



## **Summary of Quarterly Operations (October – December) with 2009 Annual Summary**

**EPA Contract No. EP-W-09-028**

### **Introduction**

This quarterly report summarizes results from the Clean Air Status and Trends Network (CASTNET) quality assurance/quality control (QA/QC) program for data collected during fourth quarter 2009. It also provides an annual summary that includes data from the three previous quarters. The results presented for filter pack data collection and field calibrations are generated from data extracted from the CASTNET Data Management Center (DMC) database using the CASTNET Data Management System Application (CDMSA). The various QA/QC criteria and policies are documented in the CASTNET Quality Assurance Project Plan (QAPP). The QAPP is comprehensive and includes standards and policies for all components of project operation from site selection through final data reporting. It is reviewed annually and updated as warranted.

### **Significant Events for 2009**

Beginning with the January 2009 calibrations, the field calibration accuracy criterion for relative humidity changed to  $\pm 10$  percent for all relative humidity measurements. Previously, the accuracy measurement criterion for relative humidity was  $\pm 5$  percent for values greater than 85 percent and  $\pm 20$  percent for values less than or equal to 85 percent. The field calibration precision criterion for relative humidity remains at  $\pm 10$  percent.

Also as of January 2009, one of the checkpoints for ozone multipoint calibrations changed from 400 parts per billion (ppb) to 450 ppb. The checkpoints for an ozone analyzer multipoint calibration are now at 0 ppb, 450 ppb, 300 ppb, 200 ppb, 100 ppb, and 60 ppb.

During first quarter 2009, MACTEC received the final report on the results of analyses of laboratory samples for the intercomparison proficiency test (PT) Study 0093 for Analyses for Rain and Soft Waters from the National Water Research Institute (NWRI) with Environment Canada. Thirty-six laboratories participated in PT Study 0093. MACTEC performed very well

with no flags or bias and achieved a classification of “ideal” on 100 percent of the analyses, and the laboratory received a performance rating of “good.” These are the highest ratings that can be received. Out of the 36 participating laboratories, MACTEC and two other laboratories received the best possible percent score of 0.00 (the sum of parameters biased and results flagged). Final results for the 2008 US Geological Survey (USGS) Interlaboratory Comparison samples were received from the USGS on March 23, 2009. MACTEC performed very well either achieving the target value or within a less than 5 percent range for all of the 144 samples analyzed.

During second quarter 2009, data sets were examined for evidence characterizing laboratory handling-related effects on the precision of filter pack concentrations. Given the internal QA/QC checks and monitoring in place and the successful analyses performed by the laboratory for Environment Canada proficiency tests and USGS intercomparison studies, which all include precision evaluations, it was determined that it is unlikely that laboratory handling significantly affects the precision of filter pack concentrations.

Precision measurement criteria for filter pack concentrations changed during third quarter 2009. Previously, these criteria required a mean absolute relative percent difference (MARPD) of 5.0 percent for all collocated CASTNET filter pack measurements, except for particulate ammonium, which had a criterion of 10.0 percent MARPD. Beginning on August 11, 2009, the precision measurement criteria were changed to a single MARPD value of 20.0 percent.

During third quarter 2009, an internal change order system that stipulates planning and notification requirements and utilization of a master list of resources was implemented. The internal change order system provides a framework for management and non-management staff to utilize when determining what steps to take, what questions to ask, and the effects that may occur with the introduction of a new component or system.

An audit of CASTNET site calibration and repair procedures at MACTEC’s office in Gainesville, FL took place during third quarter 2009. The audit verified that preparations prior to a technician’s departure to the site are performed according to standard operating procedures (SOPs). The documentation needed was checked and verified, as were the calibration kit parts and equipment, parts and equipment inventory list, procedure list, and notification of special tasks required at the site, including the necessary parts needed for the special tasks. Additional preparatory tasks such as the sending of notification letters to the site operators and shipment of parts needed to the site were also verified.

After analysis and final data reporting are completed, current procedures for post-analysis storage of filter concentrations are to refrigerate the samples for one year and then move the samples to ambient temperature storage. During third quarter 2009, the cooler failed in the auxiliary cold room where samples are stored after analysis and final data reporting, which is

approximately six months after receipt. The samples reached ambient temperature. The exact date of failure is unknown because the auxiliary cold room had not been included in the routine temperature verification schedule. After proper cold room function had been restored and samples were again at 2 to 6 degrees Celsius, three of the oldest samples from the Beltsville, MD (BEL116) site were reanalyzed. The reanalysis indicated that the original sample concentrations were repeatable. A corrective action was initiated to ensure adequate monitoring of this cold room in the future.

During fourth quarter 2009, MACTEC conducted an audit of the ABT147, CT site. Findings of note include the need to replace out-of-date documentation with current documentation and to level the solar radiation sensor and tipping bucket. The auditor suggested putting flags or other noticeable covers on the guy wires to prevent possible accidents.

Beginning on October 20, 2009 (sample week 42), with approval from EPA, MACTEC changed the analysis protocol for the collocated site at Mackville, KY (MCK231) nylon (n) filter fraction analyses for the remainder of 2009 to perform a short study. Samples for weeks 42 through 52 were extracted using the Teflon filter extraction fluid (deionized water) and included automated colorimetry (AC) analyses for ammonia ( $\text{NH}_3$ ) + ammonium ( $\text{NH}_4^+$ ) as nitrogen in addition to the regular ion chromatography (IC) analyses for sulfur dioxide ( $\text{SO}_2$ ) as sulfate ( $\text{SO}_4^{2-}$ ) and nitric acid ( $\text{HNO}_3$ ) as nitrate ( $\text{NO}_3^-$ ). Because of this change in extraction fluid, MACTEC will invalidate “nso4” and “nhno3” values from these filter packs in DRYCHEM for these weeks and will not calculate precision (MARPD) values for the 2009 fourth quarter for these two analytes. Data for the first three quarters of 2009 are available for summary precision statistics for the year. Other analytes were handled as normal for fourth quarter.

During December 2009, a package of quality assurance materials was sent to each site. The materials included updated health and safety information. A laminated sign with directions to the nearest hospital was also sent in each package for posting in a clearly visible location at the site.

### **Quarterly/Annual Summary**

Collocated filter pack precision data and completeness data for meteorological measurements are presented for data validated to Level 3 during the quarter/year. Table 1 lists the quarters of data that were validated to Level 3 during 2009 by site calibration group. Table 2 lists the sites in each calibration group along with the calibration schedule.

Table 3 presents the measurement criteria for continuous field measurements. These criteria apply to the instrument challenges performed during site calibrations. Table 4 presents the measurement criteria for laboratory filter pack measurements. These criteria apply to the QC samples listed in the following section of this report.

## Quality Control Analysis Count

The QC sample statistics presented in this report are for reference standards (RF) and continuing calibration verification spikes (CCV) used to assess accuracy and for replicate sample analyses (RP) used to assess “in-run” precision. In addition, laboratory method blanks (MB) containing reagents without a filter; laboratory blanks (LB) containing reagents and a new, unexposed filter; and field blanks (FB) containing reagents and an unexposed filter that was loaded into a filter pack assembly and shipped to and from the monitoring site while remaining in sealed packaging are also included. Tables 5 through 8 present the number of analyses in each category that were performed during each quarter of 2009.

## Sample Receipt Statistics

EPA requires that 95 percent of field samples from EPA-sponsored sites be received by the CASTNET laboratory in Gainesville, FL no later than 14 days after removal from the sampling tower. Table 9 presents the relevant sample receipt statistics for each of the four quarters of 2009 together with an annual summary for each category.

## Data Quality Indicator (DQI) Results

Figures 1 through 3 present the results of RF, CCV, and RP QC sample analyses for fourth quarter 2009. All results were within the criteria listed in Table 4 with the exception of several individual RP results. However, these are considered reasonable since higher relative percent differences generally correlate with lower sample concentrations. Of 555 reported RP results, only 4 showed an RPD above 10 percent, including 1 value at 23 percent. Table 10 presents the percent recoveries and standard deviations for RF, CCV, and RP QC sample analyses for 2009. Quarterly averages are all within criteria.

Table 11 presents quarterly collocated filter pack precision results for data validated to Level 3 during the year. Overall, with the exception of one, all of the site parameters were outside of the criteria required before they were superseded on August 11, 2009. However, 82 percent of site parameter results had a RPD of less than 10 percent.

Figure 4 presents completeness statistics for continuous measurements validated to Level 3 during the quarter. All parameters met the 90 percent criterion.

## Laboratory Control Sample Analysis

The laboratory control sample (LCS) is a reagent blank spiked with the target analytes from the established analytical methods and carried through the same extraction process that field samples must undergo. The LCS is not required by the CASTNET QA/QC program. LCS analyses are performed by the laboratory to monitor for potential sample handling artifacts and provide a means to identify possible analyte loss from extraction to extraction. The current action limits for

LCS recovery are 80 percent and 120 percent. These limits may change as data are collected and analyzed. Figure 5 presents LCS analysis results for fourth quarter 2009.

### **Blank Results**

Figures 6 through 8 present the results of MB, LB, and FB QC sample analyses for fourth quarter 2009. All results were within criteria (two times the reporting limit) listed in Table 4. Table 12 summarizes the record of filter blanks for 2009.

### **Suspect/Invalid Filter Pack Samples**

Filter pack samples that were flagged as suspect or invalid during each of the four quarters of 2009 are listed in Table 13. This table also includes associated site identification and a brief description of the reason the sample was flagged. During fourth quarter, two filter pack samples were invalidated for reasons not readily apparent during initial investigation. The investigation is ongoing at the time of this writing.

### **Field Problem Count**

Table 14 presents counts of field problems affecting continuous data collection for more than one day for each quarter during quarter 2009. The problem counts are sorted by a 30-, 60-, or 90- day time period to resolution. A category for unresolved problems is also included. Time to resolution indicates the period taken to implement corrective action. The time period does not correlate with the quantity of data affected. For example, if a 5-hour block of missing data takes 60 days to replace, it will show up in the 60-day category. By the same token, a site missing 200 hours of data due to the damage caused by a lightning strike will show up in the 30-day category if the site is repaired within 30 days, even though the data cannot be replaced.

### **Field Calibration Results**

A summary of field calibration failures by parameter for each quarter of 2009 is listed in Table 15. Calibrations were performed at 24 sites during fourth quarter 2009. For fourth quarter, all sites and parameters were within the criteria listed in Table 3 with the exception of the parameters at the six sites that are listed in Table 15.

Table 16 presents field accuracy results for 2009 based on instrument challenges performed using independent reference standards during site calibration visits. Each parameter was within its criterion with at least 90 percent frequency.

## **Tables and Figures**

**Table 1.** Data Validated to Level 3 during Third Quarter 2009

Calibration Group*	Months Available	Number of Months	Complete Quarters**	Number of Quarters
SE-4 MW-6 <sup>†</sup>	July 2008 – June 2009	12	Quarter 3 2008 – Quarter 2 2009	4
E-1 SE-5	August 2008 – July 2009	12	Quarter 4 2008 – Quarter 2 2009	3
MW-7 W-9	September 2008 – August 2009	12	Quarter 4 2008 – Quarter 2 2009	3
E-2 MW-8	October 2008 – September 2009	12	Quarter 4 2008 – Quarter 3 2009	4
E-3 W-10 <sup>‡</sup>	May 2008 – April 2009	12	Quarter 3 2008 – Quarter 1 2009	3

**Notes:** \* The sites contained in each calibration group are listed in Table 2.

\*\* This column does not include Level 3 validated months that comprise only partial calendar quarters. This information is included primarily as a reference for Table 11

<sup>†</sup> Contains MCK131/231 collocated pair

<sup>‡</sup> Contains ROM206 of the ROM406/ROM206 collocated pair

**Table 2.** Field Calibration Schedule

Calibration Group Number	Months Calibrated	Sites Calibrated			
<b>Eastern Sites (20 Total)</b>					
E-1 (8 Sites)	February/August	BEL116, MD BWR139, MD	WSP144, NJ CTH110, NY	ARE 128, PA PSU106, PA	PED108, VA VPI120, VA
E-2 (7 Sites)	April/October	ABT147, CT WST109, NH	HOW132, ME ASH135, ME	CAT175, NY HWF187, NY	EGB181 ON
E-3 (5 Sites)	May/November	KEF112, PA MKG113, PA	LRL117, PA PAR107, WV	CDR119, WV	
<b>Southeastern Sites (10 Total)</b>					
SE-4 (6 Sites)	January/July	SND152, AL GAS153, GA	BFT142, NC CND125, NC	COW137, NC PNF126, NC	
SE-5 (4 Sites)	February/August	CAD150, AR CVL151, MS	IRL141, FL SUM156, FL		
<b>Midwestern Sites (19 Total)</b>					
MW-6 (6 Sites)	January/July	CDZ171, KY CKT136, KY	MCK131, KY MCK231, KY	ESP127, TN SPD111, TN	
MW-7 (8 Sites)	March/September	ALH157, IL BVL130, IL	STK138, IL VIN140, IN	DCP114, OH OXF122, OH	QAK172, OH PRK134, WI
MW-8 (5 Sites)	April/October	SAL133, IN HOX148, MI	ANA115, MI UVL124, MI	LYK123, OH	
<b>Western Sites (10 Total)</b>					
W-9 (4 Sites)	March/September	KNZ184, KS CHE185, OK	SAN189, NE ALC188, TX		
W-10 (6 Sites)	May/November	CON186, CA PAL190, TX	GTH161, CO ROM206, CO	CNT169, WY PND165, WY	



**Table 3.** Data Quality Indicators for CASTNET Continuous Measurements

Measurement		Criteria*	
Parameter	Method	Precision	Accuracy
Wind speed	Anemometer	± 0.5 m/s	The greater of ± 0.5 m/s for winds < 5 m/s or ± 5% for winds ≥ 5 m/s
Wind direction	Wind vane	± 5°	± 5°
Sigma theta	Wind vane	Undefined	Undefined
Relative humidity	Thin film capacitor	± 10% (of full scale)	± 10%
Solar radiation	Pyranometer	± 10% (of reading taken at local noon)	± 10%
Precipitation	Tipping bucket rain gauge	± 10% (of reading)	± 0.05 inch <sup>†</sup>
Ambient temperature	Platinum RTD	± 1.0°C	± 0.5°C
Delta temperature	Platinum RTD	± 0.5°C	± 0.5°C
Ozone	UV absorbance	± 10% (of reading)	± 10%
Filter pack flow	Mass flow controller	± 10%	± 5%
Surface wetness	Conductivity bridge	Undefined	Undefined

**Note:** °C = degrees Celsius  
m/s = meters per second  
RTD = resistance-temperature device  
UV = ultraviolet

\* Precision criteria apply to collocated instruments, and accuracy criteria apply to calibration of instruments

<sup>†</sup> For target value of 0.50 inch



**Table 4.** Data Quality Indicators for CASTNET Laboratory Measurements

Analyte	Medium	Method	Through 08-10-09 Precision <sup>1</sup> (MARPD)	Beginning 08-11-09 Precision <sup>1</sup> (MARPD)	Accuracy <sup>2</sup> (%)	Nominal Reporting Limits	
						mg/L	µg/Filter
Ammonium (NH <sub>4</sub> <sup>+</sup> )	F	AC	10	20	90 - 110	0.020 <sup>*</sup>	0.5
Sodium (Na <sup>+</sup> )	F	ICP-AES	5	20	95 - 105	0.005	0.125
Potassium (K <sup>+</sup> )	F	ICP-AES	5	20	95 - 105	0.006	0.15
Magnesium (Mg <sup>2+</sup> )	F	ICP-AES	5	20	95 - 105	0.003	0.075
Calcium (Ca <sup>2+</sup> )	F	ICP-AES	5	20	95 - 105	0.006	0.15
Chloride (Cl <sup>-</sup> )	F	IC	5	20	95 - 105	0.020	0.5
Nitrate (NO <sub>3</sub> <sup>-</sup> )	F	IC	5	20	95 - 105	0.008 <sup>*</sup>	0.2
Sulfate (SO <sub>4</sub> <sup>2-</sup> )	F	IC	5	20	95 - 105	0.040	1.0

**Note:** <sup>1</sup> This column lists precision goals for both network precision calculated from collocated filter samples and laboratory precision based on replicate samples.

<sup>2</sup> This column lists laboratory accuracy goals based on reference standards and continuing calibration verification spikes. The criterion is 90-110 percent for ICP-AES reference standards.

F = filter pack samples  
 AC = automated colorimetry  
 ICP-AES = inductively coupled plasma-atomic emission spectrometry  
 IC = ion chromatography  
 MARPD = mean absolute relative percent difference  
 \* = as nitrogen

**Table 5.** QC Analysis Count for First Quarter 2009

Filter Type	Parameter	RF Sample Count	CCV Sample Count	RP Sample Count	MB Sample Count	LB Sample Count	FB Sample Count
Teflon	SO <sub>4</sub> <sup>2-</sup>	39	179	81	18	26	80
	NO <sub>3</sub> <sup>-</sup>	39	179	81	18	26	80
	NH <sub>4</sub> <sup>+</sup>	34	167	78	17	26	80
	Cl <sup>-</sup>	39	179	81	18	26	80
	Ca <sup>2+</sup>	34	169	77	17	26	80
	Mg <sup>2+</sup>	34	169	77	17	26	80
	Na <sup>+</sup>	34	169	77	17	26	80
Nylon	SO <sub>4</sub> <sup>2-</sup>	38	170	77	17	24	43
	NO <sub>3</sub> <sup>-</sup>	38	170	77	17	24	43
Cellulose	SO <sub>4</sub> <sup>2-</sup>	43	168	82	21	28	57

**Table 6.** QC Analysis Count for Second Quarter 2009

Filter Type	Parameter	RF Sample Count	CCV Sample Count	RP Sample Count	MB Sample Count	LB Sample Count	FB Sample Count
Teflon®	SO <sub>4</sub> <sup>2-</sup>	34	168	75	17	26	73
	NO <sub>3</sub> <sup>-</sup>	34	168	75	17	26	73
	NH <sub>4</sub> <sup>+</sup>	32	168	79	16	26	83
	Cl <sup>-</sup>	34	168	75	17	26	73
	Ca <sup>2+</sup>	32	171	79	16	26	83
	Mg <sup>2+</sup>	32	171	79	16	26	83
	Na <sup>+</sup>	32	171	79	16	26	83
	K <sup>+</sup>	32	171	79	16	26	83
Nylon	SO <sub>4</sub> <sup>2-</sup>	35	171	79	17	28	86
	NO <sub>3</sub> <sup>-</sup>	35	171	79	17	28	86
Cellulose	SO <sub>4</sub> <sup>2-</sup>	45	174	82	23	26	105

**Table 7.** QC Analysis Count for Third Quarter 2009

Filter Type	Parameter	RF Sample Count	CCV Sample Count	RP Sample Count	MB Sample Count	LB Sample Count	FB Sample Count
Teflon	SO <sub>4</sub> <sup>2-</sup>	39	184	81	17	26	95
	NO <sub>3</sub> <sup>-</sup>	39	184	81	17	26	95
	NH <sub>4</sub> <sup>+</sup>	37	189	88	18	26	85
	Cl <sup>-</sup>	39	184	81	17	26	95
	Ca <sup>2+</sup>	34	172	78	16	26	83
	Mg <sup>2+</sup>	34	172	78	16	26	83
	Na <sup>+</sup>	34	172	78	16	26	83
	K <sup>+</sup>	34	172	78	16	26	83
Nylon	SO <sub>4</sub> <sup>2-</sup>	32	168	77	16	26	119
	NO <sub>3</sub> <sup>-</sup>	32	168	77	16	26	119
Cellulose	SO <sub>4</sub> <sup>2-</sup>	46	182	87	23	26	86

**Table 8.** QC Analysis Count for Fourth Quarter 2009

Filter Type	Parameter	RF Sample Count	CCV Sample Count	RP Sample Count	MB Sample Count	LB Sample Count	FB Sample Count
Teflon	SO <sub>4</sub> <sup>2-</sup>	31	158	72	15	24	41
	NO <sub>3</sub> <sup>-</sup>	31	158	72	15	24	41
	NH <sub>4</sub> <sup>+</sup>	32	155	72	17	24	41
	Cl <sup>-</sup>	31	158	72	15	24	41
	Ca <sup>2+</sup>	32	164	76	16	26	41
	Mg <sup>2+</sup>	32	164	76	16	26	41
	Na <sup>+</sup>	32	164	76	16	26	41
	K <sup>+</sup>	32	164	76	16	26	41
Nylon	SO <sub>4</sub> <sup>2-</sup>	34	159	74	17	26	41
	NO <sub>3</sub> <sup>-</sup>	34	159	74	17	26	41
Cellulose	SO <sub>4</sub> <sup>2-</sup>	45	167	85	22	24	41

**Table 9.** Filter Pack Receipt Summary (2009)

Description	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Annual Summary
Count of samples received more than 14 days after removal from tower:	11	7	7	10	35
Count of all samples received:	763	760	758	699	2980
Fraction of samples received within 14 days:	0.986	0.991	0.991	0.986	0.988
Average interval in days:	4.79	4.27	4.06	4.68	4.45
First receipt date:	01/02/2009	04/01/2009	07/01/2009	10/01/2009	01/02/2009
Last receipt date:	03/30/2009	06/29/2009	09/28/2009	12/30/2009	12/30/2009

**Table 10.** Filter Pack QC Summary for 2009

Filter Type	Parameter	Reference Sample <sup>1</sup> Recovery (%R)			Continuing Calibration Verification Samples (%R)			In-Run Replicate <sup>2</sup> (RPD)		
		Mean	Std. Dev.	Count <sup>3</sup>	Mean	Std. Dev.	Count <sup>3</sup>	Mean	Std. Dev.	Count <sup>3</sup>
Teflon <sup>®</sup>	SO <sub>4</sub> <sup>2-</sup>	97.71	1.05	143	98.81	0.96	689	0.48	0.98	309
	NO <sub>3</sub> <sup>-</sup>	99.37	1.03	143	98.83	0.95	689	0.82	1.08	309
	NH <sub>4</sub> <sup>+</sup>	100.83	2.99	135	99.84	1.36	677	0.56	0.65	317
	Ca <sup>2+</sup>	104.15	3.16	132	100.44	1.01	676	1.57	2.46	310
	Mg <sup>2+</sup>	102.33	1.53	132	100.08	0.77	676	1.94	2.62	310
	Na <sup>+</sup>	100.16	2.03	132	100.2	1.02	676	1.31	1.35	310
	K <sup>+</sup>	98.1	2.87	132	100.06	0.84	676	2.18	2.8	310
	Cl <sup>-</sup>	101.97	1.66	143	99.32	1.06	689	0.56	0.76	309
Nylon	SO <sub>4</sub> <sup>2-</sup>	98.82	1.08	139	99.13	1.22	668	2.77	3.17	307
	NO <sub>3</sub> <sup>-</sup>	100.15	1.28	139	99.39	1.27	668	1.18	1.69	307
Cellulose	SO <sub>4</sub> <sup>2-</sup>	98.65	1.24	179	99.43	1.14	691	1.31	1.57	336

Notes: % R = percent recovery  
RPD = relative percent difference

- <sup>1</sup> Results of reference sample analyses provide accuracy estimates  
<sup>2</sup> Results of replicate analyses provide precision estimates  
<sup>3</sup> Number of QC Samples

**Table 11.** Precision Results for Third Quarter 2008 through Second Quarter 2009

Site Pairs	SO <sub>4</sub> <sup>2-</sup>	NO <sub>3</sub> <sup>-</sup>	NH <sub>4</sub> <sup>+</sup>	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Na <sup>+</sup>	K <sup>+</sup>	Cl <sup>-</sup>	HNO <sub>3</sub>	SO <sub>2</sub>	Total NO <sub>3</sub> <sup>-</sup>
<b>MCK131/231, KY</b>											
2008 Q3	2.36	9.4	2.38	3.78	3.73	4.1	4.39	4.63	3.91	1.94	3.25
2008 Q4	2.64	4.8	2.69	5.97	3.82	4.86	17.11	4.79	4.99	4.4	3.31
2009 Q1	4.59	11	4.29	10.68	9.85	10.4	15.43	15.36	6.61	6.48	2.92
2009 Q2	4.86	5.53	4.7	5.06	4.41	3.41	9.62	11.52	7.56	3.54	6.46
Average	2.36	9.4	2.38	3.78	3.73	4.1	4.39	4.63	3.91	1.94	3.25
<b>ROM406/206, CO</b>											
2008 Q3	6.11	15.62	5.81	9.37	8.11	9.26	5.48	4.71	6.89	7.32	6.09
2008 Q4	4.81	15.64	4.73	13.31	14.77	17.67	30.48	6.88	6.66	7.47	4.91
2009 Q1	4.15	15.16	3.57	9.42	6.55	9.57	16.43	2.12	5.96	8.61	5.61
Average	6.11	15.62	5.81	9.37	8.11	9.26	5.48	4.71	6.89	7.32	6.09

Note: 42 of 77 site-quarter-parameters were outside criteria in effect through August 10, 2009. Only 1 of 77 site-quarter-parameters would be outside of the criterion established on August 11, 2009.

**Table 12.** Summary of Filter Blanks for 2009 (page 1 of 2)

Parameter Name	Detection Limit Total µg	Total Number	Number > Detection Limit	Average Total µg	Average Absolute Deviation	Maximum Total µg
<b>FIELD BLANKS</b>						
Teflon-NH <sub>4</sub> <sup>+</sup> -N	0.500	290	0	0.500	0.000	0.500
Teflon- NO <sub>3</sub> <sup>-</sup> -N	0.200	290	7	0.202	0.587	0.393
Teflon- SO <sub>4</sub> <sup>2-</sup>	1.000	290	0	1.000	0.000	1.000
Cl <sup>-</sup>	0.500	290	1	0.500	0.000	0.525
Ca <sup>2+</sup>	0.150	290	5	0.151	0.002	0.294
Mg <sup>2+</sup>	0.075	290	0	0.075	0.000	0.075
Na <sup>+</sup>	0.125	290	2	0.125	0.000	0.174
K <sup>+</sup>	0.150	290	9	0.152	0.005	0.561
Nylon- NO <sub>3</sub> <sup>-</sup> -N	0.200	290	0	0.200	0.000	0.200
Nylon - SO <sub>4</sub> <sup>2-</sup>	1.000	290	5	1.003	0.615	1.350
Cellulose - SO <sub>4</sub> <sup>2-</sup>	2.000	290	1	2.001	0.003	2.400
<b>LABORATORY BLANKS</b>						
Teflon-NH <sub>4</sub> <sup>+</sup> -N	0.500	104	0	0.500	0.000	0.500
Teflon- NO <sub>3</sub> <sup>-</sup> -N	0.200	104	0	0.200	0.000	0.200
Teflon- SO <sub>4</sub> <sup>2-</sup>	1.000	104	0	1.000	0.000	1.000
Cl <sup>-</sup>	0.500	104	0	0.500	0.000	0.500
Ca <sup>2+</sup>	0.150	104	1	0.150	0.000	0.159
Mg <sup>2+</sup>	0.075	104	0	0.075	0.000	0.075
Na <sup>+</sup>	0.125	104	0	0.125	0.000	0.125
K <sup>+</sup>	0.150	104	1	0.151	0.001	0.207
Nylon- NO <sub>3</sub> <sup>-</sup> -N	0.200	104	0	0.200	0.000	0.200
Nylon -SO <sub>4</sub> <sup>2-</sup>	1.000	104	1	1.001	0.002	1.125
Cellulose -SO <sub>4</sub> <sup>2-</sup>	2.000	106	0	2.000	0.000	2.000
<b>METHOD BLANKS</b>						
Teflon-NH <sub>4</sub> <sup>+</sup> -N	0.500	67	0	0.500	0	0.500
Teflon- NO <sub>3</sub> <sup>-</sup> -N	0.200	67	0	0.200	0	0.200
Teflon- SO <sub>4</sub> <sup>2-</sup>	1.000	67	0	1.000	0	1.000
Cl <sup>-</sup>	0.500	67	0	0.500	0	0.500
Ca <sup>2+</sup>	0.150	65	0	0.150	0	0.150
Mg <sup>2+</sup>	0.075	65	0	0.075	0	0.075
Na <sup>+</sup>	0.125	65	0	0.125	0	0.125
K <sup>+</sup>	0.150	65	0	0.150	0	0.150
Nylon- NO <sub>3</sub> <sup>-</sup> -N	0.200	67	0	0.200	0	0.200
Nylon -SO <sub>4</sub> <sup>2-</sup>	1.000	67	0	1.000	0	1.000
Cellulose -SO <sub>4</sub> <sup>2-</sup>	2.000	89	0	2.000	0	2.000

**Table 12.** Summary of Filter Blanks for 2009 (page 2 of 2)

Parameter Name	Detection Limit Total $\mu\text{g}$	Total Number	Number > Detection Limit	Average Total $\mu\text{g}$	Average Absolute Deviation	Maximum Total $\mu\text{g}$
<b>ACCEPTANCE TEST VALUES</b>						
Teflon-NH <sub>4</sub> <sup>+</sup> -N	0.500	216	0	0.500	0.000	0.500
Teflon- NO <sub>3</sub> <sup>-</sup> -N	0.200	216	0	0.200	0.000	0.200
Teflon- SO <sub>4</sub> <sup>2-</sup>	1.000	216	0	1.000	0.000	1.000
Cl <sup>-</sup>	0.500	216	0	0.500	0.000	0.500
Ca <sup>2+</sup>	0.150	216	1	0.151	0.001	0.300
Mg <sup>2+</sup>	0.075	216	0	0.075	0.000	0.075
Na <sup>+</sup>	0.125	216	0	0.125	0.000	0.125
K <sup>+</sup>	0.150	216	0	0.150	0.000	0.150
Nylon- NO <sub>3</sub> <sup>-</sup> -N	0.200	200	0	0.200	0.000	0.200
Nylon -SO <sub>4</sub> <sup>2-</sup>	1.000	200	1	1.001	0.002	1.225
Cellulose -SO <sub>4</sub> <sup>2-</sup>	2.000	288	0	2.000	0.000	2.000

**Note:** Cellulose filters are not analyzed for ambient NO<sub>3</sub><sup>-</sup>. The blank results are used only for QC.

**Table 13.** Filter Packs Flagged as Suspect or Invalid

Site ID	Sample	Flag	Reason
<b>First Quarter 2009</b>			
ARE128, PA	0906001-06	Invalid	Insufficient flow
BEL116, MD	0905001-09	Invalid	Communication problems
CDZ171, KY	0904001-17	Invalid	Storm damage
CHE185, OK	0904001-19	Invalid	Storm damage
	0905001-19		Storm damage
CVL151, MS	0903001-26	Invalid	Communication problems
	0901001-26		Communication problems
MCK131, KY	0905001-49	Invalid	Insufficient flow
MCK231, KY	0905001-50	Invalid	Insufficient flow
QAK172, OH	0907001-64	Invalid	Storm damage
<b>Second Quarter 2009</b>			
No filter packs were flagged during second quarter 2009			
<b>Third Quarter 2009</b>			
ABT147, CT	0928001-01	Invalid	Flow volume
ARE128, PA	0930001-06	Invalid	Lightning strike
CHE185, OK	0928001-19	Invalid	Polling problems
CON186, CA	0928001-23	Invalid	Flow volume
EVE419, FL	0928001-31	Invalid	Flow volume
<b>Fourth Quarter 2009</b>			
HWF187, NY	0941001-40	Invalid	Under investigation
WNC429, SD	0944001-80	Invalid	Under investigation



**Table 14.** Field Problems Affecting Data Collection

<b>Days to Resolution</b>	<b>Problem Count</b>
<b>First Quarter 2009</b>	
30	98
60	14
90	6
Unresolved by End of Quarter	8
<b>Second Quarter 2009</b>	
30	89
60	11
90	1
Unresolved by End of Quarter	6
<b>Third Quarter 2009</b>	
30	99
60	6
90	0
Unresolved by End of Quarter	2
<b>Fourth Quarter 2009</b>	
30	81
60	15
90	0
Unresolved by Date of Publication	11

**Table 15.** Field Calibration Failures by Parameter for 2009

Site ID	Parameter(s)
<b>First Quarter 2009</b>	
ARE128, PA	Solar Radiation
CKT136, KY	Relative Humidity
CND125, NC	Ozone
COW137, NC	Ozone
CVL151, MS	Delta Temperature Wind Direction
ESP127, TN	Precipitation
PED108, VA	Wind Speed
SND152, AL	Solar Radiation
VPI120, VA	Flow Rate
<b>Second Quarter 2009</b>	
ABT147, CT	Relative Humidity
CNT169, WY	Surface Wetness
CON186, CA	Relative Humidity
EGB181, ON	Solar Radiation
HOX148, MI	Flow Rate
LRL117, PA	Wind Speed
LYK123, OH	Relative Humidity
SAL133, IN	Wind Speed
UVL124, MI	Relative Humidity Wind Direction
<b>Third Quarter 2009</b>	
ARE128, PA	Wind Direction
BEL116, MD	Wind Speed
BWR139, MD	Wind Direction
CHE185, OK	Wind Direction
CKT136, KY	Relative Humidity Flow Rate

Site ID	Parameter(s)
<b>Third Quarter 2009 (continued)</b>	
CND125, NC	Temperature Delta Temperature Solar Radiation Ozone
KNZ184, KS	Wind Direction
PED108, VA	Solar Radiation
PRK134, WI	Solar Radiation
QAK172, OH	Wind Direction
SAN189, NE	Precipitation
SPD111, TN	Relative Humidity
<b>Fourth Quarter 2009</b>	
CAT175, NY	Wind Direction
CDR119, WV	Solar Radiation
HOX148, MI	Precipitation
KEF112, PA	Precipitation
LYK123, OH	Precipitation Solar Radiation Wind Direction
PAL190, TX	Wind Direction

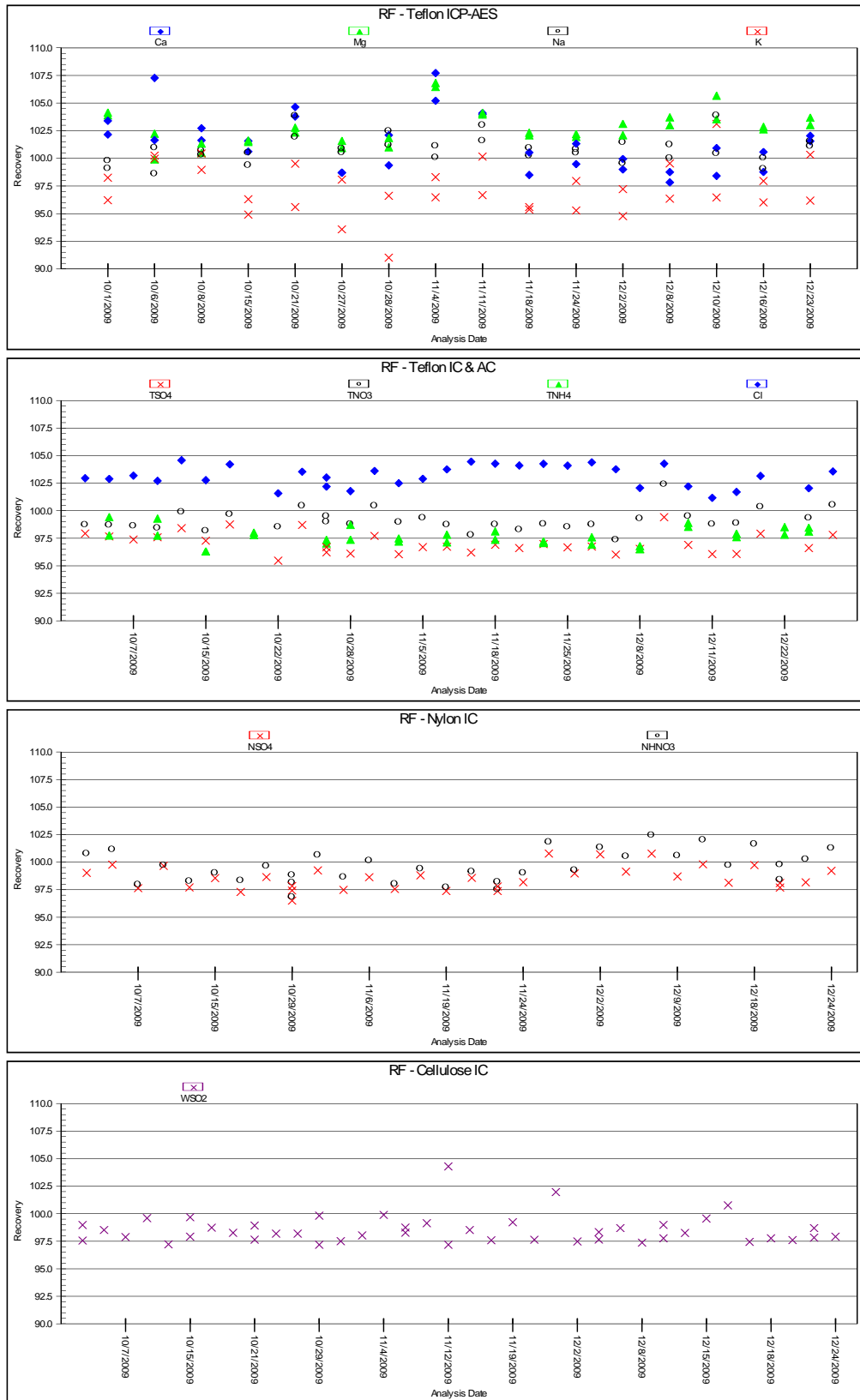
**Note:** Per CASTNET project protocols, data are flagged as “suspect” (S) but still considered valid if the calibration criterion is not exceeded by more than its magnitude (i.e., if within 2x the criterion). If ozone or flow calibrations fall within 2x the criteria, these data are adjusted per approved protocol described in the CASTNET QAPP, Revision 4.1 (MACTEC, 2008).

**Table 16.** Accuracy Results for 2009 Field Measurements

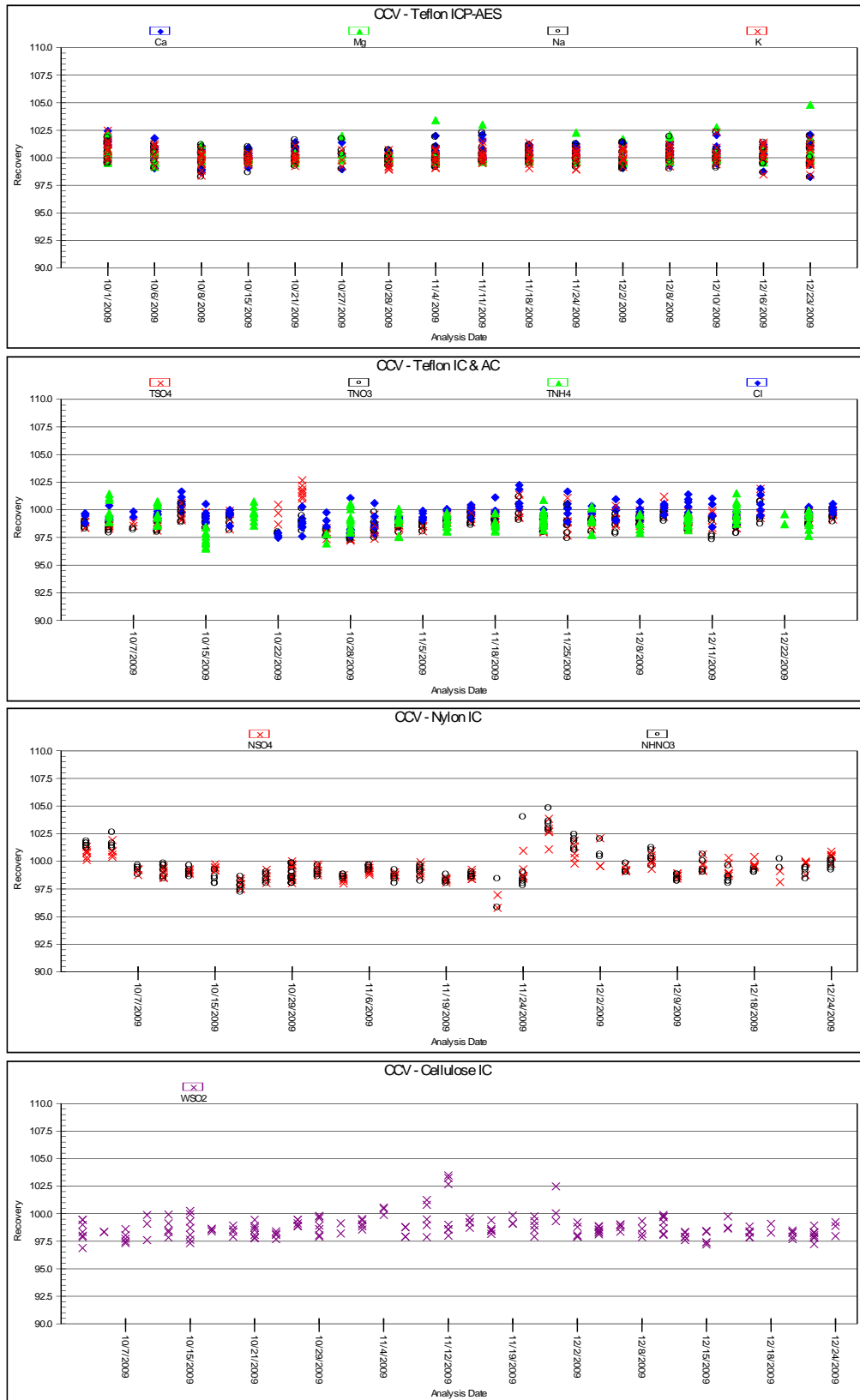
Parameter	Percent Within Criterion
Temperature (0°C)	99.1 percent
Temperature (ambient)	99.1 percent
Delta Temperature (0°C)	98.8 percent
Delta Temperature (ambient)	98.1 percent
Relative Humidity > 85%	100.0 percent
Relative Humidity ≤ 50%	100.0 percent
Solar Radiation	91.1 percent
Wind Direction North	95.7 percent
Wind Direction South	95.7 percent
Wind Speed < 5 m/s	100.0 percent
Wind Speed ≥ 5 m/s	90.4 percent
Precipitation	100.0 percent
Wetness (w/in 0.5 volts)	97.4 percent
Ozone Slope	98.2 percent
Ozone Intercept	98.2 percent
Flow Rate	96.6 percent

Notes: °C = degrees Celsius.  
m/s = meters per second.

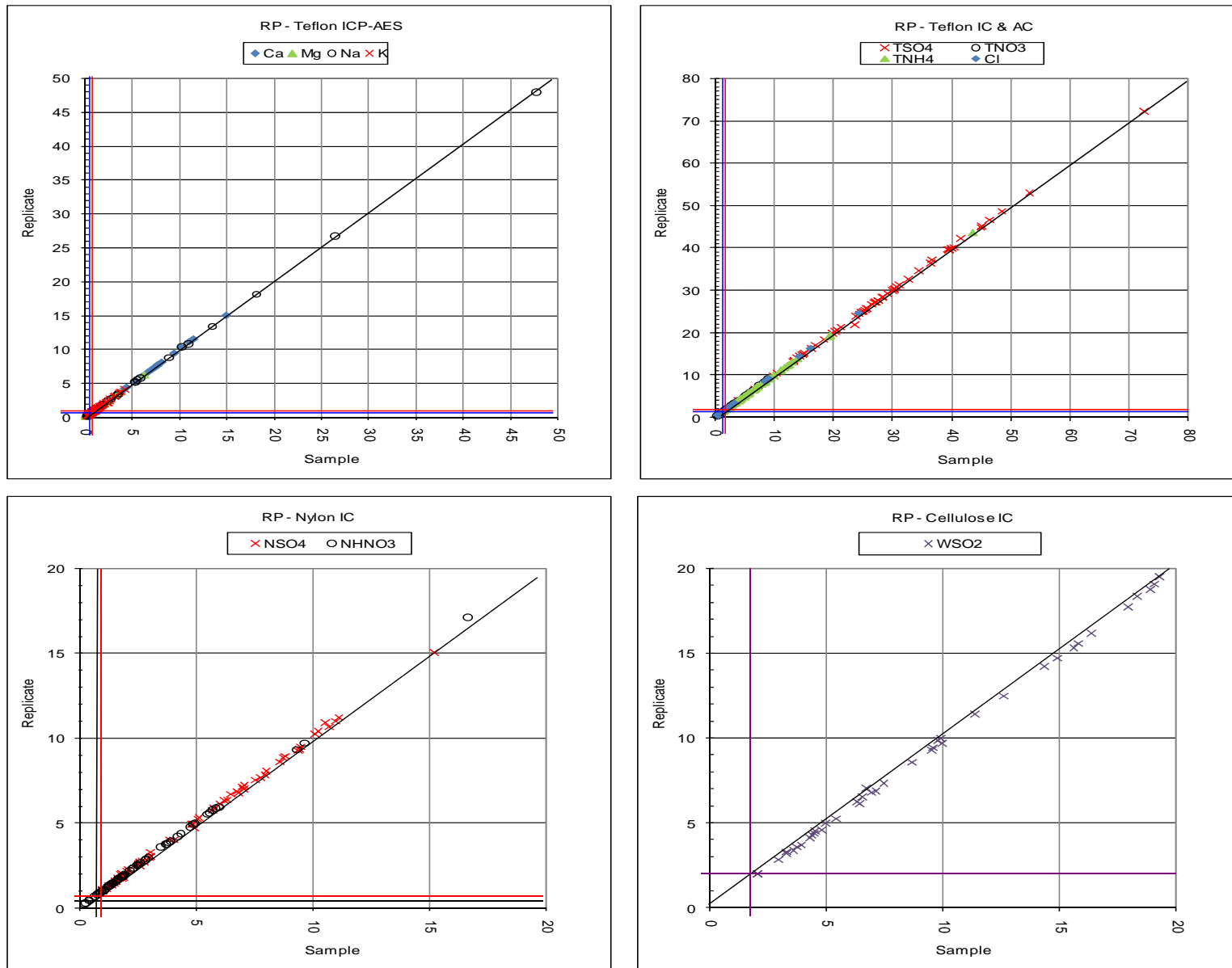
**Figure 1.** Reference Standard Results for Fourth Quarter 2009 (percent recovery)



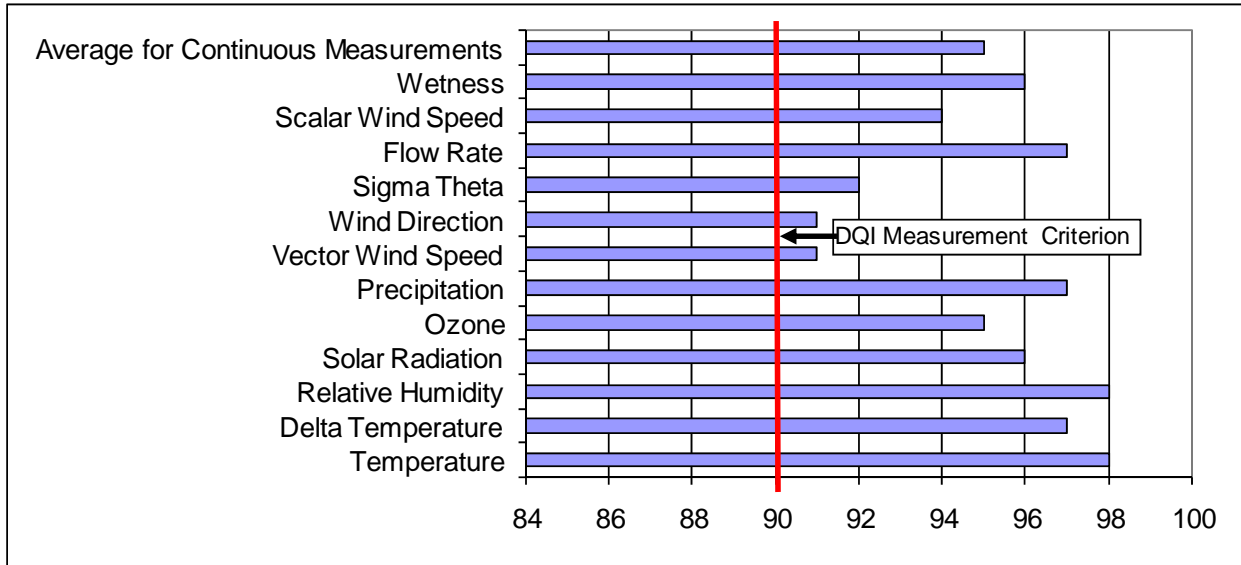
**Figure 2.** Continuing Calibration Spike Results for Fourth Quarter 2009 (percent recovery)



**Figure 3.** Replicate Sample Analysis Results for Fourth Quarter 2009 (total micrograms)



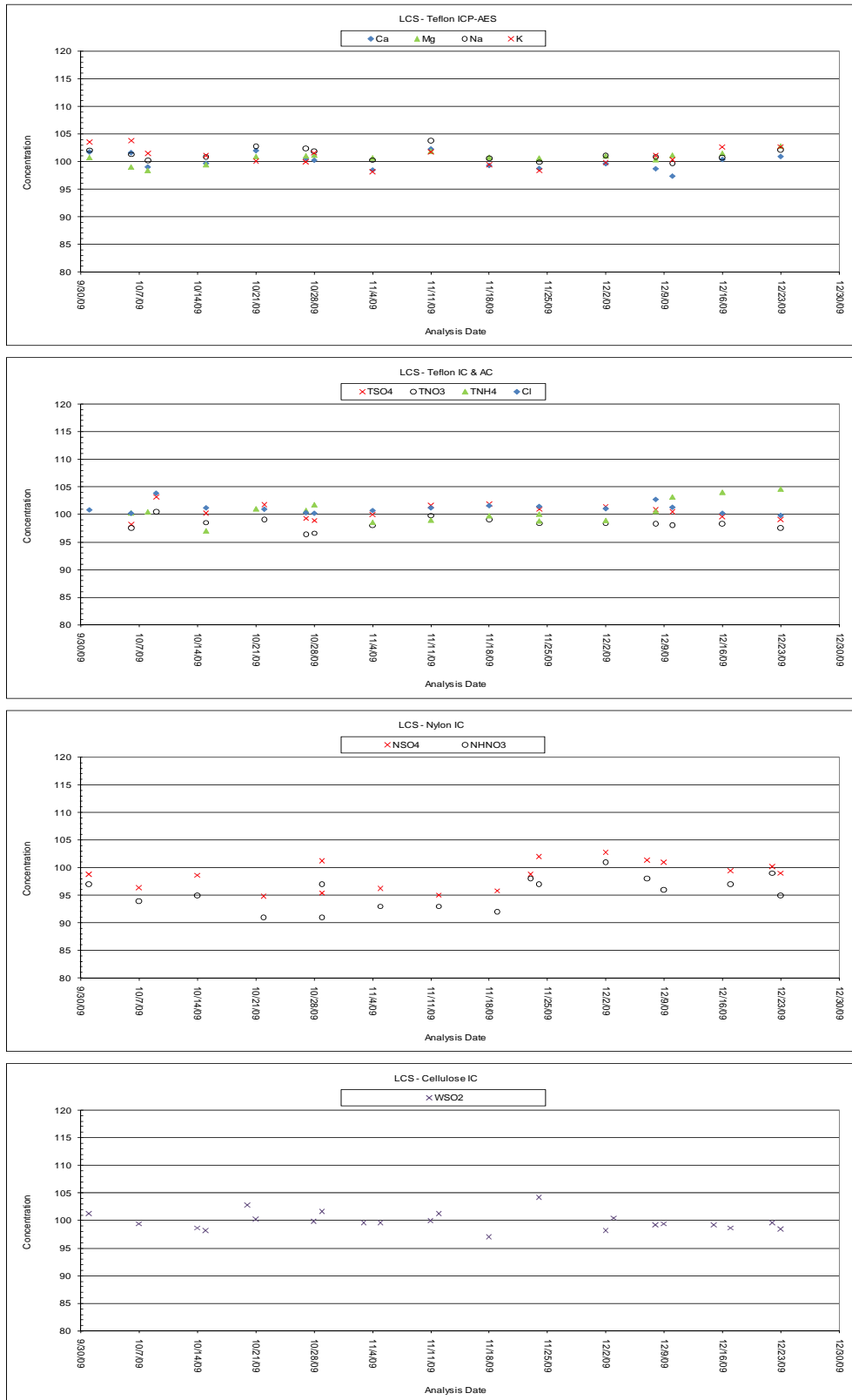
**Figure 4.** Percent Completeness of Measurements for Fourth Quarter 2008 through Fourth Quarter 2009\*



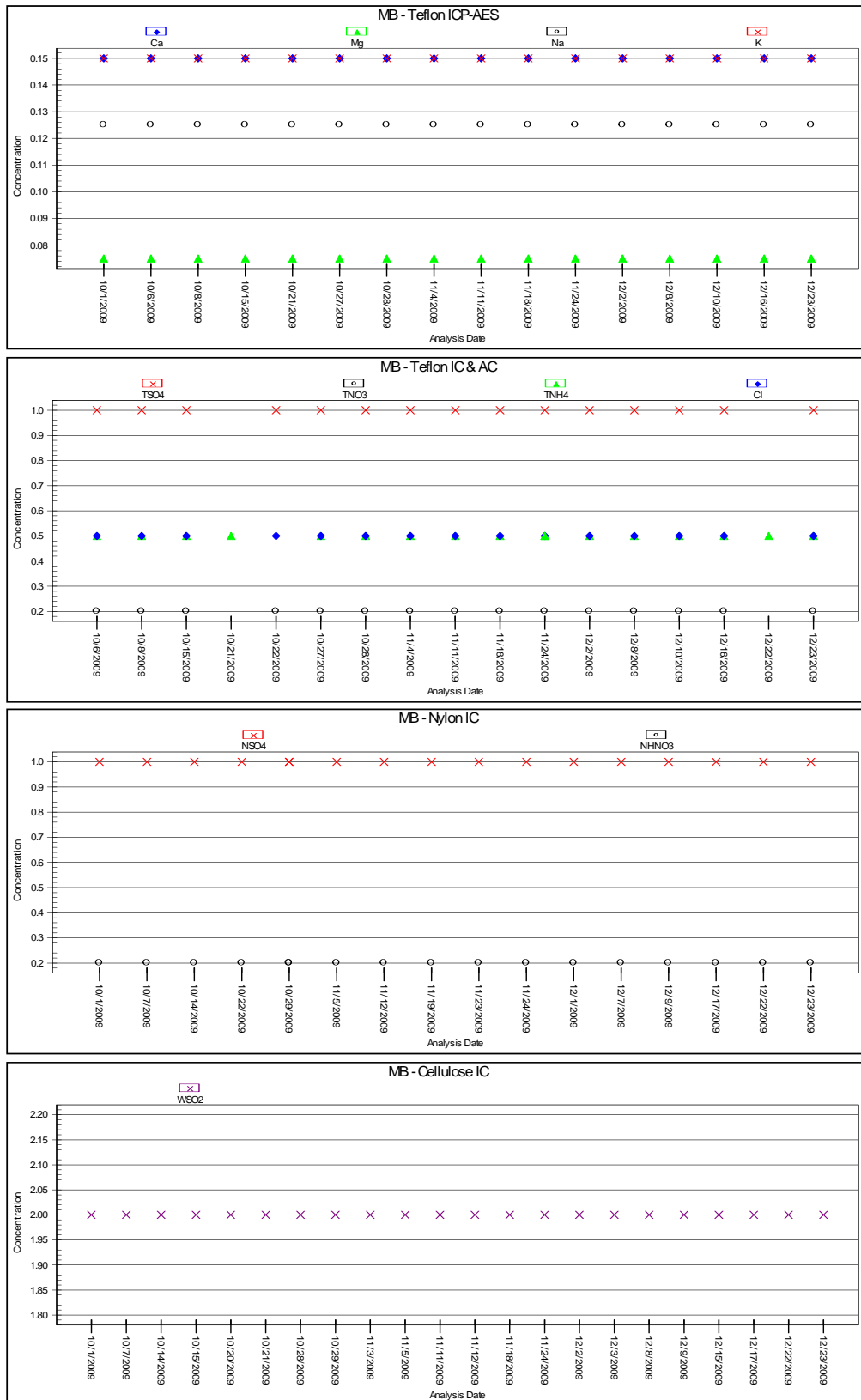
**Note:** \*Presents Level 3 data available during the fourth quarter of 2009.



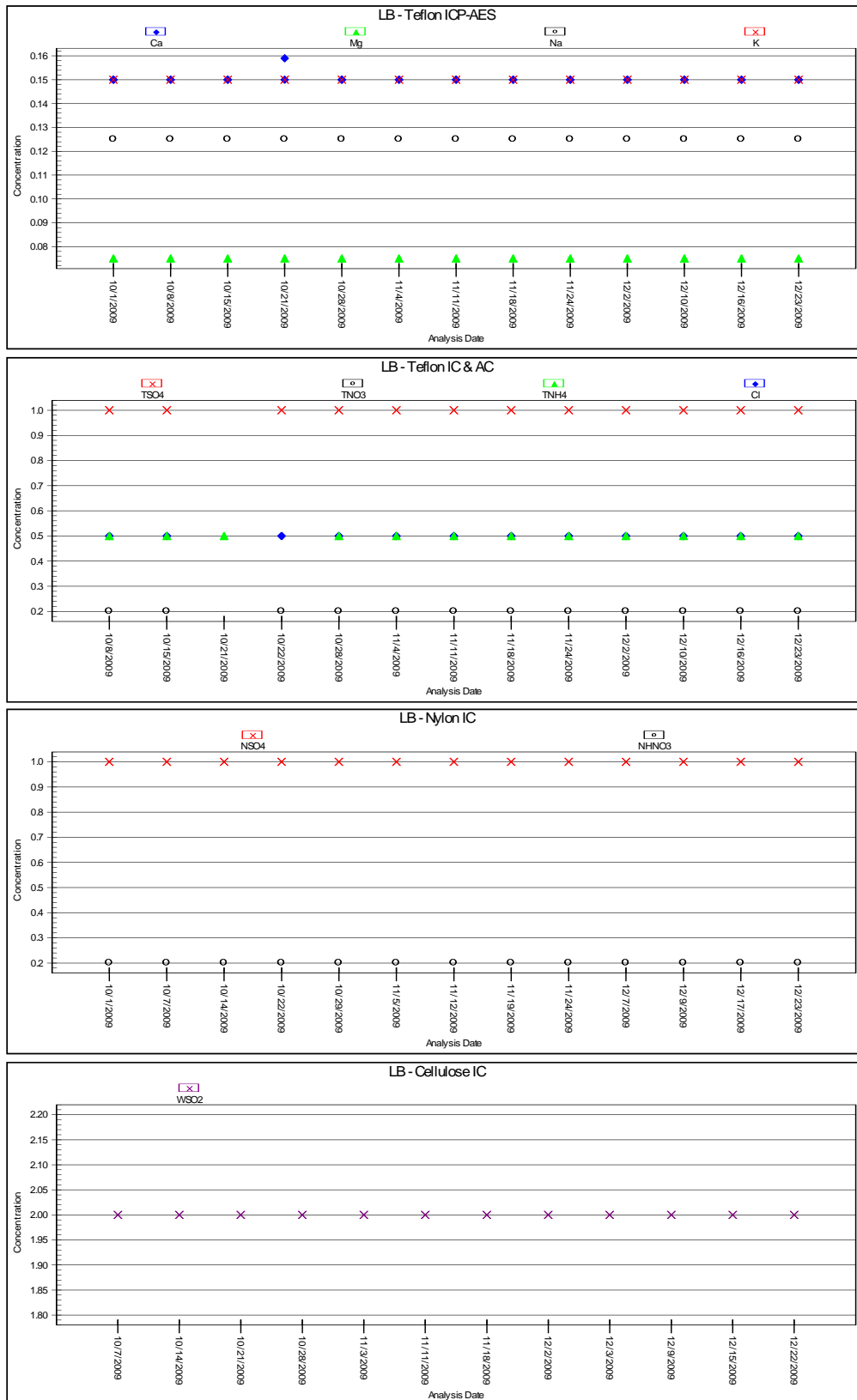
**Figure 5.** Laboratory Control Sample Results for Fourth Quarter 2009 (percent recovery)



**Figure 6. Method Blank Analysis Results for Fourth Quarter 2009 (total micrograms)**



**Figure 7.** Laboratory Blank Analysis Results for Fourth Quarter 2009 (total micrograms)



**Figure 8.** Field Blank Analysis Results for Fourth Quarter 2009 (total micrograms)

