuum	vacuum	vacuum
Elements Reported	Na Mg Al Si P S Cl K	Ca Sc	Ti V Cr	Mn Fe Co Ni Cu Zn	Ga As Se Br Rb Hf Ta W Ir Au Hg Tl Pb	Sr Y	Zr Nb Mo	Pd Ag Cd In	Sn Sb	Cs Ba La Ce Sm Eu Tb

Table 14. XRF Analysis at the ODEQ Laboratory										
Instrument: Kevex771 Software: WinXRF V2.41										
Parameter	Instrument Conditions for Routine Sample Analysis									
	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
X-ray tube parameters: Tube voltage (kV)	7.5	35	40	45	40	58				
Tube current (mA)	0.9	2.1	2.1	2.1	0.9	1.5				
Tube anode material	Rh	Rh	Rh	Rh	Rh	Rh				
Direct excitation of sample: Filter Material	Whatman 41	na	na	na	Rh	W				
Filter thickness (mm)	1 layer	na	na	na	0.1	0.1				
Secondary excitation of sample: Secondary Fluorescor	none	Ti	Fe	Ge	none	none				
Filter material	na	none	none	none	na	na				
Filter thickness (mm)	na	na	na	na	na	na				
Acquisition time (seconds)	400	400	400	400	400	400				
Energy range acquired (keV)	10	10	10	10	20	80				
Number of [MCA] channels	1024	1024	1024	1024	2048	4096				
Sample rotation (yes/no)	no	no	no	no	no	no				
Beam spot size, diameter (mm)	unknown	unknown	unknown	unknown	unknown	unknown				
Atmosphere (vacuum, He, air)	vacuum	vacuum	vacuum	vacuum	vacuum	vacuum				
Elements Reported	Na Mg Al Si P	S Cl K Ca	Sc Ti V Cr	Mn Fe Co Ni Cu Zn	Ga As Se Br Rb Sr Y Zr Nb Mo Hf Ta W Ir Au Hg Pb	Ag Cd In Sn Sb Cs Ba La Ce Sm Eu Tb				

Table 15. XRF Analysis at the RTI Laboratory										
Instrument: ThermoNoran QuanX Software: Wintrace 3.0 Build 35										
	Instrument Conditions for Routine Sample Analysis									
Parameter	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
X-ray tube parameters: Tube voltage (kV)	5	10	30	50	50					
Tube current (mA)	1.20	1.98	1.66	1.00	1.00					
Tube anode material	Rh	Rh	Rh	Rh	Rh					
Direct excitation of sample: Filter Material	no filter	Graphite	Pd Thin	Pd Thick	Cu Thin					
Filter thickness (**g/cm^2**)	na	0.06	0.03	0.15	0.338					
Secondary excitation of sample: Secondary Fluorescor	na	na	na	na	na					
Filter material	na	na	na	na	na					
Filter thickness (mm)	na	na	na	na	na					
Acquisition time (seconds)	300	300	250	200	200					
Energy range acquired (keV)	0-10	0-10	0-20	0-40	0-40					
Number of [MCA] channels	512	512	1024	2048	2048					
Sample rotation (yes/no)	no	no	no	no	no					
Beam spot size, diameter (mm)	9.5mm x 11mm Elipse	9.5mm x 11mm Elipse	9.5mm x 11mm Elipse	9.5mm x 11mm Elipse	9.5mm x 11mm Elipse					
Atmosphere (vacuum, He, air)	vacuum	vacuum	vacuum	vacuum	vacuum					
Elements Reported	Na Mg P	Al Si S K Ca Sc Cs	Cl Ti V Cr Mn Fe Co Ni Cu Zn La Ce Sm Eu Tb Hf	Ga As Se Br Rb Sr Y Zr Nb Mo Ta W Ir Au Hg Pb	Ag Cd In Sn Sb Ba					

Table 16. XRF Analysis at the RTI Laboratory										
Instrument: ThermoNoran QuanX EC Software: Wintrace 3.0 Build 31										
	Instrument Conditions for Routine Sample Analysis									
Parameter	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
X-ray tube parameters: Tube voltage (kV)	5	10	30	50	50					
Tube current (mA)	1.98	1.98	1.66	1.00	1.00					
Tube anode material	Rh	Rh	Rh	Rh	Rh					
Direct excitation of sample: Filter Material	no filter	Graphite	Pd Thin	Pd Med Thick	Cu Thin					
Filter thickness (**g/cm^2**)	na	0.06	0.03	0.09	0.338					
Secondary excitation of sample: Secondary Fluorescor	na	na	na	na	na					
Filter material	na	na	na	na	na					
Filter thickness (mm)	na	na	na	na	na					
Acquisition time (seconds)	300	300	300	300	300					
Energy range acquired (keV)	0-10	0-10	0-20	0-40	0-40					
Number of [MCA] channels	512	512	1024	2048	2048					
Sample rotation (yes/no)	no	no	no	no	no					
Beam spot size, diameter (mm)	10mm x 12mm Elipse	10mm x 12mm Elipse	10mm x 12mm Elipse	10mm x 12mm Elipse	10mm x 12mm Elipse					
Atmosphere (vacuum, He, air)	vacuum	vacuum	vacuum	vacuum	vacuum					
Elements Reported	Na Mg Al Si	P S Cl K Ca Sc	Ti V Cr Mn Fe Co Ni Cu Zn Cs Ba La Ce Sm Eu Tb Hf	Ga As Se Br Rb Sr Y Zr Nb Mo Ta W Ir Au Hg Pb	Ag Cd In Sn Sb					

Table 17. XRF Analysis at EPA's NERL Laboratory										
Instrument: Kevex771-EDX Software: LSQEPA v3-2004F (custom software)										
Parameter	Instrument Conditions for Routine Sample Analysis									
	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
X-ray tube parameters: Tube voltage (kV)	55	55	40	40	40	15				
Tube current (mA)	0.75	0.75	1.00	1.00	1.00	1.6				
Tube anode material	Rh	Rh	Rh	Rh	Rh	Rh				
Direct excitation of sample: Filter Material	none	none	none	none	none	none				
Filter thickness (mm)	none	none	none	none	none	none				
Secondary excitation of sample: Secondary Fluorescor	Zr	Ag	Ge	Fe	Ti	Al				
Filter material	none	none	none	none	none	none				
Filter thickness (mm)	none	none	none	none	none	none				
Acquisition time (seconds)	200	100	100	200	200	200				
Energy range acquired (keV)	20	20	10	10	10	10				
Number of [MCA] channels	1024	1024	1024	1024	1024	1024				
Sample rotation (yes/no)	no	no	no	no	no	no				
Beam spot size, diameter (mm)	~20	~20	~20	~20	~20	~20				
Atmosphere (vacuum, He, air)	vacuum	vacuum	vacuum	vacuum	vacuum	vacuum				
Elements Reported	Cu Zn Ga Ge As Se Br Rb W Pt Au Hg Tl Pb	Rb Sr Y Zr Nb Mo	Cr Mn Fe Co Ni Cu	K Ca Sc Ti V CrCd In Sn Sb Te I Cs Ba La Ce	Al Si P S Cl K Ca Sc Rh Pd Ag Cd In Sn Sb	Na Mg				