



# Clean Air Status and Trends Network Quality Assurance Report

<b>EPA Contract No.:</b>	<b>68-D-03-052 (Base Program)</b>
<b>MACTEC Project No.:</b>	<b>6064079000</b>
<b>Reporting Period:</b>	<b>Fourth Quarter 2008 (October – December) with 2008 Annual Summary</b>

## Summary of Quarterly Operations

### 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 2008. 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 2008

During first quarter 2008, MACTEC began installing Campbell Scientific, Inc. (Campbell) Model CR3000 data loggers at the Environmental Protection Agency (EPA)-sponsored CASTNET sites. MACTEC prepared standard operating procedures (SOPs) regarding installation, operation, and maintenance of the CR3000 data loggers; checklists; and other documentation needed to support consistent data collection across all sites. Additionally, MACTEC and EPA began working to meet requirements to make ozone measurements compliant with 40 CFR Part 58 at five CASTNET sites for the 2008 ozone season.

During second quarter 2008, The CASTNET QAPP Revision 4.1 was approved by EPA as were the SOPs for operation, calibration, maintenance, and data management activities of the trace-level gas continuous monitoring equipment for sulfur dioxide (SO<sub>2</sub>), nitrogen oxide/total reactive oxides of nitrogen (NO/NO<sub>y</sub>), and carbon monoxide (CO) located at the CASTNET site in Beltsville, MD (BEL116).

Additionally during second quarter, data and QA personnel recoded the QC field in the LABDATA\_QC database table. The table contains laboratory QC data that were generated by the Chemical Laboratory Analysis and Scheduling System (CLASS<sup>™</sup>), the laboratory

information management system (LIMS) used prior to Element DataSystem™, the LIMS currently in use. The QC data fields used by each LIMS were not consistent to one another making it necessary to standardize the QC data fields across all years to enhance the functionality of the LABDATA and LABDATA\_QC database tables and the usability of the data contained therein.

During third quarter 2008, MACTEC received notification that MACTEC's Gainesville, FL analytical laboratory, where all CASTNET analyses are performed, tied for first place out of the 39 participating laboratories in the intercomparison proficiency test (PT) Study 0092 for Analyses for Rain and Soft Waters from the National Water Research Institute (NWRI) with Environment Canada. MACTEC performed very well and achieved a classification of "ideal" on 100 percent of the analyses, and the laboratory received a rating of "good." These are the highest ratings that can be received. From a QA standpoint, PT Study 0092 is an indicator that MACTEC's analytical laboratory continues to perform analyses that are not subject to bias or contamination. MACTEC's laboratory is generally ranked as one of the top participating laboratories in NWRI intercomparison tests.

Beginning with the August 2008 calibrations, the sites were reorganized into 10 calibration groups. The sites were re-grouped to provide better allocation of resources. The number of sites in each regional group varies; nonetheless, approximately the same number of sites is calibrated each calendar month as was done previously. The calibration groups are designated by region and group number. Groups were numbered beginning in the eastern United States moving south and then west. For example, calibration group MW-7 is located in the Midwest and was the seventh group to receive a calibration group number. Also during third quarter 2008, the electronic calibration forms were finalized. As part of the finalization process, the electronic calibration forms were verified as meeting the requirements of MACTEC's corporate software policy, which was created to ensure the correct version of an electronic form is always utilized. These requirements include (1) validated calculations, (2) an established version format, and (3) "locked" form fields to prevent accidental code changes that could affect data entry.

A representative from the Defense Contract Management Agency (DCMA) performed the annual property audit at MACTEC's Gainesville, FL office during third quarter 2008. Results of the audit indicate that MACTEC continues to provide satisfactory management of government property.

During fourth quarter 2008, the CASTNET QAPP was updated during annual review. The revised QAPP was designated Revision 5.0 and submitted to EPA for review and approval on October 31, 2008. Additionally, as part of Revision 5.0, the ozone SOPs for the primary and transfer standards were completed and submitted to EPA. These ozone SOPs are one of the steps necessary to meet 40 CFR Part 58 requirements.

As of October 1, 2008, 18 EPA-sponsored CASTNET sites were 40 CFR Part 58 compliant. The data collected at these sites during fourth quarter 2008 will be validated using zero/span/precision (z/s/p) auto-calibration results and shelter temperature and submitted to EPA’s Air Quality System (AQS) by March 2009. The 18 sites include:

SND152, AL	BEL116, MD	PNF126, NC	CDZ171, TN
IRL141, FL	BWR139, MD	SAN189, NE	SPD111, TN
SUM156, FL	ASH135, ME	WSP144, NJ	PAL190, TX
GAS153, GA	HOW132, ME	HWF187, NY	PND165, WY
KNZ184, KS	BFT142, NC		

The QA Manager conducted technical and performance audits of Ambient Air Quality Services, Inc. (AAQS), one of MACTEC’s field subcontractors, on-site at ABT147, CT and KEF112, PA during November 2008. At KEF112, the subcontractor was evaluated on his technical performance and expertise during the calibration of the site and also during conversion of the site to a Part 58 compliant site. His documentation procedures were also reviewed and evaluated. Additionally, a MACTEC calibrator performed a follow-up check of AAQS by verifying the calibration of ABT147 soon after AAQS left the site. This entailed auditing the instruments to verify documented measurements and a review of on-site documentation. Overall, AAQS performed well, exhibited knowledge of what was required, and followed established protocols including those for documentation. MACTEC provides oversight and review of work performed by all field subcontractors who are hired to repair and calibrate the sites.

**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 2008 by site calibration group. Table 2a lists the sites in each calibration group along with the calibration schedule for sites calibrated through July 29, 2008. The calibration schedule, as reorganized for calibrations performed during the remainder of 2008 and for upcoming calibrations in 2009, is presented in Table 2b.

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 2008.

### **Sample Receipt Statistics**

For the current CASTNET project, which began on July 30, 2003, EPA requires that 95 percent of field samples from EPA-sponsored sites must 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 2008 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 2008. 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. The nylon nitric acid RP result that appears to be out of line as compared with other results had a relative percent difference (RPD) of 6.45 percent. Table 10 presents the percent recoveries and standard deviations for RF, CCV, and RP QC sample analyses for 2008. Quarterly averages are all within criteria.

Table 11 presents quarterly collocated filter pack precision results for data validated to Level 3 during the year. Results for MCK131/231, KY were within criteria for 7 of the 11 parameters reported. Results for ROM406/206, CO were not as good with only 1 parameter within criteria. Lower concentrations usually correlate with higher percent differences between collocated samples. The sample concentrations reported for ROM406/206 are generally lower than those reported for MCK131/231. Overall, the majority of site-parameters were outside of criterion, but 74 percent of site parameter results had a RPD of less than 10 percent and all site parameter RPD results were below 15 percent with the exception of one at 18 percent.

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

### **Laboratory Control Sample Analyses**

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 2008.

### **Blank Results**

Figures 6 through 8 present the results of MB, LB, and FB QC sample analyses for fourth quarter 2008. All results were within criteria (two times the reporting limit) listed in Table 4 with the exception of one Teflon<sup>®</sup> filter FB result. All values were less than three times the reporting limit. Table 12 summarizes the record of filter blanks for 2008.

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

Filter pack samples that were flagged as suspect or invalid during each of the four quarters of 2008 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, four filter pack samples were invalidated due to insufficient flow volume.

### **Field Problem Count**

Table 14 presents the number of field problems affecting continuous data collection for more than one day for each quarter of 2008. 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 2008 is listed in Table 15. Calibrations were performed at 22 sites during fourth quarter 2008. For fourth quarter, all sites and parameters were within the criteria listed in Table 3 with the exception of the parameters at the 12 sites that are listed in Table 15.

Table 16 presents field accuracy results for 2008 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 with the exceptions of relative humidity at 87.3 percent and solar radiation at 85 percent. However, this did not adversely affect data collection completeness because data are not considered invalid unless criteria are exceeded by more than two times the criterion. Using the two times standard, both parameters passed with 98 percent frequency.

## **Tables and Figures**

**Table 1.** Level 3 Validated Data Available as of January 2009

Calibration Group*	Months Available	Number of Months	Complete Quarters**	Number of Quarters
1	July 2007 – June 2008	12	Quarter 3 2007 – Quarter 2 2008	4
2	August 2007 – July 2008	12	Quarter 4 2007 – Quarter 2 2008	3
3 <sup>†</sup>	September 2007 – August 2008	12	Quarter 4 2007 – Quarter 2 2008	3
4, E-2, MW-8	October 2007 – September 2008	12	Quarter 4 2007 – Quarter 3 2008	4
5 <sup>‡</sup>	May 2007 – April 2008	12	Quarter 3 2007 – Quarter 1 2008	3

**Note:** \* The sites contained in each calibration group are listed in Tables 2a and 2b.  
 \*\* 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, KY  
<sup>‡</sup> Contains ROM206 of the ROM406/206 collocated pair

**Table 2a.** Field Calibration Schedule July 30, 2007 through July 29, 2008

Calibration Group Number	Months Calibrated	Sites Calibrated			
1	January/July	SND152, AL GAS153, GA CDZ171, KY	BFT142, NC CND125, NC COW137, NC	PNF126, NC ESP127, TN SPD111, TN	PED108, VA VPI120, VA
2	February/August	CAD150, AR IRL141, FL SUM156, FL	BEL116, MD BWR139, MD CVL151, MS	WSP144, NJ CTH110, NY CHE185, OK	ARE128, PA PSU106, PA ALC188, TX
3	March/September	ALH157, IL BVL130, IL STK138, IL	VIN140, IN KNZ184, KS CKT136, KY	MCK131, KY MCK231, KY SAN189, NE	DCP114, OH OXF122, OH PRK134, WI
4	April/October	ABT147, CT SAL133, IN ASH135, ME	HOW132, ME ANA115, MI HOX148, MI	UVL124, MI WST109, NH CAT175, NY	HWF187, NY LYK123, OH EGB181, ON
5	May/November	CON186, CA ROM206, CO GTH161, CO	QAK172, OH KEF112, PA LRL117, PA	MKG113, PA PAL190, TX CDR119, WV	PAR107, WV CNT169, WY PND165, WY

**Table 2b.** Field Calibration Schedule July 30, 2008 through July 29, 2009

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	CDR119, WV PAR107, 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	SAN189, NE	CHE185, OK	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)	± 5%, rel. hum. > 85% ± 20%, rel. hum. ≤ 85%
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
O <sub>3</sub>	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  
 rel. hum. = relative humidity  
 RTD = resistance-temperature device  
 UV = ultraviolet

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

† For target value of 0.50 inch

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

Analyte	Medium	Method	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	90 - 110	0.020 *	0.5
Sodium (Na <sup>+</sup> )	F	ICP-AES	5	95 - 105	0.005	0.125
Potassium (K <sup>+</sup> )	F	ICP-AES	5	95 - 105	0.006 †	0.15
Magnesium (Mg <sup>2+</sup> )	F	ICP-AES	5	95 - 105	0.003	0.075
Calcium (Ca <sup>2+</sup> )	F	ICP-AES	5	95 - 105	0.006 †	0.15
Chloride (Cl <sup>-</sup> )	F	IC	5	95 - 105	0.020	0.5
Nitrate (NO <sub>3</sub> <sup>-</sup> )	F	IC	5	95 - 105	0.008 *	0.2
Sulfate (SO <sub>4</sub> <sup>2-</sup> )	F	IC	5	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. The goal for the ICP-AES precision RPD criterion changed from 10 percent to 5 percent at the onset of the new contract beginning on July 30, 2003. The precision criterion is applied as described below:

QC conditions: (v1 = initial response; v2 = replicate response; RL = nominal reporting limit)

Condition 1: if (v1 or v2 < RL and the absolute value of (v1 - v2) < RL) = OK

Condition 2: if (v1-v2) < RL and v1 < 5 x RL) = OK

Condition 3: if (v1 > 5\*RL and RPD < 5%) = OK

Status: one of the conditions is OK = Precision QC Passes

<sup>2</sup> This column lists laboratory accuracy goals based on reference standards and continuing calibration verification spikes. The goal for the ICP-AES accuracy criterion changed from 90 – 110 percent to 95 – 105 percent for continuing calibration verification spikes at the onset of the new contract beginning on July 30, 2003. The criterion remains 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

† = Effective September 26, 2007 changed to 0.006 mg/L from 0.003 mg/L for calcium and 0.005 mg/L for potassium

For more information on analytical methods and associated precision and accuracy criteria, see the CASTNET QAPP, Revision 4.1 (MACTEC, 2008).

**Table 5.** QC Analysis Count for First Quarter 2008

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>	36	176	80	17	22	45
	NO <sub>3</sub> <sup>-</sup>	36	176	80	17	22	45
	NH <sub>4</sub> <sup>+</sup>	36	170	77	18	22	45
	Cl <sup>-</sup>	36	176	80	17	22	45
	Ca <sup>2+</sup>	34	174	81	17	22	45
	Mg <sup>2+</sup>	34	174	81	17	22	45
	Na <sup>+</sup>	34	174	81	17	22	45
	K <sup>+</sup>	34	174	81	17	22	45
Nylon	SO <sub>4</sub> <sup>2-</sup>	34	165	77	17	16	42
	NO <sub>3</sub> <sup>-</sup>	34	165	77	17	16	42
Cellulose	SO <sub>4</sub> <sup>2-</sup>	44	175	66	22	22	43

**Table 6.** QC Analysis Count for Second Quarter 2008

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>	36	175	78	17	26	80
	NO <sub>3</sub> <sup>-</sup>	36	175	78	17	26	80
	NH <sub>4</sub> <sup>+</sup>	34	167	75	17	26	80
	Cl <sup>-</sup>	36	175	75	17	26	80
	Ca <sup>2+</sup>	34	172	77	17	26	80
	Mg <sup>2+</sup>	34	172	77	17	26	80
	Na <sup>+</sup>	34	172	77	17	26	80
	K <sup>+</sup>	34	172	77	17	26	80
Nylon	SO <sub>4</sub> <sup>2-</sup>	36	166	74	18	28	82
	NO <sub>3</sub> <sup>-</sup>	36	166	74	18	28	82
Cellulose	SO <sub>4</sub> <sup>2-</sup>	42	166	78	21	26	82

**Table 7.** QC Analysis Count for Third Quarter 2008

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>	40	186	85	20	26	123
	NO <sub>3</sub> <sup>-</sup>	40	186	85	20	26	123
	NH <sub>4</sub> <sup>+</sup>	38	180	83	19	26	123
	Cl <sup>-</sup>	40	186	84	20	26	123
	Ca <sup>2+</sup>	39	183	84	19	26	123
	Mg <sup>2+</sup>	39	183	84	19	26	123
	Na <sup>+</sup>	39	183	84	19	26	123
	K <sup>+</sup>	39	183	84	19	26	123
Nylon	SO <sub>4</sub> <sup>2-</sup>	37	179	82	19	26	87
	NO <sub>3</sub> <sup>-</sup>	37	179	82	19	26	87
Cellulose	SO <sub>4</sub> <sup>2-</sup>	44	179	88	22	26	117

**Table 8.** QC Analysis Count for Fourth Quarter 2008

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>	41	180	88	19	26	85
	NO <sub>3</sub> <sup>-</sup>	41	180	88	19	26	85
	NH <sub>4</sub> <sup>+</sup>	36	179	91	18	26	85
	Cl <sup>-</sup>	41	180	88	19	26	85
	Ca <sup>2+</sup>	39	181	90	18	26	85
	Mg <sup>2+</sup>	39	181	90	18	26	85
	Na <sup>+</sup>	39	181	90	18	26	85
	K <sup>+</sup>	39	181	90	18	26	85
Nylon	SO <sub>4</sub> <sup>2-</sup>	34	171	80	17	26	85
	NO <sub>3</sub> <sup>-</sup>	34	171	80	17	26	85
Cellulose	SO <sub>4</sub> <sup>2-</sup>	43	166	86	22	24	85

**Table 9.** Filter Pack Receipt Summary (2008)

Description	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Annual Summary
Count of samples received more than 14 days after removal from tower:	31	12	11	11	65
Count of all samples received:	785	730	755	773	3043
Fraction of samples received within 14 days:	0.961	0.984	0.985	0.986	0.979*
Average interval in days:	6.00	4.656	4.57	5.303	5.132*
First receipt date:	01/02/2008	04/02/2008	07/01/2008	10/1/2008	01/02/2008
Last receipt date:	03/31/2008	06/30/2008	09/29/2008	12/31/2008	12/31/2008

Note: \*annual average

**Table 10.** Filter Pack QC Summary for 2008

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>	98.6	1.69	153	99.6	1.39	717	0.71	1.29	331
	NO <sub>3</sub> <sup>-</sup>	100.0	1.33	153	99.6	1.28	717	1.18	1.87	331
	NH <sub>4</sub> <sup>+</sup>	101.7	1.88	144	99.6	1.22	696	0.63	0.71	326
	Ca <sup>2+</sup>	104.4	2.87	146	100.8	1.21	710	1.84	2.90	332
	Mg <sup>2+</sup>	102.7	1.50	146	100.1	0.80	710	1.58	1.97	332
	Na <sup>+</sup>	98.2	2.32	146	100.2	1.12	710	1.21	2.31	332
	K <sup>+</sup>	97.8	2.46	146	100.1	0.96	710	1.73	1.90	332
	Cl <sup>-</sup>	99.8	1.53	153	100.0	1.24	717	1.67	3.11	327
Nylon	SO <sub>4</sub> <sup>2-</sup>	99.8	1.77	144	99.9	1.54	692	1.58	1.99	317
	NO <sub>3</sub> <sup>-</sup>	99.6	1.38	144	100.3	1.43	692	0.87	1.07	317
Cellulose	SO <sub>4</sub> <sup>2-</sup>	100.2	1.17	173	99.5	0.96	686	2.31	3.04	318

Note: % 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 2007 through Second Quarter 2008

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>											
2007 Q4	1.27	3.99	2.10	4.86	3.57	3.01	10.87	5.64	5.16	3.27	3.62
2008 Q1	1.78	4.68	2.00	7.67	4.66	2.39	2.45	5.04	2.66	1.89	2.17
2008 Q2	2.01	13.16	1.65	12.21	11.67	8.88	6.94	5.04	3.18	2.86	4.26
Average	1.69	7.28	1.92	8.25	6.63	4.76	6.75	5.24	3.67	2.67	3.35
<b>ROM406/206, CO</b>											
2007 Q3	9.41	11.85	8.48	10.04	13.08	10.25	14.84	5.55	7.22	10.53	7.40
2007 Q4	8.24	18.02	7.55	9.55	8.76	13.15	10.54	5.71	4.44	6.48	6.84
2008 Q1	7.12	10.35	6.61	9.16	10.50	10.22	13.98	6.02	7.13	6.28	7.26
Average	8.26	13.41	7.55	9.58	10.78	11.21	13.12	5.76	6.26	7.76	7.17

**Note:** 40 of 66 site-quarter-parameters were outside criterion

**Table 12.** Summary of Filter Blanks for 2008 (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 <sup>®</sup> -NH <sub>4</sub> <sup>+</sup> -N	0.500	335	0	0.500	0.000	0.500
Teflon <sup>®</sup> - NO <sub>3</sub> -N	0.200	335	22	0.206	0.012	0.670
Teflon <sup>®</sup> - SO <sub>4</sub> <sup>2-</sup>	1.000	335	0	1.000	0.000	1.000
Cl <sup>-</sup>	0.500	335	2	0.501	0.003	0.800
Ca <sup>2+</sup>	0.150	335	0	0.150	0.000	0.150
Mg <sup>2+</sup>	0.075	335	0	0.075	0.000	0.075
Na <sup>+</sup>	0.125	335	0	0.125	0.000	0.125
K <sup>+</sup>	0.150	335	0	0.150	0.000	0.150
Nylon- NO <sub>3</sub> -N	0.200	334	0	0.200	0.000	0.200
Nylon - SO <sub>4</sub> <sup>2-</sup>	1.000	334	9	1.009	0.017	1.825
Cellulose - SO <sub>4</sub> <sup>2-</sup>	2.000	335	27	2.023	0.043	2.850
<b>LABORATORY BLANKS</b>						
Teflon <sup>®</sup> -NH <sub>4</sub> <sup>+</sup> -N	0.500	100	0	0.500	0.000	0.500
Teflon <sup>®</sup> - NO <sub>3</sub> -N	0.200	100	3	0.204	0.009	0.625
Teflon <sup>®</sup> - SO <sub>4</sub> <sup>2-</sup>	1.000	100	0	1.000	0.000	1.000
Cl <sup>-</sup>	0.500	100	1	0.511	0.022	1.625
Ca <sup>2+</sup>	0.150	100	1	0.150	0.001	0.185
Mg <sup>2+</sup>	0.075	100	0	0.075	0.000	0.075
Na <sup>+</sup>	0.125	100	1	0.134	0.018	1.009
K <sup>+</sup>	0.150	100	1	0.175	0.050	2.655
Nylon- NO <sub>3</sub> -N	0.200	96	0	0.200	0.000	0.200
Nylon -SO <sub>4</sub> <sup>2-</sup>	1.000	96	1	1.008	0.016	1.800
Cellulose -SO <sub>4</sub> <sup>2-</sup>	2.000	98	3	2.021	0.041	3.400
<b>METHOD BLANKS</b>						
Teflon <sup>®</sup> -NH <sub>4</sub> <sup>+</sup> -N	0.500	72	0	0.500	0.000	0.500
Teflon <sup>®</sup> - NO <sub>3</sub> -N	0.200	73	0	0.200	0.000	0.200
Teflon <sup>®</sup> - SO <sub>4</sub> <sup>2-</sup>	1.000	73	0	1.000	0.000	1.000
Cl <sup>-</sup>	0.500	73	0	0.500	0.000	0.500
Ca <sup>2+</sup>	0.150	71	0	0.150	0.000	0.150
Mg <sup>2+</sup>	0.075	71	0	0.075	0.000	0.075
Na <sup>+</sup>	0.125	71	0	0.125	0.000	0.125
K <sup>+</sup>	0.150	71	0	0.150	0.000	0.150
Nylon- NO <sub>3</sub> -N	0.200	72	0	0.200	0.000	0.200
Nylon -SO <sub>4</sub> <sup>2-</sup>	1.000	72	0	1.000	0.000	1.000
Cellulose -SO <sub>4</sub> <sup>2-</sup>	2.000	87	0	2.000	0.000	2.000

**Table 12.** Summary of Filter Blanks for 2008 (page 2 of 2)

Parameter Name	Detection Limit Total µg	Total Number	Number > Detection Limit	Average Total µg	Average Absolute Deviation	Maximum Total µg
<b>ACCEPTANCE TEST VALUES</b>						
Teflon®-NH <sub>4</sub> <sup>+</sup> -N	0.500	240	0	0.500	0.000	0.500
Teflon®- NO <sub>3</sub> -N	0.200	240	2	0.200	0.000	0.238
Teflon® - SO <sub>4</sub> <sup>2-</sup>	1.000	240	0	1.000	0.000	1.000
Cl <sup>-</sup>	0.500	240	0	0.500	0.000	0.500
Ca <sup>2+</sup>	0.150	240	0	0.150	0.000	0.150
Mg <sup>2+</sup>	0.075	240	0	0.075	0.000	0.075
Na <sup>+</sup>	0.125	240	0	0.125	0.000	0.125
K <sup>+</sup>	0.150	240	0	0.150	0.000	0.150
Nylon- NO <sub>3</sub> -N	0.200	220	0	0.200	0.000	0.200
Nylon -SO <sub>4</sub> <sup>2-</sup>	1.000	220	0	1.000	0.000	1.000
Cellulose -SO <sub>4</sub> <sup>2-</sup>	2.000	270	1	2.002	0.004	2.600

**Note:** Cellulose filters are not analyzed for ambient NO<sub>3</sub>. 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 2008</b>			
IRL141, FL	0801001-41	Invalid	Insufficient flow volume
CAT175, NY	0803001-15	Invalid	Insufficient flow volume
<b>Second Quarter 2008</b>			
ALH157, IL	0815001-04	Invalid	Communication problems
CNT169, WY	0823001-22	Invalid	Communication problems
CVL151, MS	0818001-26	Invalid	Communication problems
	0819001-26	Invalid	Communication problems
HOW132, ME	0816001-38	Invalid	Communication problems
	0818001-38	Invalid	Communication problems
LYK123, OH	0822001-47	Invalid	Communication problems
	0823001-47	Invalid	Communication problems
<b>Third Quarter 2008</b>			
ALH157, IL	0828001-04	Invalid	Insufficient flow volume
		Invalid	Insufficient flow volume
ANA115, MI	0827001-05	Invalid	Insufficient flow volume
	0833001-05	Invalid	Insufficient flow volume
	0834001-05	Invalid	Insufficient flow volume
BFT142, NC	0830001-10	Invalid	Insufficient flow volume
IRL141, FL	0828001-41	Invalid	Insufficient flow volume
LYK123, OH	0832001-47	Invalid	Insufficient flow volume
PND165, WY	0828001-60	Invalid	Insufficient flow volume
PSU106, PA	0831001-63	Invalid	Insufficient flow volume
SPD111, TN	0829001-72	Invalid	Insufficient flow volume
<b>Fourth Quarter 2008</b>			
CNT169, WY	0847001-22	Invalid	Insufficient flow volume
CON186, CA	0846001-23	Invalid	Insufficient flow volume
MCK131, KY	0843001-49	Invalid	Insufficient flow volume
MCK231, KY	0843001-50	Invalid	Insufficient flow volume

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

<b>Days to Resolution</b>	<b>Problem Count</b>
<b>First Quarter 2008</b>	
30	50
60	12
90	4
Unresolved by End of Quarter	12
<b>Second Quarter 2008</b>	
30	91
60	14
90	1
Unresolved by End of Quarter	20
<b>Third Quarter 2008</b>	
30	104
60	4
90	1
Unresolved by End of Quarter	17
<b>Fourth Quarter 2008</b>	
30	69
60	23
90	1
Unresolved by Date of Publication	14

**Table 15.** Field Calibration Failures by Parameter for 2008

Site ID	Parameter(s)
<b>First Quarter 2008</b>	
BEL116, MD	Wind Direction
CDZ171, KY	Relative Humidity Wind Direction
CHE185, OK	Flow Rate
CND125, NC	Temperature Wind Direction
ESP127, TN	Precipitation
IRL141, FL	Relative Humidity Wind Direction
SND152, AL	Relative Humidity
WSP144, NJ	Wind Direction
<b>Second Quarter 2008</b>	
ASH135, ME	Precipitation
CDR119, WV	Relative Humidity Solar Radiation
CNT169, WY	Wind Direction
HOW132, ME	Temperature
HOX148, MI	Relative Humidity
HWF187, NY	Solar Radiation
KEF112, PA	Relative Humidity Wind Direction
LYK123, OH	Relative Humidity
PAR107, WV	Solar Radiation
PRK134, WI	Relative Humidity Solar Radiation Wind Direction
ROM206, CO	Relative Humidity Wind Speed
STK138, IL	Relative Humidity Solar Radiation
WST109, NH	Solar Radiation Wind Direction

Site ID	Parameter(s)
<b>Third Quarter 2008</b>	
BFT142, NC	Ozone
CDZ171, KY	Delta Temperature
ESP127, TN	Solar Radiation
GAS153, GA	Ozone
SPD111, TN	Solar Radiation
<b>Fourth Quarter 2008</b>	
ANA115, MI	Wind Direction
CKT136, KY	Wind Speed Precipitation
CON186, CA	Delta Temperature
GTH161, CO	Flow Rate
KEF112, PA	Temperature Delta Temperature
LYK123, OH	Wind Direction
MCK131, KY	Wind Direction
MCK231, KY	Ozone Precipitation
MKG113, PA	Solar Radiation
ROM206, CO	Wind Direction
WST109, NH	Temperature
UVL124, MI	Ozone

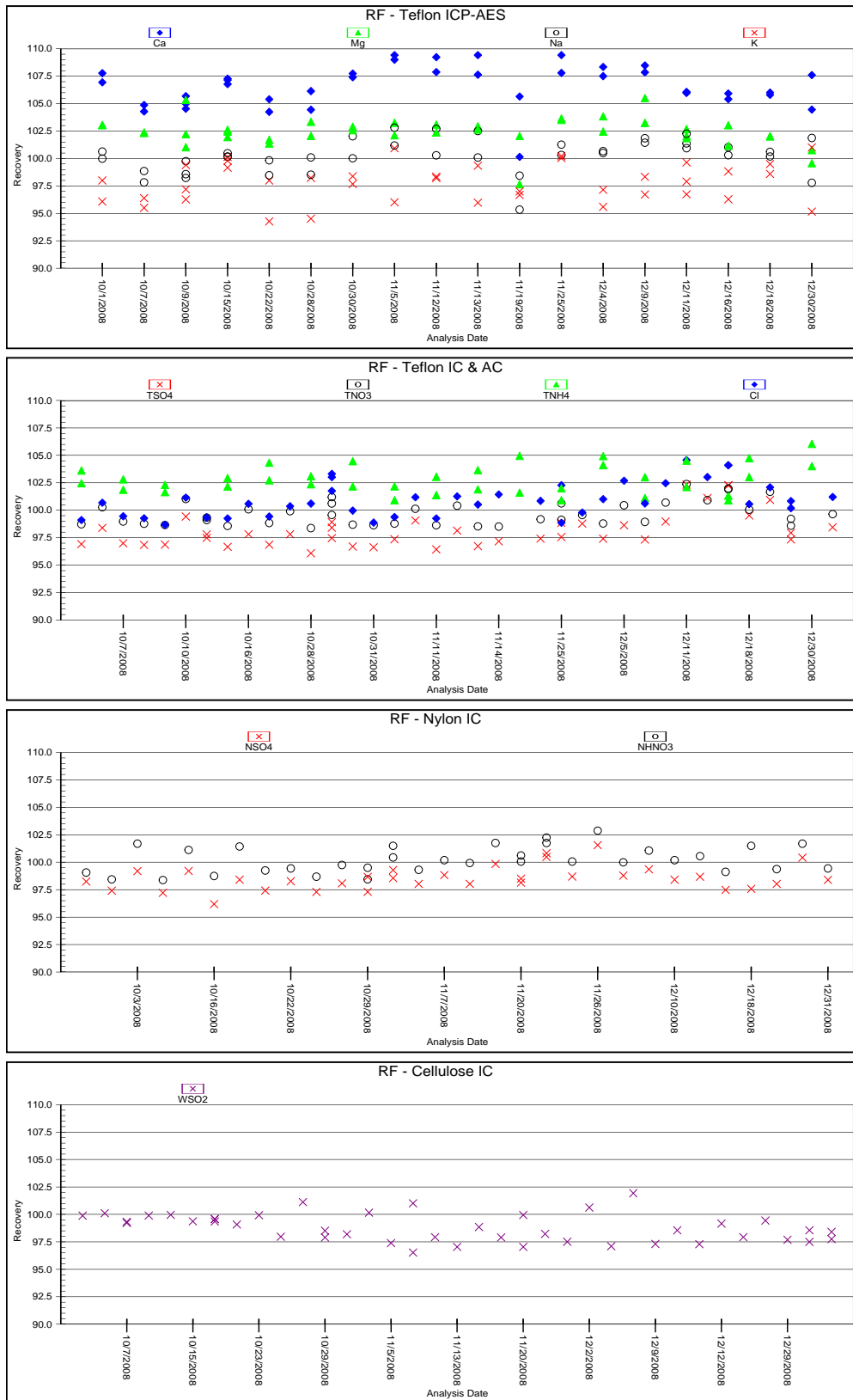
**Note:** Per CASTNET project protocols, data are flagged as “suspect” (S) but still considered valid if the calibration criterion is not exceeded by more than its magnitude (i.e., if within 2x the criterion). If ozone or flow calibrations fall within 2x the criteria, these data are adjusted per approved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

**Table 16.** Accuracy Results for 2008 Field Measurements

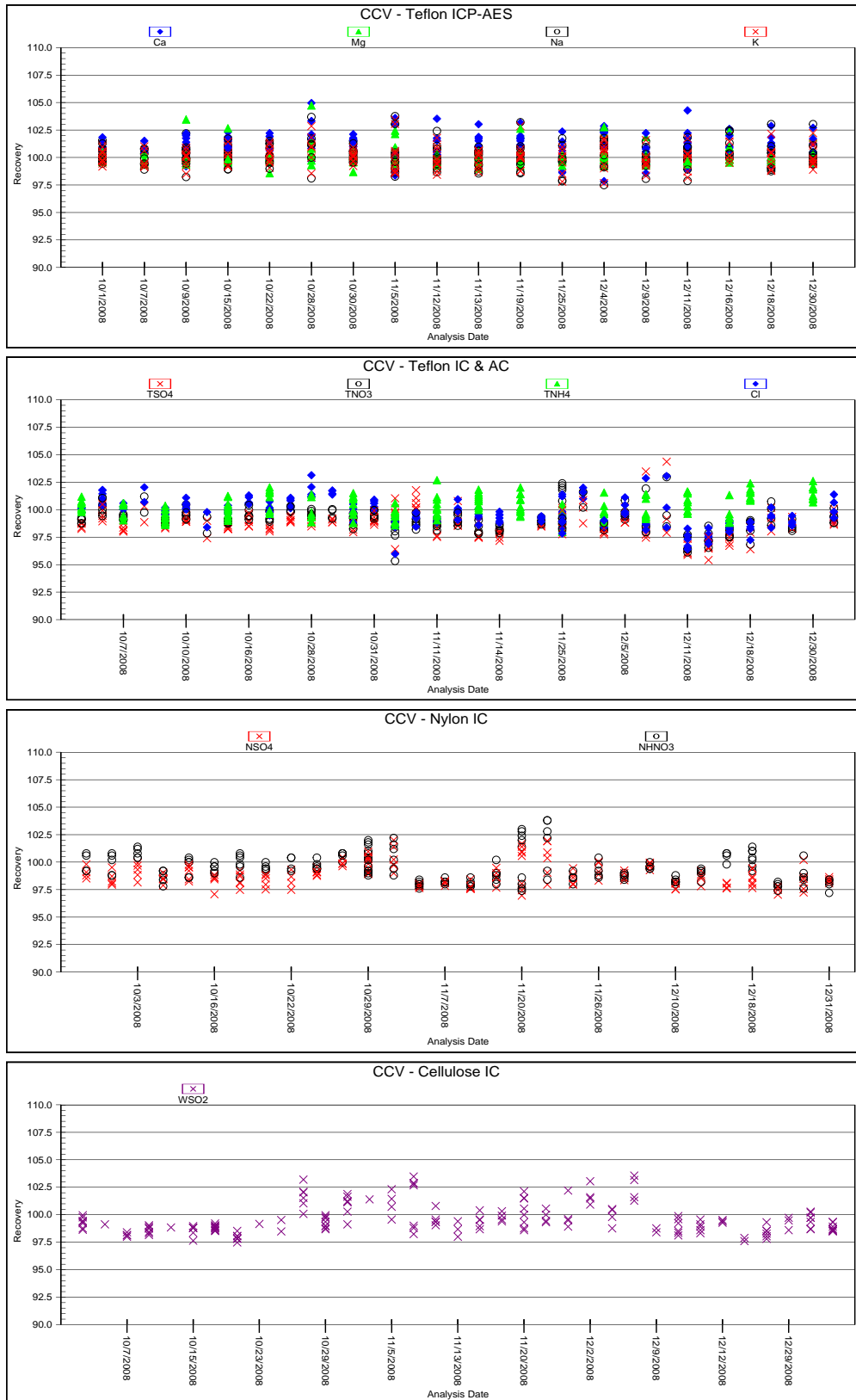
Parameter	Percent Within Criterion
Temperature (0°C)	98.3 percent
Temperature (ambient)	99.1 percent
Delta Temperature (0°C)	98.3 percent
Delta Temperature (ambient)	96.6 percent
*Relative Humidity > 85%	87.3 percent
Relative Humidity ≤ 50%	99.1 percent
*Solar Radiation	85.0 percent
Wind Direction North	92.2 percent
Wind Direction South	92.2 percent
Wind Speed < 5 m/s	98.2 percent
Wind Speed ≥ 5 m/s	98.2 percent
Precipitation	100.0 percent
Wetness (w/in 0.5 volts)	99.1 percent
Ozone Slope	97.2 percent
Ozone Intercept	98.2 percent
Flow Rate	100.0 percent

**Note:** °C = degrees Celsius.  
 m/s = meters per second.  
 \* = 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). The percent within 2x criterion for relative humidity > 85% was 98.2 percent. The percent within 2x criterion for solar radiation was 98.1 percent.

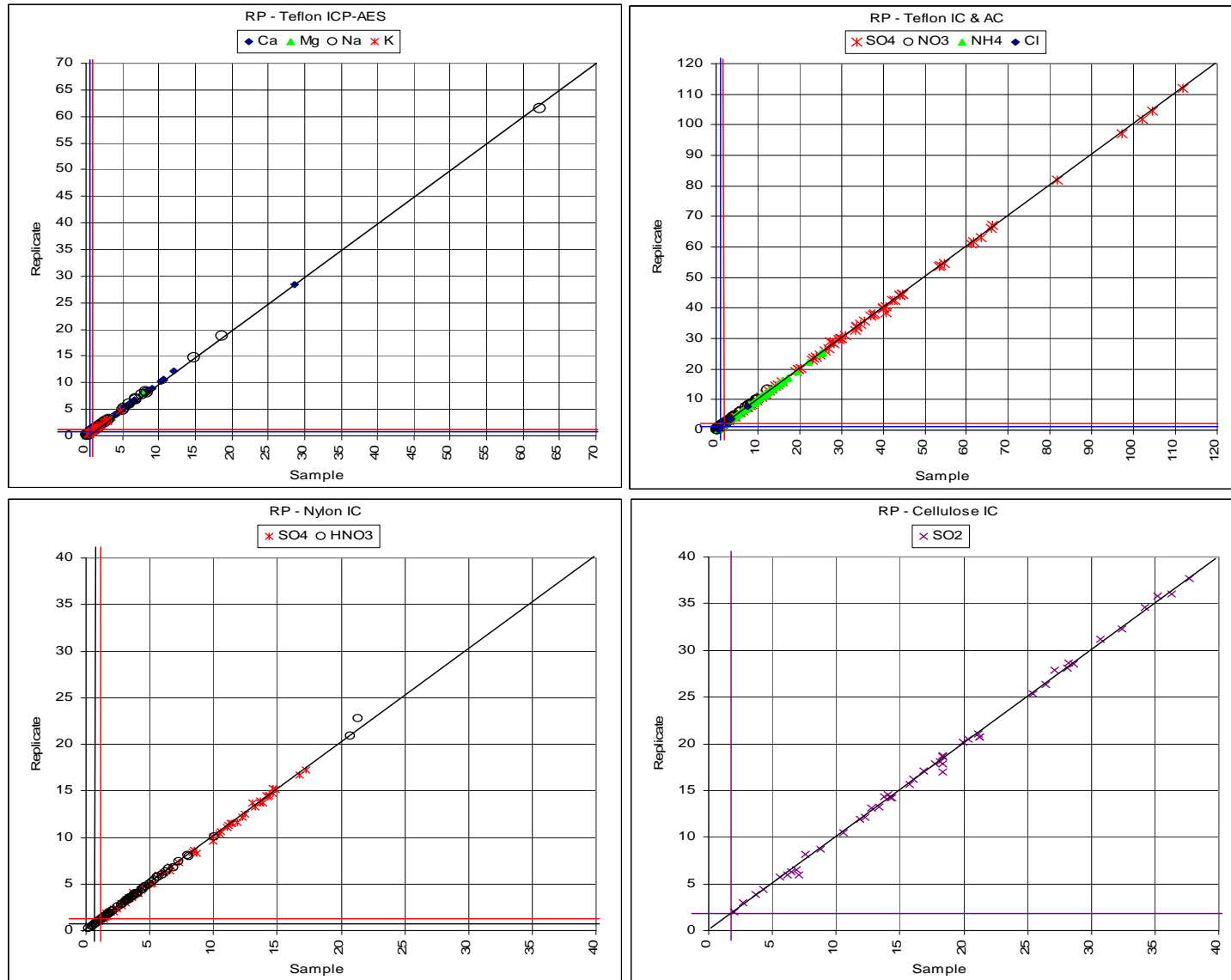
**Figure 1.** Reference Standard Results for Fourth Quarter 2008 (percent recovery)



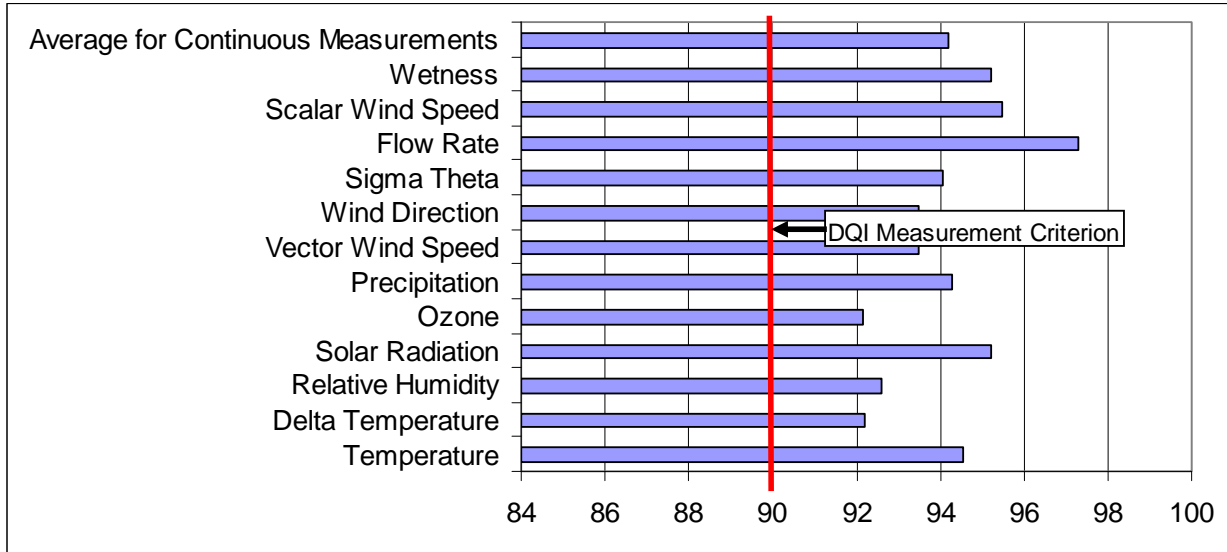
**Figure 2.** Continuing Calibration Verification Spike Results for Fourth Quarter 2008 (percent recovery)



**Figure 3.** Replicate Sample Analysis Results for Fourth Quarter 2008 (total micrograms)



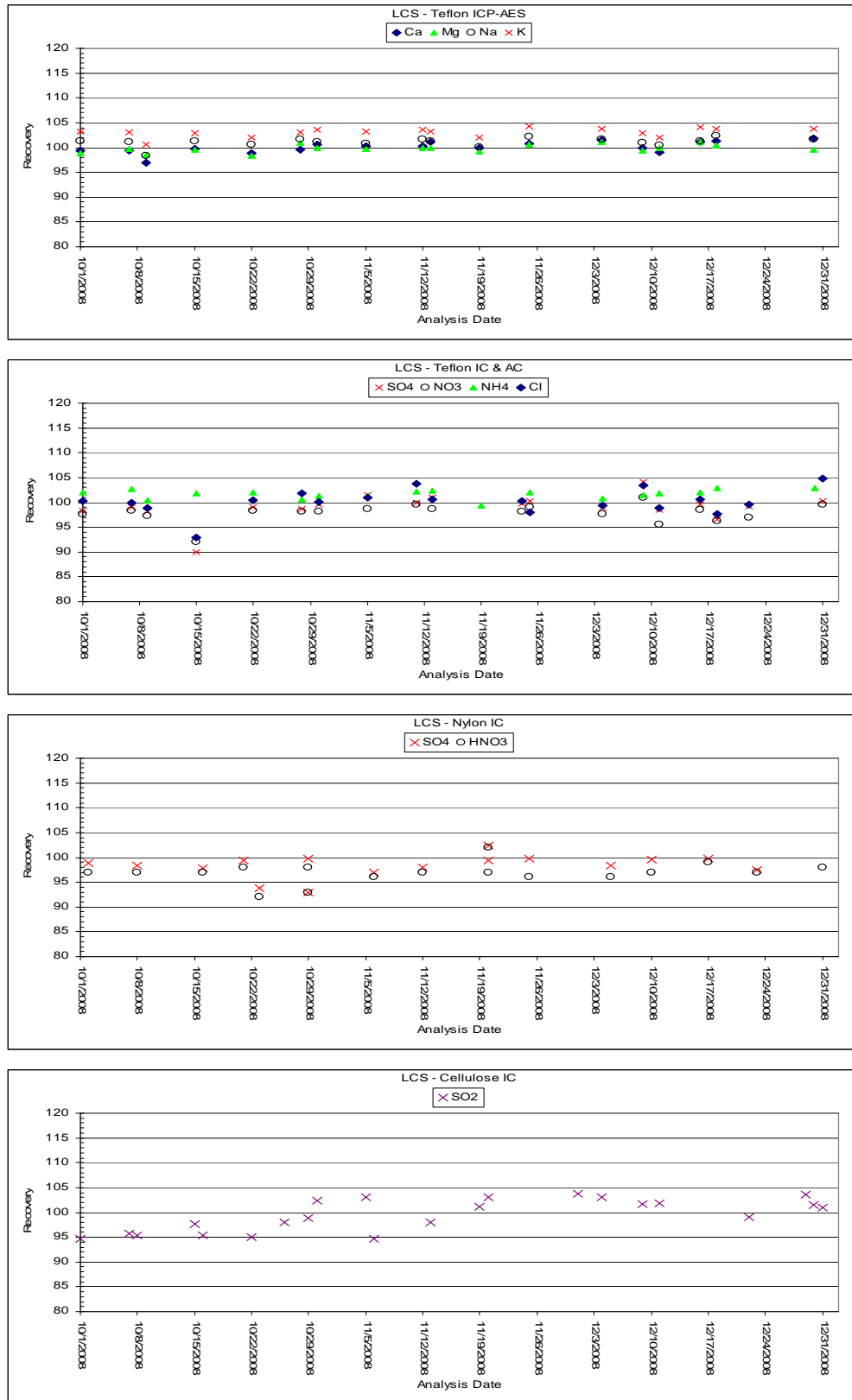
**Figure 4.** Percent Completeness of Measurements for Third Quarter 2007 through Third Quarter 2008\*



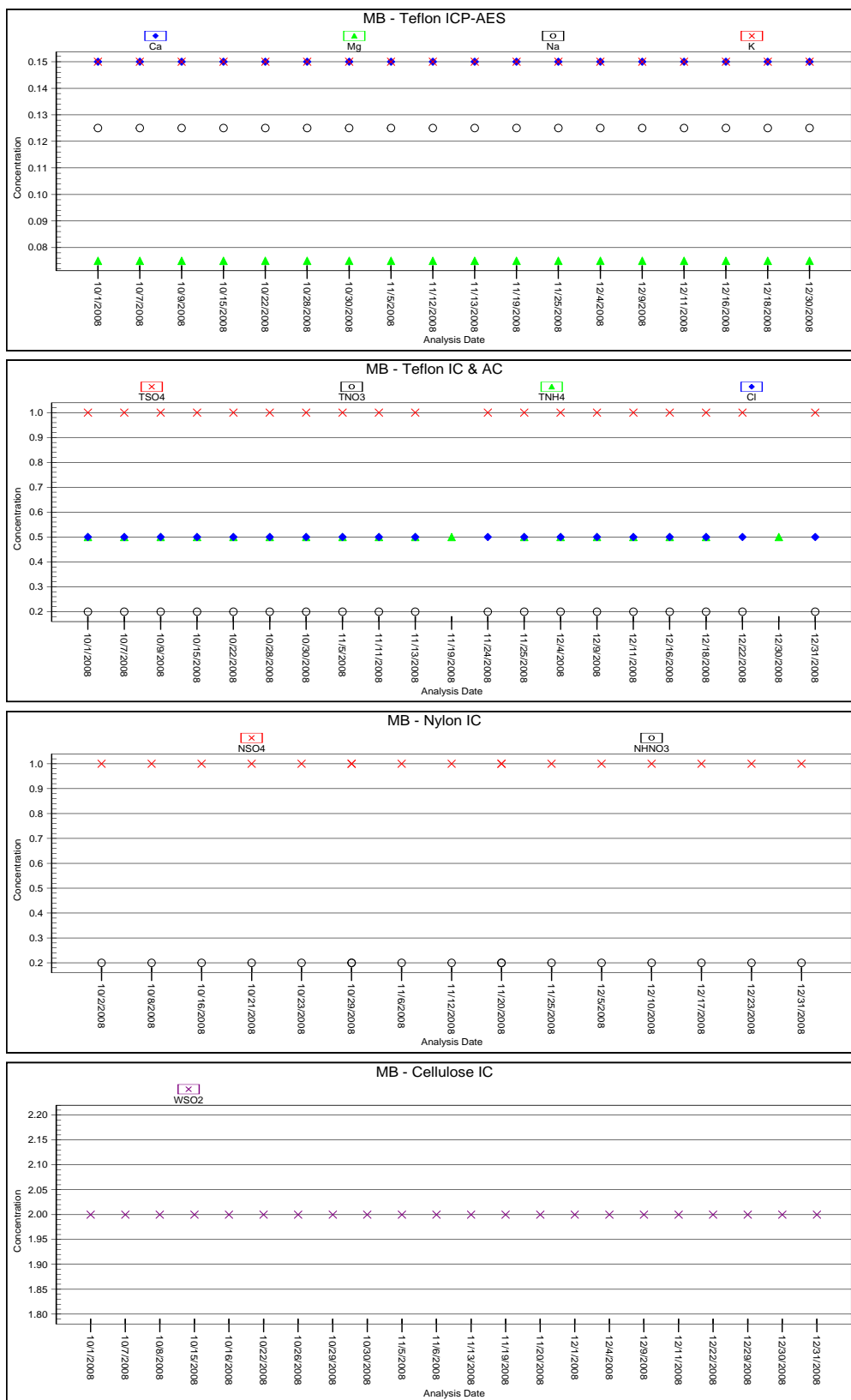
**Note:** \*Presents Level 3 data available during the 2008 calendar year.



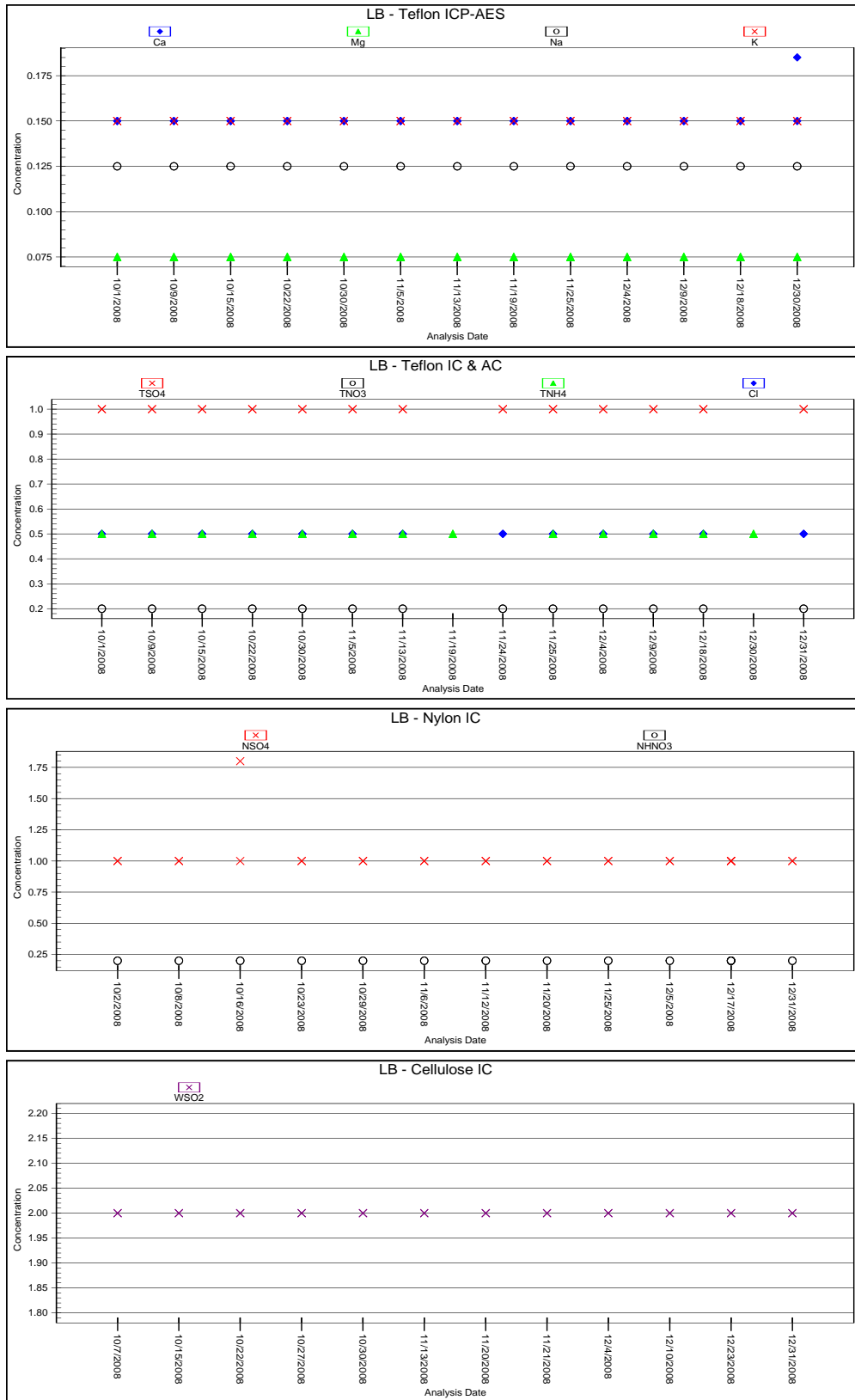
**Figure 5.** Laboratory Control Sample Results for Fourth Quarter 2008 (percent recovery)



**Figure 6.** Method Blank Analysis Results for Fourth Quarter 2008 (total micrograms)



**Figure 7.** Laboratory Blank Analysis Results for Fourth Quarter 2008 (total micrograms)



**Figure 8.** Field Blank Analysis Results for Fourth Quarter 2008 (total micrograms)

