



## **Summary of Quarterly Operations (October through December) with 2015 Annual Summary**

**EPA Contract No. EP-W-15-003**

### **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 2015. It also provides an annual summary that includes data from the three previous quarters. The various QA/QC criteria and policies are documented in the CASTNET Quality Assurance Project Plan (QAPP; Amec Foster Wheeler, 2014). 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 2015**

During 2015, AMEC Environment and Infrastructure, Inc. (AMEC) received Modification 0006 to Contract EP-W-15-003 in which EPA accepted AMEC's name change to Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler).

There were two changes in Key Personnel for CASTNET during 2015. Amec Foster Wheeler received Contract Modification 0066 to the CASTNET IV contract (EP-W-09-028) on January 14, 2015, which approved Ann Bernhardt as Amec Foster Wheeler's CASTNET QA Supervisor. Additionally, Amec Foster Wheeler received Contract Modification 0009 to the CASTNET Bridge contract (EP-W-15-003) on October 27, 2015, which approved Katherine Barry as the CASTNET Laboratory Operations Manager.

During 2015, Amec Foster Wheeler submitted sample analyses for proficiency test (PT) studies 0105 and 0106 for Rain and Soft Waters to the National Laboratory of Environmental Testing (NLET), a branch of the National Water Research Institute (NWRI) with Environment Canada that provides QA services. Amec Foster Wheeler received the results from PT study 0105 in March. A low bias was indicated for the pH analyses. One sample was flagged "action high" for potassium and chloride. Amec Foster Wheeler was rated good for the study overall. Corrective

action was implemented for the low bias and “action high” flags. The documented completed corrective action was submitted to the American Association for Laboratory Accreditation (A2LA) along with the study results as required for accredited laboratories. The corrective action was accepted by A2LA. Amec Foster Wheeler received results from PT study 0106 in August. Amec Foster Wheeler was rated “very good” for analyses for PT study 0106. Amec Foster Wheeler’s 5-year average remained “very good,” the highest rating available.

During January 2015, comments received from EPA on the CASTNET QAPP Revision 8.2 were incorporated into the QAPP, and Revision 8.2 was finalized. After EPA approved the final version of the QAPP Revision 8.2, it was distributed to the designated recipients.

Amec Foster Wheeler corporate continued to support the analytical laboratory’s activities with regard to maintaining 17025:2005 accreditation under the International Organization for Standardization (ISO)/International Electrotechnical Commission (IEC). An assessment of the laboratory was performed by an assigned assessor from A2LA in early April 2015. There was a single deficiency related to the existing scope of accreditation requiring an explicit definition of the authority of the QA Manager to ensure the management system is implemented and followed. This deficiency was addressed by revising the laboratory quality manual. Objective evidence of the corrective action was provided to A2LA in early May 2015. Amec Foster Wheeler’s accreditation was renewed and is good for two years until May 31, 2017.

Additionally, Amec Foster Wheeler extended ISO/IEC 17025:2005 accreditation to select field-based activities. This accreditation is good until May 31, 2017.

An annual management review in support of maintaining ISO/IEC 17025:2005 accreditation by A2LA is required. The report was provided to the Amec Foster Wheeler management group in December 2015.

EPA’s Office of Air Quality Planning and Standards (OAQPS) requested that only ozone 1-point QC checks that are associated with valid data be submitted to EPA’s Air Quality System (AQS). Those 1-point QC checks that are associated with data that have been invalidated are being excluded starting with the January 2015 ozone data.

During second quarter, Amec Foster Wheeler determined that ozone concentration data from the Rocky Mountain National Park, CO site (ROM206) showed concentrations have been 2 to 3 parts per billion (ppb) higher than those measured by the collocated ROM406 site since installation of the reactive oxides of nitrogen (NO<sub>y</sub>) analyzer at ROM206. During third quarter, Amec Foster Wheeler took corrective action by placing all of the ozone analyzers at the trace-level gas monitoring sites on the standard zero air generation system used at CASTNET sites that do not measure trace-level gases.

The CASTNET QA Manager worked with EPA to revise the CASTNET QAPP siting criteria to include siting criteria from Title 40 Code of Federal Regulations (CFR) Part 58 that specifically addresses ozone monitoring for AQS-submitting sites. Modifications to siting criteria included specific sets of criteria for the different types of sites: small-footprint, filter pack-only sites; AQS-submitting (i.e., 40 CFR Part 58-compliant) ozone sites; and classic sites.

Road construction near the Pinedale WY (PND165) site began during third quarter. Continuation of the road improvement project is planned for the warm season over the next two years. Road construction activities are expected to affect monitoring activities at the site. Amec Foster Wheeler worked with EPA, the National Park Service, and the Bureau of Land Management to develop a flagging protocol for data collected during active periods of road construction. The reactive oxides of nitrogen (NO<sub>y</sub>) concentration data collected during the road construction period will be flagged as follows:

A = Anomalous value resulting from local anthropogenic activity

Additionally, ozone and filter pack concentration data will be flagged:

& = Ambient concentration data measured/collected coincident with data flagged A

The NO<sub>y</sub> data from the site will be reviewed using routine protocols with an emphasis on examination of 1-minute data and comparison with historical concentrations. For example, Figure 1 depicts 1-minute data used to flag hourly measurements as anomalous for hours 0400, 0800, and 1900 on September 14, 2015. Figure 2 depicts 1-minute data used to flag hourly measurements as anomalous for hours 1200 through 1700 on September 15, 2015. In both cases, the data not flagged are well within the site's historical concentration range and exhibit the gradual changes in concentration expected for ambient data. As per the flagging protocol, anomalous high readings will be flagged per the hour affected. In addition, ozone and filter pack data collected simultaneously will be flagged as coincident with the anomalous NO<sub>y</sub> data. When the ozone and filter pack data are reviewed through routine processes, the & flag will be exchanged with A for hours deemed anomalous in their own right.

The required 3-year ozone facility technical systems audit (TSA) of Amec Foster Wheeler's CASTNET ozone laboratory and a field site took place during November 2015. Jeff Nichol (RTI International, Inc.) audited the selected field site at Prince Edward, VA (PED108) on Tuesday, November 10, during the site operator's normal weekly site visit. Mr. Nichol performed the TSA of the CASTNET ozone laboratory facility on November 16 and 17, 2015. Mr. Nichol completed the majority of the facility audit on Monday, November 16, and observed the handling of the site operator calls by Amec Foster Wheeler field personnel on Tuesday, November 17. Mr. Nichol had positive and complimentary comments during the TSA. There were no technical findings mentioned at the debriefing, only recommendations regarding documentation. The final TSA report was provided to Amec Foster Wheeler by Mr. Nichol in December. Amec Foster Wheeler forwarded the final TSA report to EPA.

Work was completed on the annual update of the CASTNET QAPP Revision 8.3 and EPA's comments were incorporated into the draft final version during December 2015. The updates to the QAPP included changes recommended by the TSA auditor. The signature page of the QAPP was updated for Revision 8.3 to include current representatives from CASTNET primary sponsors.

### **Quarterly/Annual Summary**

Table 1 lists the quarters of data that were validated to Level 3 during 2015 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. Table 5 presents the critical criteria for ozone monitoring. Table 6 presents the critical criteria for trace-level gas monitoring.

### **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 7 through 10 present the number of analyses in each category that were performed during each quarter of 2015.

### **Sample Receipt Statistics**

Ninety-five 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 11 presents the relevant sample receipt statistics for each of the four quarters of 2015 together with an annual summary for each category.

### **Data Quality Indicator (DQI) Results<sup>1</sup>**

Figures 3 through 5 present the results of RF, CCV, and RP QC sample analyses for fourth quarter 2015. All results were within the criteria listed in Table 4 with the exception of a single calcium RP result. The associated sample concentration is less than 3 times the reporting limit for calcium. Table 12 presents the percent recoveries and standard deviations for RF, CCV, and RP QC sample analyses for 2015. Quarterly averages are all within criteria.

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<sup>1</sup> Reported statistics are calculated based on values rounded according to ASTM E29-08, Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications E29 (ASTM, 2008).

Table 13 presents quarterly collocated filter pack precision results for data validated to Level 3 during the year. Results for MCK131/231, KY and ROM406/206, CO were within the criterion for all of the 11 parameters reported.

Figure 6 presents completeness statistics for continuous measurements validated to Level 3 during the year. All parameters met the 90 percent criterion.

Table 14 presents summary statistics of critical criteria measurements at ozone sites collected during fourth quarter 2015. The statistics presented contain data validated at Level 2 and Level 3. All data associated with QC checks that fail to meet the criteria listed in Table 5 were or will be invalidated unless the cause of failure has no affect on ambient data collection, and passing results still meet frequency criteria. Results in shaded cells either exceed documented criteria or are otherwise notable. Table 15 presents observations associated with the shaded cell results in Table 14.

Table 16 presents summary statistics of critical criteria measurements at trace-level gas monitoring sites collected during fourth quarter 2015. The statistics presented contain data validated at Level 2 and Level 3. All data associated with QC checks that fail to meet the criteria listed in Table 6 were or will be invalidated unless the cause of failure has no affect on ambient data collection, and passing results still meet frequency criteria. Results in shaded cells either exceed documented criteria or are otherwise notable. Table 17 presents observations associated with the shaded cell results in Table 16.

### **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. Figure 7 presents LCS analysis results for fourth quarter 2015. All recovery values were between 83 percent and 107 percent.

### **Blank Results**

Figures 8 through 10 present the results of MB, LB, and FB QC sample analyses for fourth quarter 2015. All fourth quarter results were within criteria (two times the reporting limit) listed in Table 4 with the exception of three cellulose FB samples. Table 18 summarizes the record of filter blanks for 2015. All 2015 results were within the two times reporting limit criterion with the exception of the three cellulose FB samples noted previously, five Teflon FB samples (three potassium, one calcium, and one sodium), and one Teflon filter acceptance test sample (the associated box of filters was rejected as required by protocol). The number of FB samples

exceeding the criterion is high compared with previous years. These results are under investigation. All other blank QC checks in their respective batches were within criteria.

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

Filter pack samples that were flagged as suspect or invalid during each of the four quarters of 2015 are listed in Table 19. This table also includes associated site identification and a brief description of the reason the sample was flagged. During fourth quarter, 18 filter pack samples were invalidated.

### **Field Problem Count**

Table 20 presents counts of field problems affecting continuous data collection for more than one day for each quarter during 2015. 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.

### **Field Calibration Results**

A summary of field calibration failures by parameter for each quarter of 2015 is listed in Table 21. Calibrations were performed at 25 sites during fourth quarter 2015. During 2015, all sites and parameters were within the criteria listed in Table 3 with the exception of the parameters at the eight sites that are listed in Table 21.

Table 22 presents field accuracy results for 2015 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 except solar radiation at 81.8 percent frequency. Per CASTNET project protocols, data are flagged but still considered valid if the calibration criterion is not exceeded by more than its magnitude (i.e., if within 2x the criterion). All calibration failures reported in 2015 for the indicated parameters were within 2x the criterion with the exception of solar radiation at PAL190, TX. Data associated with the failure were invalidated.

### **References**

Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler). 2014. *Clean Air Status and Trends Network (CASTNET) Quality Assurance Project Plan (QAPP) Revision 8.2*. Prepared for U.S. Environmental Protection Agency (EPA), Office of Air and Radiation, Clean Air Markets Division, Washington, DC. Contract No. EP-W-15-003. Gainesville, FL. <http://java.epa.gov/castnet/documents.do>.

American Society for Testing and Materials (ASTM). 2008. *ASTM E29-08, Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications*. ASTM International, West Conshohocken, PA, DOI: 10.1520/E0029-08. [www.astm.org](http://www.astm.org).



U.S. Environmental Protection Agency (EPA). 2015. Appendix A to Part 58 – Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS), Special Purpose Monitors (SPMs), and Prevention of Significant Deterioration (PSD) Air Monitoring. 40 *CFR* Part 58.

**Table 1** Data Validated to Level 3 through Fourth Quarter 2015

Calibration Group*	Months Available	Number of Months	Complete Quarters	Number of Quarters
SE-4/MW-6 <sup>†</sup>	July 2014 – June 2015	12	Quarter 3 2014 – Quarter 2 2015	4
E-1/SE-5	August 2014 – July 2015	12	Quarter 4 2014 – Quarter 2 2015	3
MW-7/W-9	September 2014 – August 2015	12	Quarter 4 2014 – Quarter 2 2015	3
E-2 /MW-8	October 2014 – September 2015	12	Quarter 4 2014 – Quarter 3 2015	4
E-3/W-10 <sup>‡</sup>	May 2014 – April 2015	12	Quarter 3 2014 – Quarter 1 2015	3

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

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

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

**Table 2** Field Calibration Schedule for 2015

Calibration Group	Months Calibrated	Sites Calibrated			
<b>Eastern Sites (24 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 (11 Sites)	April/October	ABT147, CT ASH135, ME HOW191, ME	WST109, NH CAT175, NY HWF187, NY	NIC001, NY WFM007, NY WFM105, NY	EGB181, ON UND002, VT
E-3 (5 Sites)	May/November	KEF112, PA MKG113, PA	LRL117, PA PAR107, WV	CDR119, WV	
<b>Southeastern Sites (11 Total)</b>					
SE-4 (7 Sites)	January/July	SND152, AL GAS153, GA	BFT142, NC CND125, NC	COW005, NC COW137, NC	SPD111, TN
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	PNF126, NC ESP127, TN	
MW-7 (9 Sites)	March/September	ALH157, IL BVL130, IL STK138, IL	VIN140, IN RED004, MN DCP114, OH	OXF122, OH QAK172, OH PRK134, WI	
MW-8 (4 Sites)	April/October	SAL133, IN HOX148, MI	ANA115, MI UVL124, MI		
<b>Western Sites (10 Total)</b>					
W-9 (5 Sites)	March/September	KNZ184, KS KIC003, KS	CHE185, OK SAN189, NE	ALC188, TX	
W-10 (5 Sites)	May/November	GTH161, CO ROM206, CO	CNT169, WY PND165, WY	PAL190, TX	



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

Measurement Parameter <sup>2</sup> Method		Criteria <sup>1</sup>	
		Precision	Accuracy
Filter pack flow	Mass flow controller	± 10%	± 5%
Ozone <sup>3</sup>	UV absorbance	All points within ± 2% of full scale of best fit straight line Linearity error < 5%	
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
Ambient temperature	Platinum RTD	± 1.0°C	± 0.5°C
Delta temperature	Platinum RTD	± 0.5°C	± 0.5°C
Relative humidity	Thin film capacitor	± 10% (of full scale)	± 10%
Precipitation	Tipping bucket rain gauge	± 10% (of reading)	± 0.05 inch <sup>4</sup>
Solar radiation	Pyranometer	± 10% (of reading taken at local noon)	± 10%
Surface wetness	Conductivity bridge	Undefined	Undefined

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

<sup>1</sup> Precision criteria apply to collocated instruments, and accuracy criteria apply to calibration of instruments. Collocated precision criteria do not apply to 40 CFR Part 58 ozone measurements.

<sup>2</sup> Meteorological parameters are only measured at five of the EPA-sponsored CASTNET sites: BVL130, IL; BEL116, MD; CHE185, OK; COW137, NC; and PAL190, TX.

<sup>3</sup> Ozone is not measured at 10 EPA-sponsored CASTNET sites: KIC003, KS; KNZ184, KS; RED004, MN; COW005, NC; EGB181, ON; CAT175, NY; NIC001, NY; WFM007, NY; WFM105, NY; and UND002, VT.

<sup>4</sup> For target value of 0.50 inch

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

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

**Notes:** <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-OES reference standards.

AC = automated colorimetry  
 IC = ion chromatography  
 ICP-OES = inductively coupled plasma-optical emission spectrometry  
 MARPD = mean absolute relative percent difference  
 mg/L = milligrams per liter  
 µg/Filter = micrograms per filter  
 \* = as nitrogen

Values are rounded according to American Society for Testing and Materials (ASTM) E29-08, Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications (ASTM, 2008).

For more information on analytical methods and associated precision and accuracy criteria, see the CASTNET QAPP, (Amec Foster Wheeler, 2014).

**Table 5** Ozone Critical Criteria\*

Type of Check	Analyzer Response
Zero	Less than ± 3 parts per billion (ppb)
Span	Less than or equal to ± 7 percent between supplied and observed concentrations
Single Point QC	Less than or equal to ± 7 percent between supplied and observed concentrations

**Notes:** \* Applies to CASTNET sites that are configured and operated in accordance with 40 CFR Part 58 (EPA, 2015). The minimum frequency for these checks is once every two weeks.

Values are rounded according to ASTM E29-08, Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications (ASTM, 2008).

**Table 6** Trace-level Gas Monitoring Critical Criteria \*

Parameter	Analyzer Response	
	Zero Check	Span Check / Single Point QC Check
SO <sub>2</sub>	Less than ± 3 ppb	Less than or equal to ± 10 percent between supplied and observed concentrations
NO <sub>y</sub>	Less than ± 3 ppb	
CO	Less than ± 40 ppb	

**Notes:** \*Applies to CASTNET sites that are configured and operated in accordance with 40 CFR Part 58 (EPA, 2015). The minimum frequency for these checks is once every two weeks.

Values are rounded according to ASTM E29-08, Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications E29 (ASTM, 2008).

SO<sub>2</sub> = sulfur dioxide

NO<sub>y</sub> = total reactive oxides of nitrogen

CO = carbon monoxide

ppb = parts per billion

**Table 7** QC Analysis Count for First Quarter 2015

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>	53	201	86	18	26	130
	NO <sub>3</sub> <sup>-</sup>	53	201	86	18	26	130
	NH <sub>4</sub> <sup>+</sup>	36	185	89	18	26	130
	Cl <sup>-</sup>	53	201	86	18	26	130
	Ca <sup>2+</sup>	36	186	88	18	26	130
	Mg <sup>2+</sup>	36	186	88	18	26	130
	Na <sup>+</sup>	36	186	88	18	26	130
	K <sup>+</sup>	36	186	88	18	26	130
Nylon	SO <sub>4</sub> <sup>2-</sup>	36	183	83	18	26	130
	NO <sub>3</sub> <sup>-</sup>	48	195	89	24	26	136
Cellulose	SO <sub>4</sub> <sup>2-</sup>	37	185	82	18	26	130

**Table 8** QC Analysis Count for Second Quarter 2015

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>	51	193	82	18	26	96
	NO <sub>3</sub> <sup>-</sup>	51	193	82	18	26	96
	NH <sub>4</sub> <sup>+</sup>	36	175	81	18	26	96
	Cl <sup>-</sup>	51	193	82	18	26	96
	Ca <sup>2+</sup>	38	181	83	19	26	96
	Mg <sup>2+</sup>	38	181	83	19	26	96
	Na <sup>+</sup>	38	181	83	19	26	96
	K <sup>+</sup>	38	181	83	19	26	96
Nylon	SO <sub>4</sub> <sup>2-</sup>	37	181	79	18	26	96
	NO <sub>3</sub> <sup>-</sup>	51	195	86	25	26	103
Cellulose	SO <sub>4</sub> <sup>2-</sup>	35	177	80	17	26	96

**Table 9** QC Analysis Count for Third Quarter 2015

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>	51	196	82	18	26	94
	NO <sub>3</sub> <sup>-</sup>	51	196	82	18	26	94
	NH <sub>4</sub> <sup>+</sup>	36	179	81	18	26	94
	Cl <sup>-</sup>	51	196	82	18	26	94
	Ca <sup>2+</sup>	36	181	82	18	26	94
	Mg <sup>2+</sup>	36	181	82	18	26	94
	Na <sup>+</sup>	36	181	82	18	26	94
	K <sup>+</sup>	36	181	82	18	26	94
Nylon	SO <sub>4</sub> <sup>2-</sup>	41	182	80	20	26	94
	NO <sub>3</sub> <sup>-</sup>	53	194	86	26	26	100
Cellulose	SO <sub>4</sub> <sup>2-</sup>	37	182	82	18	26	94

**Table 10** QC Analysis Count for Fourth Quarter 2015

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>	48	180	74	15	24	92
	NO <sub>3</sub> <sup>-</sup>	48	180	74	15	24	92
	NH <sub>4</sub> <sup>+</sup>	48	155	72	15	22	92
	Cl <sup>-</sup>	48	180	74	15	24	92
	Ca <sup>2+</sup>	30	160	70	15	22	92
	Mg <sup>2+</sup>	30	160	70	15	22	92
	Na <sup>+</sup>	30	160	70	15	22	92
	K <sup>+</sup>	30	160	70	15	22	92
Nylon	SO <sub>4</sub> <sup>2-</sup>	32	160	72	15	22	92
	NO <sub>3</sub> <sup>-</sup>	44	172	78	21	22	98
Cellulose	SO <sub>4</sub> <sup>2-</sup>	31	160	70	15	22	92

**Table 11** Filter Pack Receipt Summary for 2015

Description	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Annual Summary
Count of samples received more than 14 days after removal from tower:	22	9	11	9	51
Count of all samples received:	875	751	832	711	3,169
Fraction of samples received within 14 days:	0.975	0.988	0.987	0.987	0.984
Average interval in days:	5.190	4.762	4.993	5.224	5.042*
First receipt date:	01/02/2015	04/02/2015	07/01/2015	10/01/2015	01/02/2015
Last receipt date:	03/31/2015	06/25/2015	09/30/2015	12/17/2015	12/17/2015

Notes: \*annual average

**Table 12 Filter Pack QC Summary for 2015**

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	SO <sub>4</sub> <sup>2-</sup>	97.73	1.81	48	99.52	1.38	180	1.21	1.09	74
	NO <sub>3</sub> <sup>-</sup>	101.33	1.79	48	98.87	1.64	180	1.34	1.27	74
	NH <sub>4</sub> <sup>+</sup>	100.34	2.38	30	101.24	1.77	155	0.68	0.84	72
	Ca <sup>2+</sup>	98.52	2.19	30	100.15	1.02	160	1.63	3.42	70
	Mg <sup>2+</sup>	100.42	0.93	30	99.95	0.74	160	1.17	1.00	70
	Na <sup>+</sup>	99.12	1.11	30	99.80	1.06	160	1.13	0.81	70
	K <sup>+</sup>	98.06	1.75	30	99.83	0.86	160	1.66	1.55	70
	Cl <sup>-</sup>	100.33	1.90	48	102.61	1.32	180	1.60	1.35	74
Nylon	SO <sub>4</sub> <sup>2-</sup>	98.27	0.64	32	99.61	0.92	160	4.40	3.93	72
	NO <sub>3</sub> <sup>-</sup>	101.78	0.99	44	97.79	1.28	172	2.84	2.43	78
Cellulose	SO <sub>4</sub> <sup>2-</sup>	99.51	0.97	31	99.98	0.60	160	6.00	3.66	70

**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 13 Precision Results for Third Quarter 2014 through Second Quarter 2015**

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>											
2014 Q3	1.36	5.58	1.87	3.76	2.85	2.50	4.23	0.46	2.76	2.72	1.74
2014 Q4	1.53	5.11	1.15	8.32	6.53	4.22	4.41	5.97	5.13	2.67	3.71
2015 Q1	1.86	1.92	1.47	8.16	5.56	8.12	3.56	9.88	3.48	1.63	1.42
2015 Q2	2.21	5.54	1.70	5.17	4.01	2.91	4.60	2.57	3.92	7.44	2.83
Average	1.74	4.54	1.55	6.35	4.74	4.44	4.20	4.72	3.82	3.62	2.43
<b>ROM406/206, CO</b>											
2014 Q3	4.33	9.87	5.48	5.43	5.68	6.85	6.16	2.10	5.44	8.66	4.36
2014 Q4	5.72	11.38	6.20	10.50	9.57	9.92	10.61	14.74	8.15	12.91	6.87
2015 Q1	4.03	14.81	5.09	8.62	5.75	9.32	7.64	6.06	7.55	17.83	4.41
2015 Q2	3.70	16.36	5.54	4.18	2.72	3.20	4.60	5.87	1.31	13.16	9.85
Average	4.45	13.11	5.58	7.18	5.93	7.32	7.25	7.19	5.61	13.14	6.37

**Notes:** 0 of 88 site-quarter-parameters were outside criterion  
MARPD = mean absolute relative percent difference



**Table 14** Ozone QC Summary for Fourth Quarter 2015 (1 of 2)

Site ID	% Span Pass <sup>1</sup>	Span  %D  <sup>2</sup>	% Single Point QC Pass <sup>1</sup>	Single Point QC  %D  <sup>2</sup>	Single Point QC CL <sup>3</sup>	% Zero Pass <sup>1</sup>	Zero Average (ppb) <sup>2</sup>
ABT147, CT	100.00	0.86	100.00	0.78	0.10	100.00	0.20
ALC188, TX	100.00	0.95	100.00	1.13	0.19	100.00	0.38
ALH157, IL	100.00	0.94	100.00	0.72	0.11	100.00	0.14
ANA115, MI	98.92	1.00	100.00	0.65	0.09	97.80	0.85
ARE128, PA	100.00	0.62	100.00	0.61	0.11	100.00	0.31
ASH135, ME	100.00	0.92	100.00	0.93	0.09	100.00	0.18
BEL116, MD	100.00	1.33	98.89	1.20	0.26	100.00	0.34
BFT142, NC	100.00	1.19	97.78	1.27	0.24	100.00	0.15
BVL130, IL	100.00	0.70	100.00	1.53	0.09	100.00	0.41
BWR139, MD	100.00	2.60	100.00	3.24	0.17	100.00	0.17
CAD150, AR	100.00	0.78	98.81	0.91	0.23	100.00	0.34
CDR119, WV	100.00	1.70	100.00	2.08	0.13	100.00	0.28
CDZ171, KY	100.00	0.41	100.00	0.47	0.08	100.00	0.13
CKT136, KY	100.00	0.56	100.00	1.07	0.10	100.00	0.14
CND125, NC	100.00	1.62	98.92	1.20	0.25	100.00	0.23
CNT169, WY	100.00	1.23	100.00	0.77	0.10	100.00	0.71
COW137, NC	100.00	1.26	100.00	1.76	0.13	100.00	0.62
CTH110, NY	95.96	2.82	98.99	1.68	1.08	93.94	1.83
CVL151, MS	100.00	0.76	100.00	0.88	0.15	100.00	0.28
DCP114, OH	98.57	2.16	100.00	1.17	0.21	100.00	0.19
ESP127, TN	100.00	0.66	100.00	0.60	0.08	100.00	0.16
GAS153, GA	90.20	1.88	89.22	1.89	0.47	100.00	0.57
GTH161, CO	91.35	3.60	92.93	3.76	0.46	100.00	0.22

**Table 14** Ozone QC Summary for Fourth Quarter 2015 (2 of 2)

Site ID	% Span Pass <sup>1</sup>	Span  %D  <sup>2</sup>	% Single Point QC Pass <sup>1</sup>	Single Point QC  %D  <sup>2</sup>	Single Point QC CL <sup>3</sup>	% Zero Pass <sup>1</sup>	Zero Average (ppb) <sup>2</sup>
HOX148, MI	100.00	0.28	100.00	1.10	0.08	100.00	0.74
HWF187, NY	100.00	0.84	100.00	0.88	0.07	100.00	0.11
IRL141, FL	100.00	2.44	100.00	1.66	0.24	100.00	0.91
KEF112, PA	100.00	2.63	100.00	2.86	0.22	100.00	0.21
LRL117, PA	100.00	0.63	97.92	0.94	0.28	98.96	0.33
MCK131, KY	98.94	1.42	98.94	1.65	0.19	100.00	0.40
MCK231, KY	100.00	1.23	100.00	1.64	0.19	100.00	0.56
MKG113, PA	100.00	0.54	100.00	0.48	0.05	100.00	0.13
OXF122, OH	100.00	1.60	98.95	2.15	0.24	98.95	0.83
PAL190, TX	100.00	1.16	100.00	1.52	0.20	100.00	0.27
PAR107, WV	100.00	0.85	98.82	1.18	0.30	100.00	0.54
PED108, VA	98.95	3.59	97.89	3.76	0.20	100.00	0.31
PND165, WY	100.00	1.20	100.00	2.45	0.11	100.00	0.60
PNF126, NC	100.00	1.62	100.00	1.88	0.12	100.00	0.25
PRK134, WI	100.00	1.42	100.00	1.10	0.22	100.00	0.44
PSU106, PA	100.00	2.80	100.00	3.10	0.10	100.00	0.21
QAK172, OH	100.00	0.99	100.00	0.57	0.13	100.00	0.22
ROM206, CO	100.00	1.03	100.00	1.21	0.17	100.00	0.19
SAL133, IN	100.00	0.83	100.00	0.99	0.13	100.00	0.21
SAN189, NE	100.00	0.47	100.00	0.43	0.06	100.00	0.10
SND152, AL	100.00	1.69	100.00	2.10	0.16	100.00	0.36
SPD111, TN	100.00	0.63	100.00	0.82	0.14	100.00	0.24
STK138, IL	78.85	8.12	79.81	5.85	2.08	86.54	2.05
SUM156, FL	100.00	1.11	98.84	1.31	0.26	100.00	0.43
UVL124, MI	100.00	0.87	100.00	0.93	0.07	100.00	0.12
VIN140, IN	100.00	0.40	100.00	0.51	0.07	100.00	0.30
VPI120, VA	100.00	0.66	100.00	0.86	0.08	100.00	0.32
WSP144, NJ	100.00	1.08	100.00	0.95	0.13	98.90	0.64
WST109, NH	100.00	0.37	100.00	0.47	0.08	100.00	0.16

**Notes:** <sup>1</sup> Percentage of comparisons that pass the criteria listed in Table 5. Values falling below 90 percent are addressed in Table 15.

<sup>2</sup> Absolute value of the average percent differences between the on-site transfer standard and the site monitor. Values exceeding the criteria listed in Table 5 are addressed in Table 15.

<sup>3</sup> 90 percent confidence limit of the coefficient of variation. This should be less than or equal to the 7 percent single point QC check critical criterion. Values exceeding this criterion are addressed in Table 15.

%D = percent difference

CL = confidence limit

ppb = parts per billion

**Table 15** Ozone QC Observations for Fourth Quarter 2015

Site ID	QC Criterion	Comments
GAS153, GA	% Single Point QC Pass	The sample pump failed in late December. Associated data will be invalidated.
STK138, IL	% Span Pass Span  %D   % Single Point QC Pass % Zero Pass	There was a leak in the sampling system in early October. Associated data were invalidated.

**Notes:** %D = percent difference

**Table 16** Trace-level Gas QC Summary for Fourth Quarter 2015

Parameter	% Span Pass <sup>1</sup>	Span  %D  <sup>2</sup>	% Single Point QC Pass <sup>1</sup>	Single Point QC  %D  <sup>2</sup>	Single Point QC CL <sup>3</sup>	% Zero Pass <sup>1</sup>	Zero Average (ppb) <sup>2</sup>
<b>BEL116, MD</b>							
SO <sub>2</sub>	97.30	3.26	94.59	3.39	1.13	100.00	0.50
NO <sub>y</sub>	92.50	5.77	95.00	5.13	0.83	97.56	2.26
<b>BVL130, IL</b>							
SO <sub>2</sub>	90.20	6.79	88.24	28.03	21.60	88.24	8.25
NO <sub>y</sub>	100.00	2.59	100.00	2.38	0.43	97.87	0.57
CO	97.73	3.25	79.55	10.71	4.56	90.70	14.11
<b>HWF187, NY</b>							
NO <sub>y</sub>	100.00	1.41	100.00	2.18	0.36	98.00	0.71
<b>PND165, WY</b>							
NO <sub>y</sub>	97.92	4.28	97.96	6.77	3.59	100.00	0.25
<b>PNF126, NC</b>							
NO <sub>y</sub>	100.00	5.18	97.73	5.95	0.51	100.00	0.34
<b>ROM206, CO</b>							
NO <sub>y</sub>	100.00	1.53	100.00	2.27	0.38	97.87	0.59

**Notes:** <sup>1</sup> Percentage of comparisons that pass the criteria listed in Table 6. Values falling below 90 percent are addressed in Table 17.

<sup>2</sup> Absolute value of the average percent differences between the supplied and observed concentrations. Values exceeding the criteria listed in Table 6 are addressed in Table 17.

<sup>3</sup> 90 percent confidence limit of the coefficient of variation. This should be less than or equal to the 10 percent single point QC check critical criterion. Values exceeding this criterion are addressed in Table 17.

%D = percent difference

CL = confidence limit

ppb = parts per billion

**Table 17** Trace-level Gas QC Observations for Fourth Quarter 2015

Site ID	Parameter	QC Criterion	Comments
BVL130, IL	SO <sub>2</sub>	% Single Point QC Pass Single Point QC  %D  Single Point QC CL % Zero Pass Zero Average	The analyzer malfunctioned in November. Associated data were invalidated.
BVL130, IL	CO	% Single Point QC Pass Single Point QC  %D	The sample pump failed in November. Associated data were invalidated.

**Notes:** %D = percent difference

CL = confidence limit

**Table 18** Summary of Filter Blanks for 2015 (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	414	0	0.500	0.000	0.500
Teflon- NO <sub>3</sub> <sup>-</sup> -N	0.200	414	4	0.200	0.001	0.288
Teflon- SO <sub>4</sub> <sup>2-</sup>	1.000	414	0	1.000	0.000	1.000
Cl <sup>-</sup>	0.500	414	2	0.502	0.003	1.178
Ca <sup>2+</sup>	0.150	414	7	0.151	0.003	0.453
Mg <sup>2+</sup>	0.075	414	1	0.075	0.000	0.078
Na <sup>+</sup>	0.125	414	3	0.126	0.002	0.525
K <sup>+</sup>	0.150	414	3	0.172	0.044	8.680
Nylon- NO <sub>3</sub> <sup>-</sup> -N	0.200	440	0	0.200	0.000	0.200
Nylon - SO <sub>4</sub> <sup>2-</sup>	1.000	414	0	1.000	0.000	1.000
Cellulose - SO <sub>4</sub> <sup>2-</sup>	2.000	414	44	2.124	0.223	9.295
<b>LABORATORY BLANKS</b>						
Teflon-NH <sub>4</sub> <sup>+</sup> -N	0.500	102	0	0.500	0.000	0.500
Teflon- NO <sub>3</sub> <sup>-</sup> -N	0.200	102	0	0.200	0.000	0.200
Teflon- SO <sub>4</sub> <sup>2-</sup>	1.000	102	0	1.000	0.000	1.000
Cl <sup>-</sup>	0.500	102	0	0.500	0.000	0.500
Ca <sup>2+</sup>	0.150	102	0	0.150	0.000	0.150
Mg <sup>2+</sup>	0.075	102	0	0.075	0.000	0.075
Na <sup>+</sup>	0.125	102	0	0.125	0.000	0.125
K <sup>+</sup>	0.150	102	0	0.150	0.000	0.150
Nylon- NO <sub>3</sub> <sup>-</sup> -N	0.200	102	0	0.200	0.000	0.200
Nylon -SO <sub>4</sub> <sup>2-</sup>	1.000	102	0	1.000	0.000	1.000
Cellulose -SO <sub>4</sub> <sup>2-</sup>	2.000	102	1	2.016	0.032	3.660
<b>METHOD BLANKS</b>						
Teflon-NH <sub>4</sub> <sup>+</sup> -N	0.500	70	0	0.500	0.000	0.500
Teflon- NO <sub>3</sub> <sup>-</sup> -N	0.200	70	0	0.500	0.000	0.200
Teflon- SO <sub>4</sub> <sup>2-</sup>	1.000	70	0	0.500	0.000	1.000
Cl <sup>-</sup>	0.500	70	0	0.500	0.000	0.500
Ca <sup>2+</sup>	0.150	71	0	0.493	0.000	0.150
Mg <sup>2+</sup>	0.075	71	0	0.493	0.000	0.075
Na <sup>+</sup>	0.125	71	0	0.493	0.000	0.125
K <sup>+</sup>	0.150	71	0	0.493	0.000	0.150
Nylon- NO <sub>3</sub> <sup>-</sup> -N	0.200	98	0	0.357	0.000	0.200
Nylon -SO <sub>4</sub> <sup>2-</sup>	1.000	72	0	0.486	0.000	1.000
Cellulose -SO <sub>4</sub> <sup>2-</sup>	2.000	69	0	0.507	0.000	2.000

**Table 18** Summary of Filter Blanks for 2015 (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	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	0	0.150	0.000	0.150
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	1	0.161	0.022	2.486
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	0	1.000	0.000	1.000
Cellulose -SO <sub>4</sub> <sup>2-</sup>	2.000	270	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 19** Filter Packs Flagged as Suspect or Invalid

Site ID	Sample	Reason
<b>First Quarter 2015</b>		
ALC188, TX	1502001-03	Potassium data suspect and flagged as invalid.
CAN407, UT	1505001-14	Insufficient flow volume
CDR119, WV	1503001-16	Concentration data suspect and flagged as invalid.
CDZ171, KY	1507001-17	Insufficient flow volume
GRS420, TN	1502001-36	Concentration data suspect and flagged as invalid.
KIC003, KS	1503001-44	Insufficient flow volume
LAV410, CA	1506001-46	Flow system malfunctioned
LRL117, PA	1502001-47 1503001-47 1505001-47	Concentration data suspect and flagged as invalid.
<b>Second Quarter 2015</b>		
BUF603, WY	1517003-02	Insufficient flow volume
FOR605, WY	1518003-03	Insufficient flow volume
GLR468, MT	1518001-33	Insufficient flow volume
HWF187, NY	1517001-40	Insufficient flow volume
IRL141, FL	1516001-41	Insufficient flow volume
JOT403, CA	1518001-42	Insufficient flow volume
KIC003, KS	1519001-44	Insufficient flow volume
MCK231, KY	1515001-50	Potassium data invalidated
PND165, WY	1520001-60	Insufficient flow volume
ROM206, CO	1520001-66	Insufficient flow volume
STK138, IL	1520001-74	Insufficient flow volume

Site ID	Sample	Reason
<b>Third Quarter 2015</b>		
BEL116, MD	1533001-09	Insufficient flow volume
CAD150, AR	1530001-13	Insufficient flow volume
DCP114, OH	1537001-26	Power failure resulted in insufficient flow volume
FOR605, WY	1531003-03	Insufficient flow volume
JOT403, CA	1531001-42	Insufficient flow volume
PNF126, NC	1531001-61	Power failure resulted in insufficient flow volume
PSU106, PA	1536001-63	Insufficient flow volume
SHN418, VA	1536001-71	Insufficient flow volume
VIN140, IN	1536001-80	Insufficient flow volume
<b>Fourth Quarter 2015</b>		
CNT169, WY	1545001-22 1546001-22	Insufficient flow volume
DCP114, OH	1546001-26 1548001-26 1549001-26	Insufficient flow volume
DIN431, UT	1541001-28 1543001-28 1544001-28	Insufficient flow volume
FOR605, WY	1544003-03	Insufficient flow volume
GRS420, TN	1541001-36 1542001-36	Insufficient flow volume
JOT403, CA	1544001-42	Insufficient flow volume
PAL190, TX	1548001-55	Insufficient flow volume
PND165, WY	1548001-60	Insufficient flow volume
WFM007, NY	1541001-83 1542001-83	Suspect data
YEL408, WY	1541001-88	Insufficient flow volume
YOS404, CA	1548001-89	Insufficient flow volume

**Table 20** Field Problems Affecting Data Collection

<b>Days to Resolution</b>	<b>Problem Count</b>
<b>First Quarter 2015</b>	
30	230
60	8
90	3
Unresolved by End of Quarter	10
<b>Second Quarter 2015</b>	
30	230
60	5
90	1
Unresolved by End of Quarter	33
<b>Third Quarter 2015</b>	
30	337
60	15
90	3
Unresolved by End of Quarter	24
<b>Fourth Quarter 2015</b>	
30	228
60	11
90	0
Unresolved by Date of Publication	13

**Table 21** Field Calibration Failures by Parameter for 2015

Site ID	Parameter(s)
<b>First Quarter 2015</b>	
BVL130, IL	Flow Rate Temperature Wind Direction
CHE185, OK	Solar Radiation
CKT136, KY	Temperature
CTH110, NY	Flow Rate
<b>Second Quarter 2015</b>	
PAL190, TX	Solar Radiation
<b>Third Quarter 2015</b>	
BEL116, MD	Wind Direction
CAD150, AR	Flow Rate
<b>Fourth Quarter 2015</b>	
ABT147, CT	Flow Rate

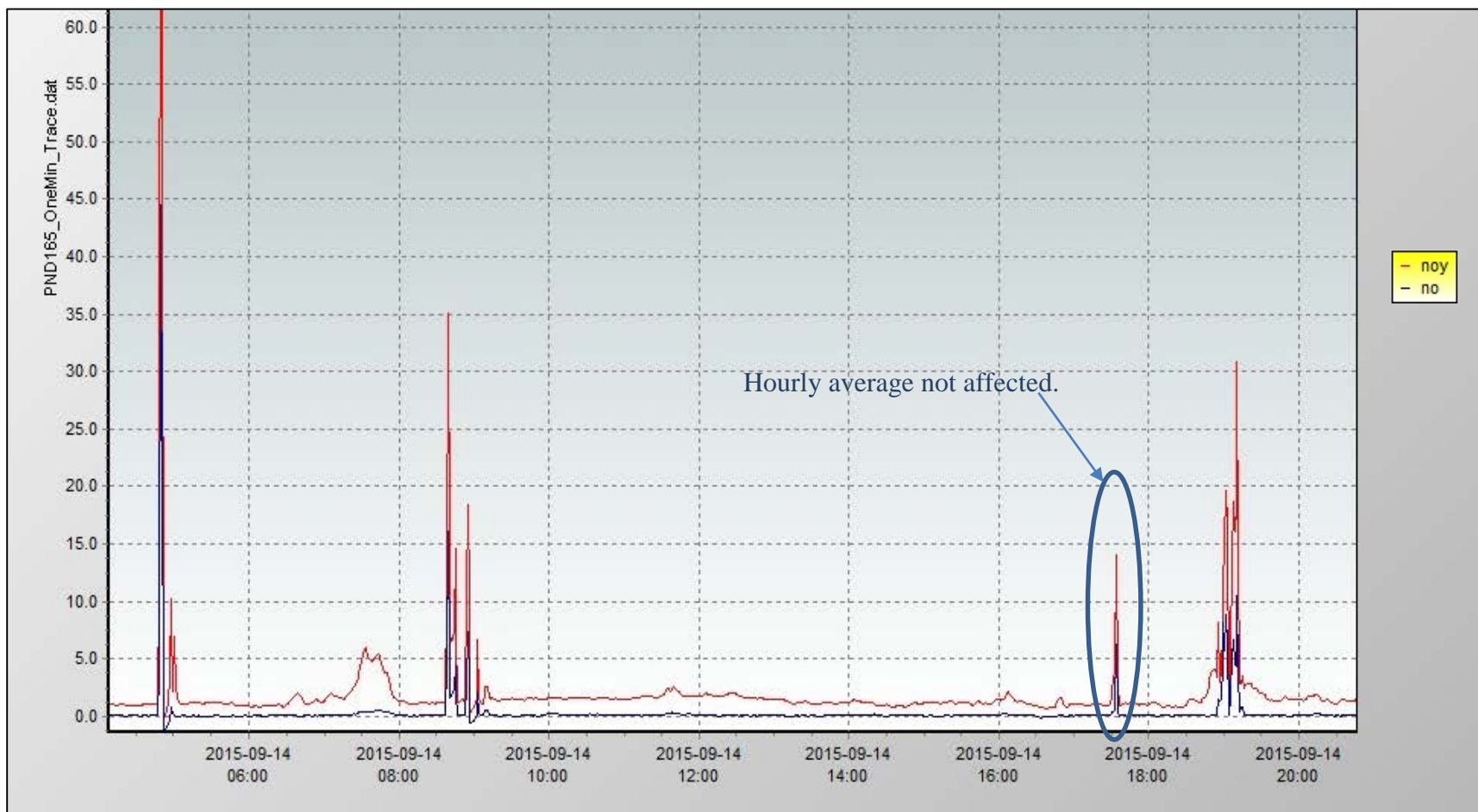
**Note:** Per CASTNET project protocols, data for all parameters except flow are flagged as “suspect” (S) but still considered valid if the calibration criterion is not exceeded by more than its magnitude (i.e., if within 2x the criterion). If flow calibrations fall within 2x the criterion, these data are adjusted per approved protocol described in the CASTNET QAPP, (Amec Foster Wheeler, 2014). Please refer to Table 14 for documentation of the QC failures affecting the validity of ozone data.

**Table 22** Accuracy Results for 2015 Field Measurements

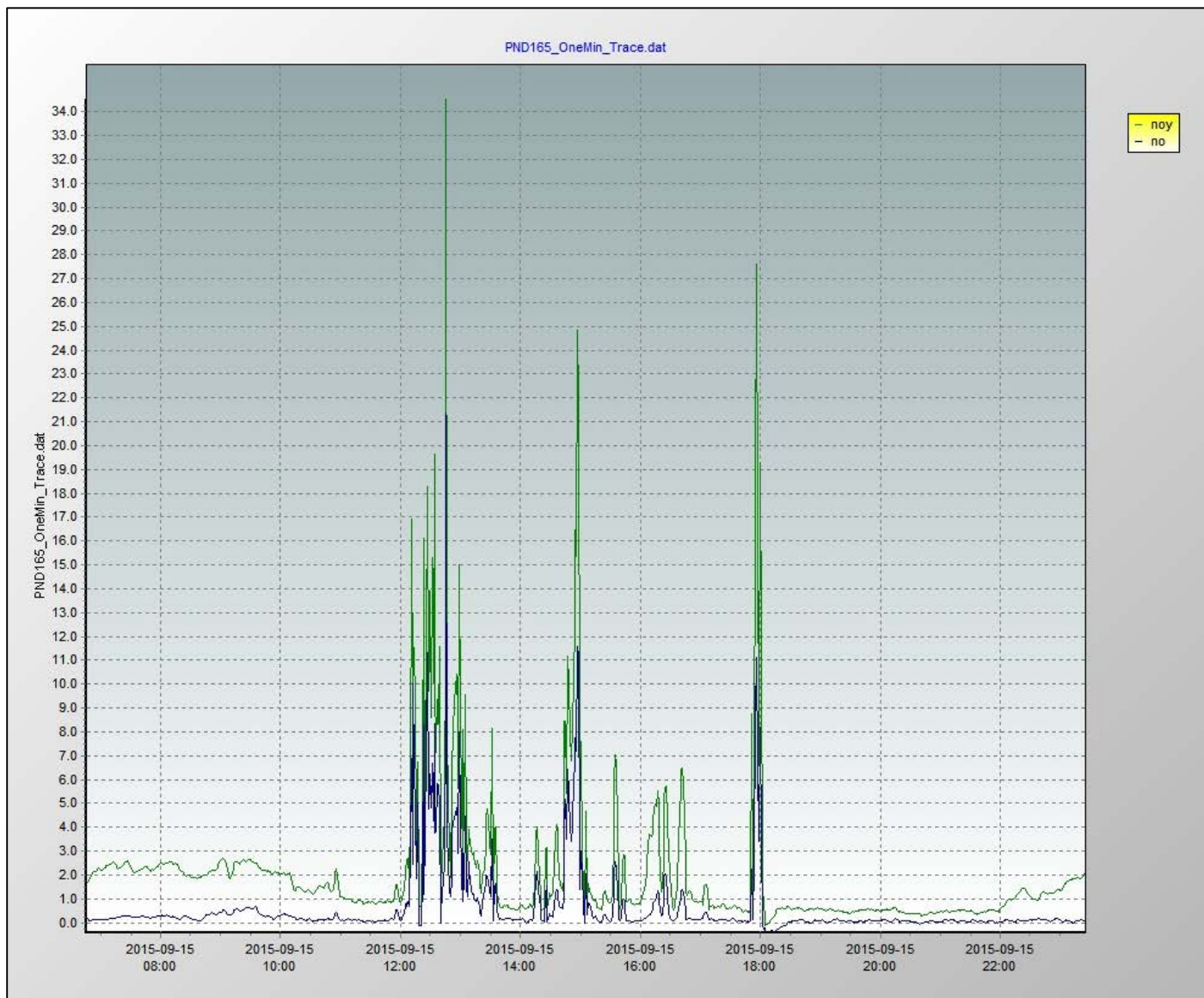
Parameter	Percent Within Criterion
Flow Rate	96.8
Wind Speed < 5 m/s	100.0
Wind Speed ≥ 5 m/s	100.0
Wind Direction North	90.9
Wind Direction South	90.9
Temperature (0°C)	99.2
Temperature (ambient)	98.4
Delta Temperature (0°C)	100.0
Delta Temperature (ambient)	100.0
Relative Humidity	100.0
Precipitation	100.0
Solar Radiation*	81.8
Wetness (within 0.5 volts)	100.0

**Notes:** °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). All calibration failures reported in 2015 for the indicated parameters were within 2x the criterion with the exception of solar radiation at PAL190, TX. Associated data were invalidated.

**Figure 1** PND165, WY 1-Minute Trace-level Gas Data (ppb) – September 14, 2015

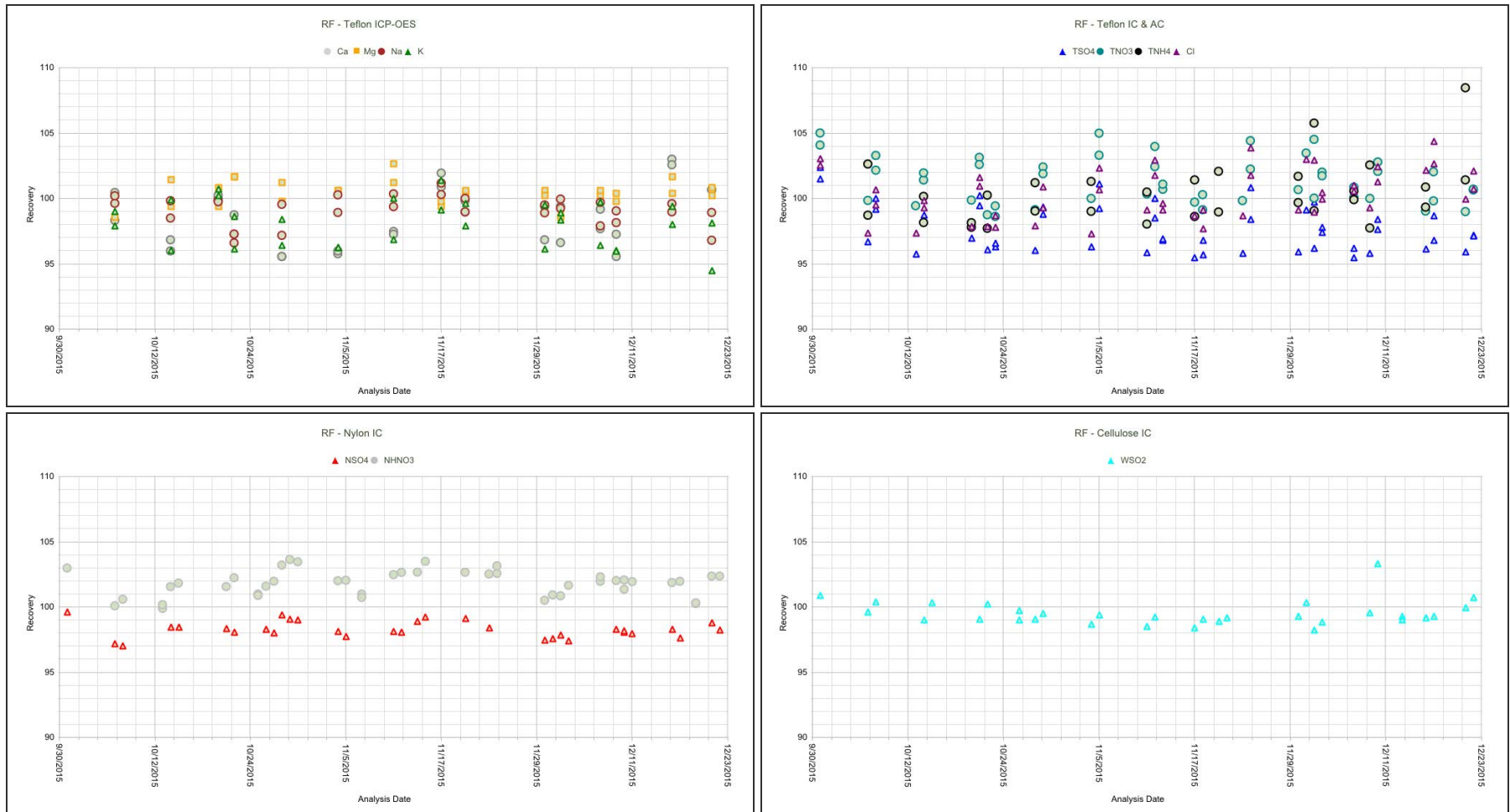


**Figure 2** PND165, WY 1-Minute Trace-level Gas Data (ppb) – September 15, 2015

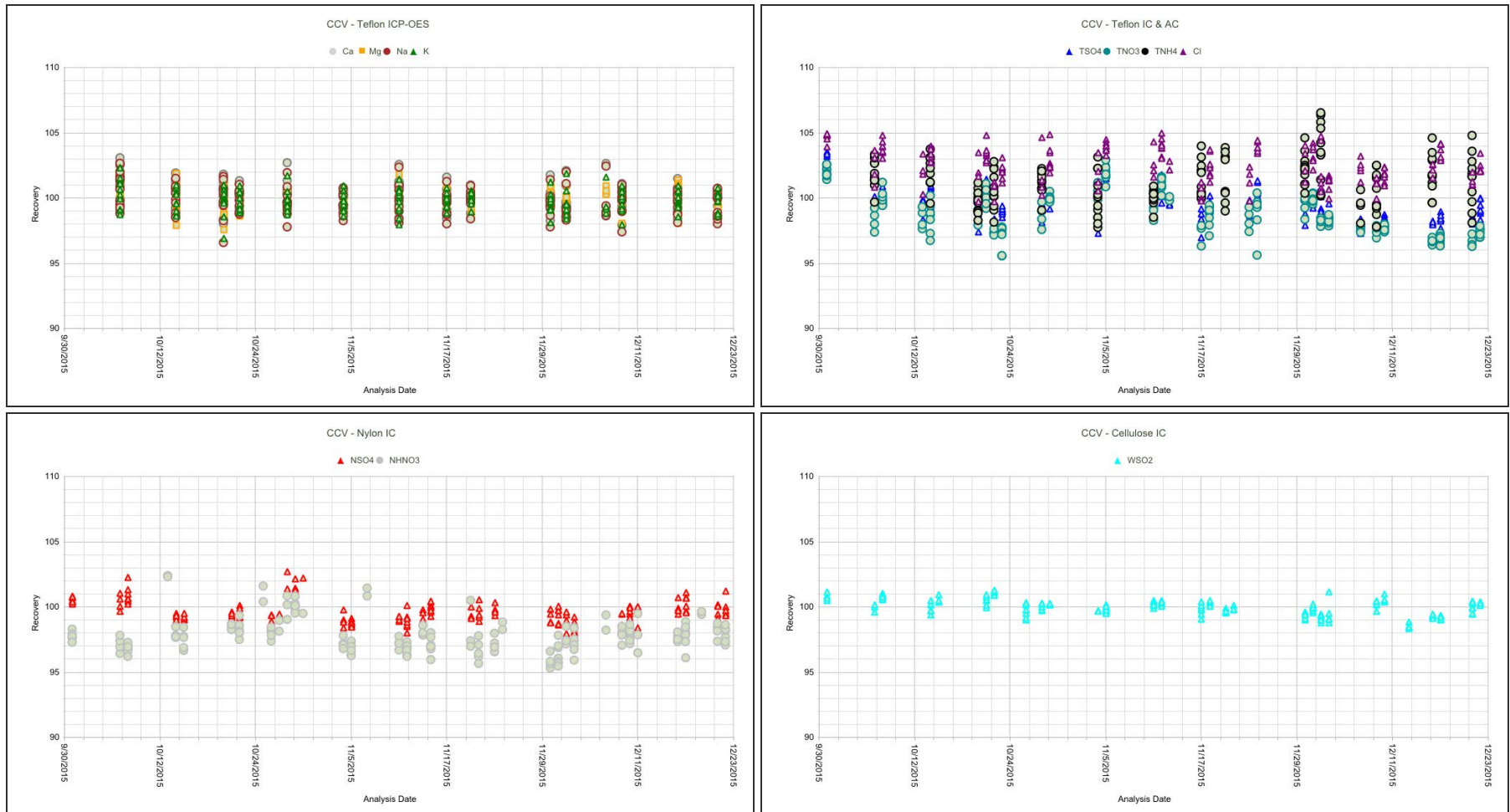




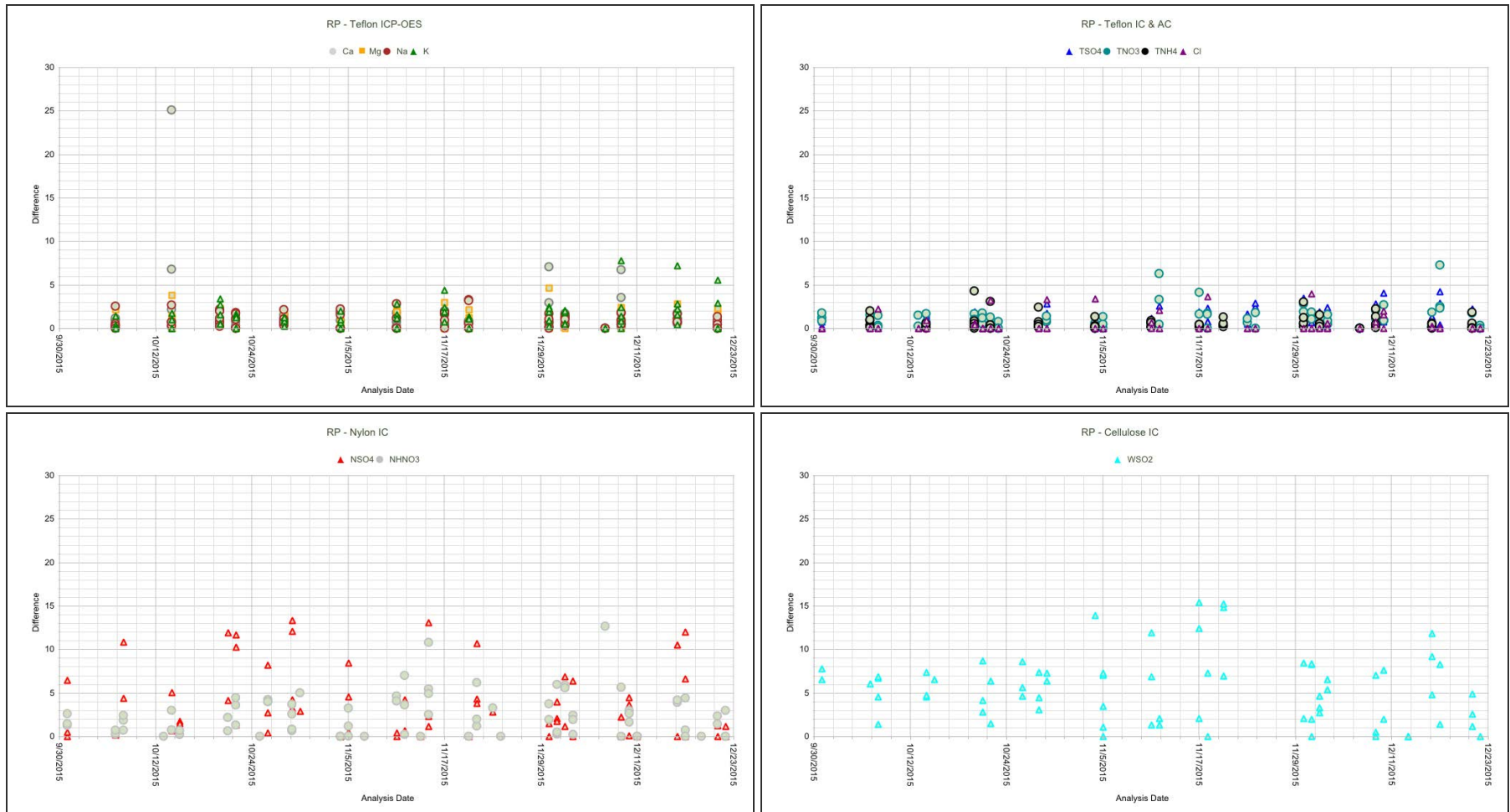
**Figure 3** Reference Standard Results for Fourth Quarter 2015 (percent recovery)



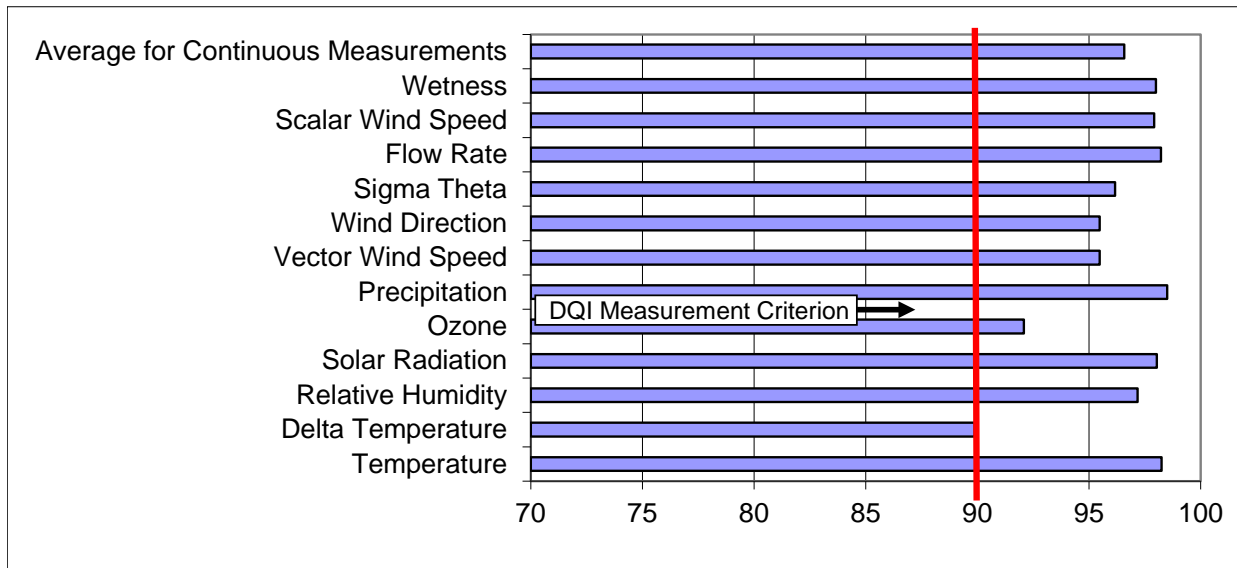
**Figure 4** Continuing Calibration Spike Results for Fourth Quarter 2015 (percent recovery)



**Figure 5** Replicate Sample Analysis Results for Fourth Quarter 2015 (percent difference)

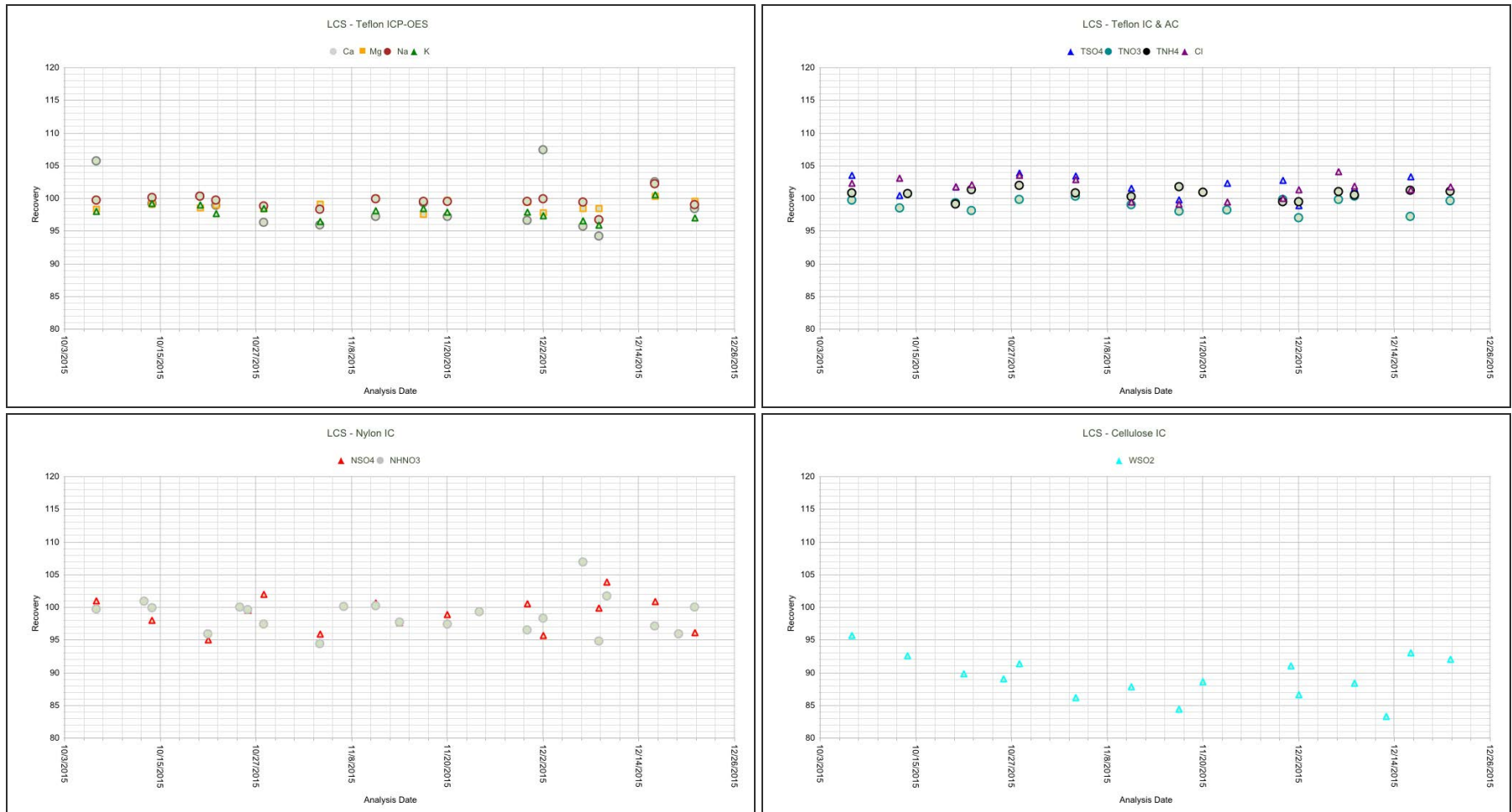


**Figure 6** Percent Completeness of Measurements for Second Quarter 2014 through Third Quarter 2015\*

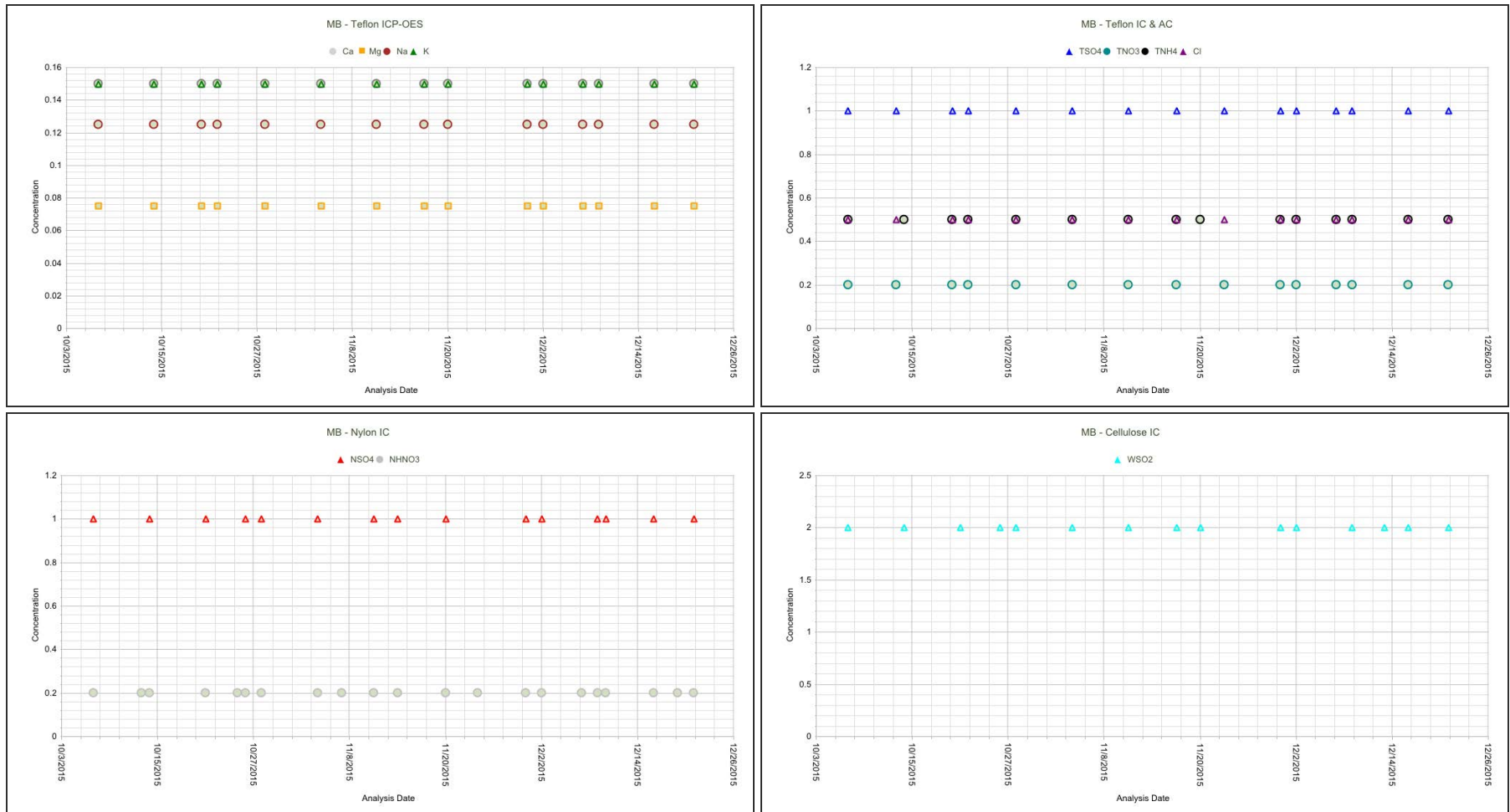


**Note:** \*Presents Level 3 data available during the fourth quarter of 2015

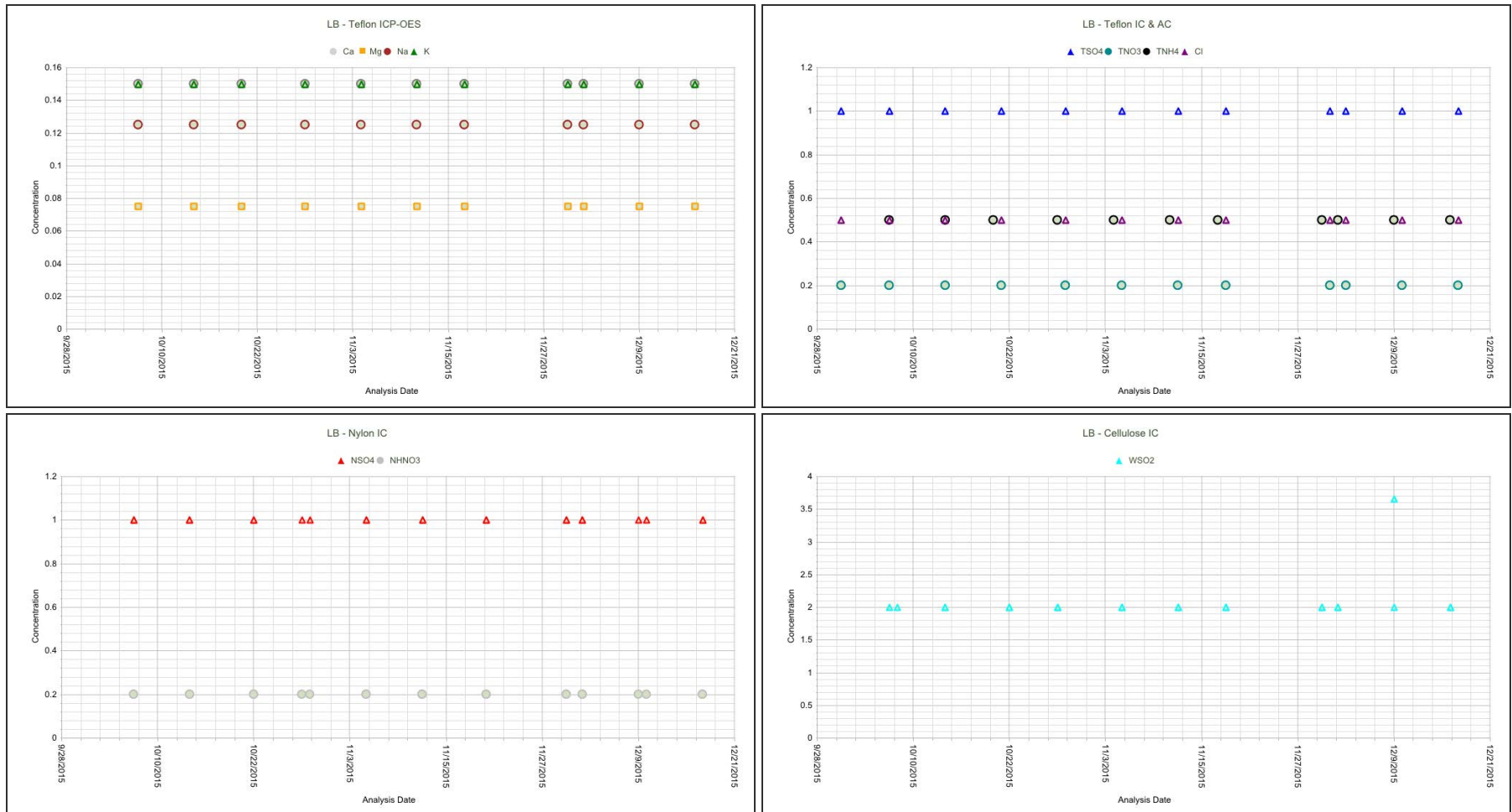
**Figure 7** Laboratory Control Sample Results for Fourth Quarter 2015 (percent recovery)



**Figure 8** Method Blank Analysis Results for Fourth Quarter 2015 (total micrograms)



**Figure 9** Laboratory Blank Analysis Results for Fourth Quarter 2015 (total micrograms)





**Figure 10** Field Blank Analysis Results for Fourth Quarter 2015 (total micrograms)

