U.S. EPA Ambient Air Protocol Gas Verification Program

Annual Report for Calendar Year 2018

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Annual Report for Calendar Year 2018

U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
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Acronyms and Abbreviations

AA-PGVP	Ambient Air Protocol Gas Verification Program
AMTIC	Ambient Monitoring Technology Information Center
AQS	Air Quality System
CFR	Code of Federal Regulations
EPA	Environmental Protection Agency
GMIS	Gas Manufacturer's Internal Standard
MQO	measurement quality objective
NIST	National Institute of Standards and Technology
NTRM	NIST Traceable Reference Material
OAQPS	Office of Air Quality Planning and Standards
OAR	Office of Air and Radiation
OIG	Office of the Inspector General
ORD	Office of Research and Development
PQAO	primary quality assurance organization
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RAVL	Regional Analytical Verification Laboratory
RPD	relative percent difference
SOP	standard operating procedure
SRM	standard reference material

1.0 Introduction

Background and Program Goals

The basic principles of the U.S. Environmental Protection Agency's (EPA) *Traceability Protocol for the Assay and Certification of Gaseous Calibration Standards* (EPA, 1997)[1] were developed jointly by EPA, the National Bureau of Standards (now National Institute of Standards and Technology [NIST]), and specialty gas producers over 30 years ago. At the time, commercially prepared calibration gases were perceived as being too inaccurate and too unstable for use in calibrations and audits of continuous source emission monitors and ambient air quality monitors[2]. The protocol was developed to improve the quality of the gases by establishing their traceability to NIST Standard Reference Materials (SRMs) and to provide reasonably priced products. This protocol established the gas metrological procedures for measurement and certification of these calibration gases for EPA's Acid Rain Program under 40 Code of Federal Regulations (CFR) Part 75, for the Ambient Air Quality Monitoring Program under 40 CFR Part 58, and for the Source Testing Program under 40 CFR Parts 60, 61, and 68. EPA required monitoring organizations implementing these programs ("the regulated community") to use EPA Protocol Gases as their calibration gases. EPA revised the protocol to establish detailed statistical procedures for estimating the total uncertainty of these gases. EPA's Acid Rain Program developed acceptance criteria for the uncertainty estimate[3].

Specialty gas producers prepare and analyze EPA Protocol Gases without direct governmental oversight. In the 1980s and 1990s, EPA conducted a series of EPA-funded accuracy assessments of EPA Protocol Gases sold by producers. The intent of these audits was to:

- increase the acceptance and use of EPA Protocol Gases as calibration gases;
- provide a quality assurance (QA) check for the producers of these gases; and
- help users identify producers who can consistently provide accurately certified gases.

Either directly or through third parties, EPA procured EPA Protocol Gases from the producers, assessed the accuracy of the gases' certified concentrations through independent analyses, and inspected the accompanying certificates of analysis for completeness and accuracy. The producers were not aware that EPA had procured the gases for these audits.

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[1] EPA-600/4-77-027b

[2] Decker, C.E. et al., 1981. "Analysis of Commercial Cylinder Gases of Nitric Oxide, Sulfur Dioxide, and Carbon Monoxide at Source Concentrations," *Proceedings of the APCA Specialty Conference on Continuous Emission Monitoring-Design, Operation, and Experience*, APCA Publication No. SP-43.

[3] "Continuous Emission Monitoring," *Code of Federal Regulations,* Title 40, Part 75

The accuracy of the EPA Protocol Gases' certified concentrations was assessed using SRMs as the analytical reference standards. If the difference between the audit's measured concentration and the producer's certified concentration was more than ±2.0 percent or if the documentation was incomplete or inaccurate, EPA notified the producer to resolve and correct the problem.

The results of the accuracy assessments were published in peer-reviewed journals and were posted on EPA's Technology Transfer Network website. The accuracy assessments were discontinued in 1998.

In 2009, the Office of the Inspector General (OIG) published the report *EPA Needs an Oversight Program for Protocol Gases*[4]. One of the report's findings suggested that EPA "does not have reasonable assurance that the gases that are used to calibrate emissions monitors for the Acid Rain Program and continuous ambient monitors for the nation's air monitoring network are accurate". OIG recommended that the Office of Air and Radiation (OAR) implement oversight programs to assure the quality of the EPA Protocol Gases that are used to calibrate these monitors. It also recommended that EPA's Office of Research and Development (ORD) update and maintain the document *Traceability Protocol for Assay and Certification of Gaseous Calibration Standards* to ensure that the monitoring programs' objectives are met.

In order to address the OIG findings for ambient air monitoring, the Office of Air Quality Planning and Standards (OAQPS), in cooperation with EPA Regions 2 and 7, developed an Ambient Air Protocol Gas Verification Program (AA-PGVP). The program establishes gas metrology laboratories in Regions 2 and 7 to verify the certified concentrations of EPA Protocol Gases used to calibrate ambient air quality monitors. The program is expected to ensure that producers selling EPA Protocol Gases participate in the AA-PGVP and provides end users with information about participating producers and verification results.

The EPA Ambient Air Quality Monitoring Program's QA requirements, as described in Section 2.6.1 of 40 CFR Part 58, Appendix A, include:

> *"Gaseous pollutant concentration standards (permeation devices or cylinders of compressed gas) used to obtain test concentrations for CO, SO2, NO, and NO2 must be traceable to either a National Institute of Standards and Technology (NIST) Traceable Reference Material (NTRM) or a NIST-certified Gas Manufacturer's Internal Standard (GMIS), certified in accordance with one of the procedures given in reference 4 of this appendix. Vendors advertising certification with the procedures provided in reference 4 of this appendix and distributing gases as "EPA Protocol Gas" for ambient air monitoring purposes must participate in the EPA Ambient Air Protocol Gas Verification Program or not use "EPA" in any form of advertising. Monitoring organizations must provide information to the EPA on the gas producers they use on an annual basis and those PQAOs purchasing standards will be obligated, at the request of the EPA, to participate in the program at least once every 5 years by sending a new unused standard to a designated verification laboratory."*

[4] https://www.epa.gov/office-inspector-general/report-epa-needs-oversight-program-protocol-gases-09-P-0235.pdf

This program is considered a verification program because its current level of evaluation does not allow for a large enough sample of EPA Protocol Gases from any one specialty gas producer to yield a statistically rigorous assessment of the accuracy of the producer's gases. It will not provide end users with a scientifically defensible estimate of whether gases of acceptable quality can be purchased from a specific producer. Rather, the results provide information to end users that the specialty gas producer is participating in the program and with information that may be helpful when selecting a producer.

Purpose of This Document

The purpose of this document is to report the activities that occurred in 2018 and provide the results of the verifications performed.

This document will not explain the implementation of the AA-PGVP, the quality system or the verification procedure. That information has been documented in the Implementation Plan, Quality Assurance Project Plan (QAPP) and standard operating procedures (SOPs) that can be found on the AA-PGVP Web Page on the Ambient Monitoring Technology Information Center (AMTIC)[5].

[5] http://www.epa.gov/ttn/amtic/aapgvp.html

2.0 Implementation Summary

Since program implementation started in 2010, when most of the initial preparation work took place, no major "new" implementation activities took place in 2018. The following provides a brief explanation of the 2018 implementation process.

Producer Information Data Collection – In 2010 EPA sent out an Excel spreadsheet to each monitoring organization to obtain information on the gas standard producers being used by the monitoring organization and to determine their interest in participating in the program. In 2011, EPA worked with Research Triangle Institute to develop a web-based survey that one point of contact for each monitoring organization could access. This made recording and evaluation of the survey information much easier for the monitoring organizations and EPA. Based on the information obtained from monitoring organization surveys, EPA developed a list of the specialty gas producers being used by the monitoring organizations. From this list, EPA identified at least one point of contact for each producer.

AA-PGVP Verification Dates – OAQPS worked with the Region 2 and 7 Regional Analytical Verification Laboratories (RAVLs) to establish verification dates as indicated in Table 1. The dates were posted on the AMTIC website[6]. Monitoring organizations would contact the Regions to schedule cylinder verifications.

Table 1. RAVL Verification Dates

Quarter	Region 2		Region 7	
	Cylinder Receipt	Analysis	Cylinder Receipt	Analysis
1	TBD[1]	TBD	No later than Feb 27	Feb 26 – Mar 9
2	TBD	TBD	No later than May 25	June 4 – June 15
3	TBD	TBD	No later than Aug 31	Sept 10 – Sept 21
4	TBD	TBD	No later than Nov 16	Nov 26 – Dec 7
Open House	TBD		December 12, 2018	

[1] TBD – to be determined

RAVL Open House – Based on the information gained from monitoring organization surveys, EPA contacted the producers by e-mail to invite them to visit the RAVLs. The Region 7 open house was held on December 12, 2018. Two cylinders were analyzed in the Region 2 open house in 2018.

[6] http://www.epa.gov/ttn/amtic/aapgvp.html

Flow of the AA-PGVP

Figure 1 provides a flow diagram of the implementation activities of the AA-PGVP. The major activities in these steps are explained below. More details of these steps are found in the AA-PGVP Implementation Plan, QAPP and SOPs.

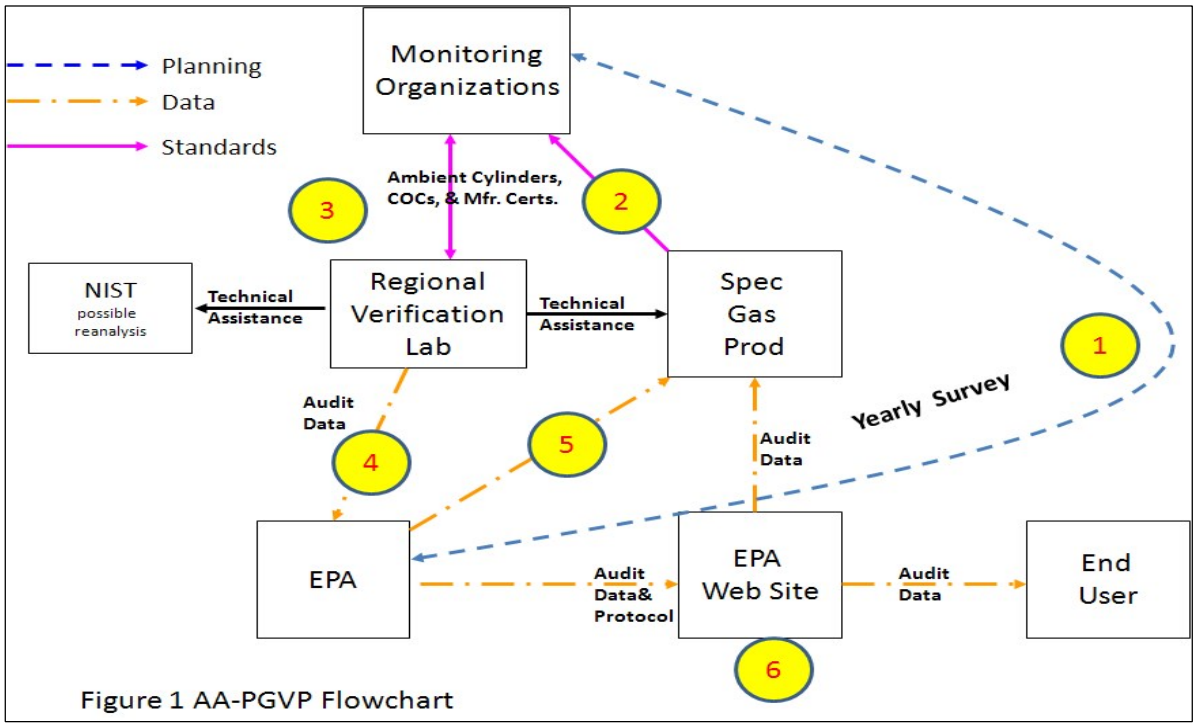

Figure 1. AA-PGVP Flow Chart

1. EPA sends e-mails to the monitoring organization's points of contact to complete the AA-PGVP Survey. EPA compiles information on specialty gas producers and the monitoring organizations that plan to participate. EPA tries to schedule the monitoring organization in an appropriate verification quarter based on delivery of standards from the specialty gas producer.

2. The monitoring organizations order gas standards from specialty gas producers during the normal course of business. If EPA cannot get a cylinder from the monitoring organization, and that producer is being used, EPA will invite the producer to send a cylinder directly to an RAVL.

3. The monitoring organizations send a new/unused standard, specialty gas certification and chain of custody form to the RAVLs.

4. The RAVLs analyze the cylinders and provide the validated results to OAQPS and the monitoring organizations.

5. OAQPS reviews the data and sends verification results to the specialty gas vendors.

6. At the end of the year, OAQPS compiles final results into a report, sends the report out to the specialty gas vendors and posts it on the AA-PGVP AMTIC web page.

3.0 Survey and Verification Results

Monitoring Organization Survey

Based upon the maximum capability of 40 gas cylinders per RAVL per year, the AA-PGVP selection goal, in the following order, is:

1) At least one gas standard from every specialty gas producer being used by the monitoring community.

2) If all specialty gas producers have been assessed at least once, then attempt to verify three standards per specialty gas producer.

3) If all specialty gas producers have been assessed three times, weigh additional verifications by producer market share in the ambient air monitoring community.

In order to determine what specialty gas producers were being used by monitoring organizations, EPA asked each monitoring organization to complete a web-based survey. Participation in 2018 slightly decreased in comparison to 2017; EPA received surveys from 57 out of a possible 162 monitoring organizations. Although these 57 reporting organizations participated in the web-based survey, only 17 cylinders were submitted from 10 monitoring organizations and primary quality assurance organizations (PQAO) for verification in 2018.

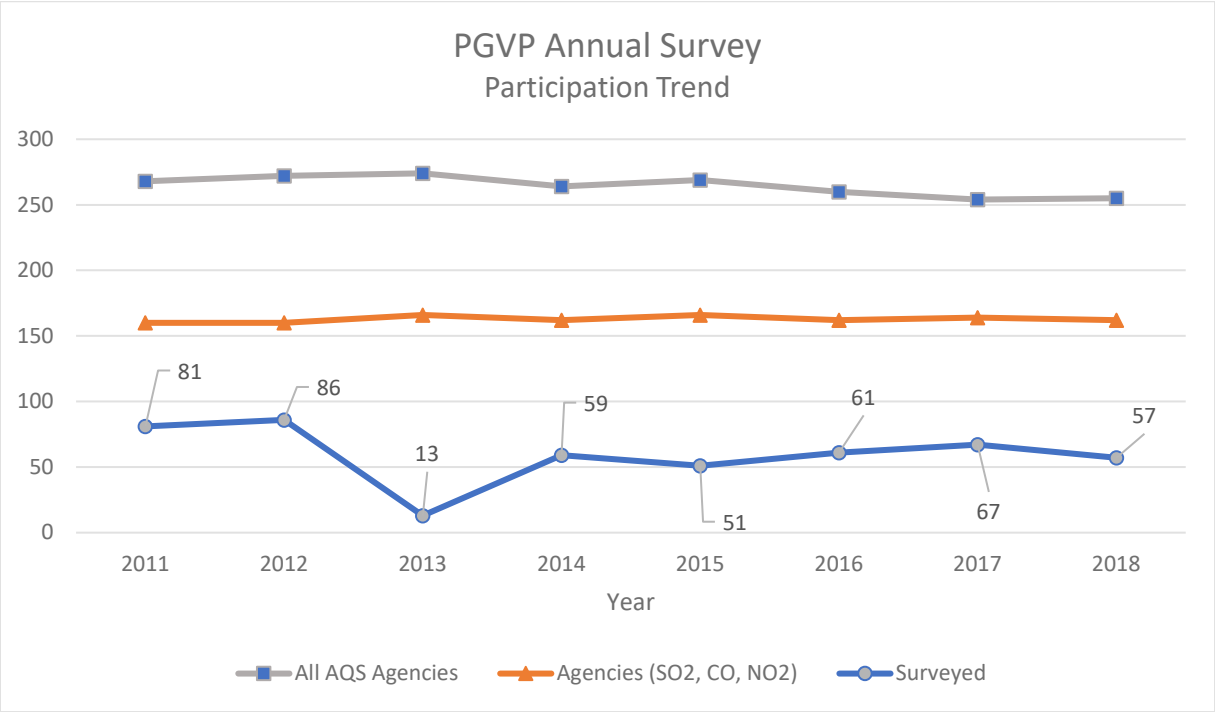

FIGURE 2. ANNUAL SURVEY PARTICIPATION TREND

Survey Results

Figure 3 identifies, as a percentage of the total responses, the fraction of the ambient air monitoring network supported by quality assurance/quality control (QA/QC) standards from a particular specialty gas producer. The responses for the 2018 annual survey included 18% of the agencies reporting that they were using or intended to use Scott-Marrin protocol gas cylinders in 2018. PraxaIr acquired Scott-Marrin in 2017. No Scott-Marrin protocol gas cylinders were submitted for verification during calendar year 2018. As such, figure 3 combines the surveyed responses for Praxair and Scott-Marrin and presents them singularly as Praxair to reflect this merger. After the merger, Praxair has the largest protocol gas market share for the ambient air monitoring program per our 2018 survey. As mentioned above, only 57 of the 162 monitoring organizations responded, so this cannot be considered a complete survey.

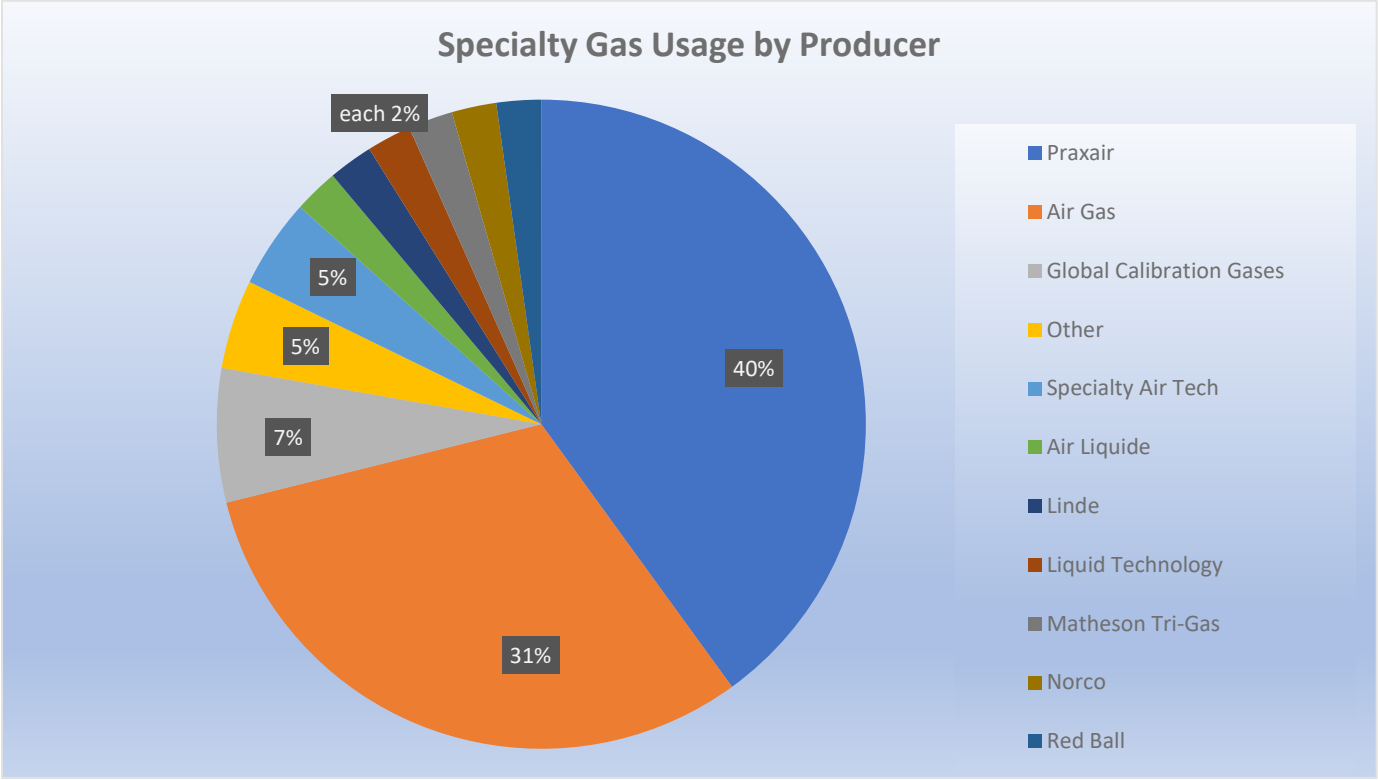

FIGURE 3 SPECIALTY GAS USAGE BY PRODUCER (2018 ANNUAL SURVEY)

Twelve specialty gas producers were identified in the survey. However, some gas producers have more than one production facility and the intent of the AA-PGVP is to attempt to receive one gas cylinder from every production facility being used in the national network. For 2018, of the 19 production facilities identified on the annual survey, 13 were not verified during calendar year 2018.

Participation in the AA-PGVP is mandatory as of 2016. The survey asked whether a monitoring organization was receiving new gas standards during the year and also whether they would like to participate by sending a cylinder to one of the RAVLs. Of the 57 respondents to the annual survey, only 10 PQAOs sent cylinders to EPA for verification. Table 2 lists the cylinders verified in calendar year 2018. Some of these cylinders contained multiple pollutants so there are more verifications than cylinders.

Table 2. Gas Standards Sent to RAVLs in Calendar Year 2018

Qtr	Cylinder ID	Pollutant	Lab	Producer	Facility	Agency
1	CC197754	SO2	7	Air Gas	Chicago, IL	DCHD
1	SA14452	CO, SO2, NO, NOx	7	PraxAir	Los Angeles, CA	Air Resource Specialists
3	LL87181	SO2	7	Air Gas	Chicago, IL	Missouri DNR
3	CC409659	NO, NOx	7	Air Gas	Chicago, IL	Polk County Air Quality
3	FF44751	NO, NOx	7	Air Gas	Chicago, IL	Polk County Air Quality
3	SD12125	CO, NO, NOx	7	Matheson	Twinsburg, OH	SCAQMD
3	SD13764	SO2	7	Matheson	Waverly, NE	KDHE
3	SD14642	NO, NOx	7	Matheson	Waverly, NE	KDHE
3	LL83903	CO, NO, NOx	7	PraxAir	Los Angeles, CA	SCAQMD
3	EB0055421	NO, NOx	7	Red Ball	Shreveport, LA	Cherokee Nation Env. Programs
4	CC459555	CO	7	Air Gas	Chicago, IL	Polk County Air Quality
4	LL167081	NO, NOx	7	Air Gas	Richmond, VA	VA-DEQ
4	CC-230086	CO	7	Linde	Alpha, NJ	City of Albuquerque
4	CC88510	SO2	7	Linde	Alpha, NJ	City of Albuquerque
4	CC88635	NO, NOx	7	Linde	Alpha, NJ	City of Albuquerque
4	EX0012188	SO2	2	PraxAir	Morrisville, PA	NJDEP
4	FF25936	CO	2	PraxAir	Morrisville, PA	NJDEP
4	CC139535	CO	7	PraxAir	Toledo, OH	(Sent by Producer)

Verification Results

As indicated in 40 CFR Part 75 Appendix A, EPA Protocol Gases must have a certified uncertainty (95 percent confidence interval) that must not be greater than plus or minus 2 percent (±2.0%) of the certified concentration (tag value) of the gas mixture. This acceptance criterion is for the Acid Rain Program. The AA-PGVP adopted the criteria as its data quality objective and developed a quality system to allow the RAVLs to determine whether or not an individual protocol gas standard concentration was within ±2% of the certified value. The Ambient Air Program has never identified an acceptance criterion for the protocol gases. Since the AA-PGVP has not been established to provide a statistically rigorous assessment of any specialty gas producer, the RAVLs report all valid results as analyzed, but it is suggested that any difference greater than ±4% is cause for concern. Information related to the analytical reference standards, analytical instruments and methods used, the data reduction procedures and the data assessment procedures are all found in the AA-PGVP QAPP and SOP and are not repeated in this report. Table 3 provides the measurement quality objectives (MQOs) that are included in the AA-PGVP QAPP (Table 7-1 of the QAPP). The acceptance criteria in Table 3 were met for each day of verification. In addition, conformance to these requirements can be found in the measurement data worksheets that are generated for each comparison run and are available upon request. Appendix A provides a report of the quality control (QC) checks associated with each verification run. Table 4 provides the verification results for CO and SO_2, and Table 5 provides the NO_x results.

Table 3. MQOs for the AA-PGVP

Requirement	Frequency	Acceptance Criteria	Protocol Gas Doc. Reference	Comments
Completeness	All standards analyzed	95%		Based on an anticipated 40 cylinders per lab per year.
Quarterly Flow Calibration	Quarterly -no more than 1 mo. before verification	Calibration flow accuracy within ± 1%	2.3.7	Using flow primary standard
Calibrator Dilution Check	Quarterly -within 2 weeks of assay	± 1% RD	2.3.5.1	Second SRM. Three or more discrete measurements
Analyzer Calibration	Quarterly - within 2 weeks of assay	± 1% RPD (each point) Slope 0.89 – 1.02	2.1.7.2	5 points between 50-90% of upper range limit of analyzer + zero point
Zero & Span Verifications	Each day of verification	SE mean ≤ 1% and accuracy ± 5% RD	2.1.7.3, 2.3.5.4	Drift accountability. 3 discrete measurements of zero and span
Precision Test [1]	Day of Verification	± 1% RD standard error of the mean	2.3.5.4	SRM at conc. >80% of analyzer URL
Routine Data Check	Any Standard with Value >2% Tag Value	NA		Sample run three times to verify value.
Lab Comparability	2/year	± 2 % RPD	NA	Sample run three average value used.
Standards Certification				
Primary flow standard	Annually-Certified by NVLAP certified lab	1.0 %	**NA**	Compared to NIST Traceable
NIST SRMs	Expiration date SRM pressure > 150 psig			Will follow NIST recertification requirements

[1] The precision test does not need to be accomplished if analyzer calibrated on same day as analysis.

Table 4. 2018 AA-PGVP CO & SO_2 Verification Results

Producer	Facility	Cylinder ID	Pollutant	Assay Conc	Producer Conc	% Bias	95% Uncert	Nat. Usage of Producer per Survey
PraxAir	Los Angeles, CA	SA14452	CO	161.56	161	0.35	0.24	40%
PraxAir	Los Angeles, CA	LL83903	CO	913.87	918	-0.45	0.29	40%
PraxAir	Toledo, OH	CC139535*	CO	2525.05	2527	-0.08	0.3	40%
PraxAir	Morrisville, PA	FF25936	CO	762.58	781	**-2.36**	0.48	40%
Air Gas	Chicago, IL	CC459555	CO	243.62	241.2	1	0.24	31%
Matheson	Twinsburg, OH	SD12125	CO	891.63	890	0.18	0.3	2%
Linde	Alpha, NJ	CC-230086	CO	150.71	151.5	-0.52	0.32	2%
PraxAir	Los Angeles, CA	SA14452	SO2	13.04	13.2	-1.2	0.12	40%
PraxAir	Morrisville, PA	EX0012188	SO2	2.08	2.06	1.14	0.41	40%
Air Gas	Chicago, IL	CC197754	SO2	10.03	10.07	-0.35	0.14	31%
Air Gas	Chicago, IL	LL87181	SO2	24.76	24.94	-0.73	0.17	31%
Matheson	Waverly, NE	SD13764	SO2	10.45	10.31	1.31	0.19	2%
Linde	Alpha, NJ	CC88510	SO2	4.12	5.01	**-17.76**	0.54	2%

Notes: * Cylinder Sent by Producer

Table 5. 2018 AA-PGVP NO & NO_X Verification Results

Producer	Facility	Cylinder ID	Pollutant	Assay Conc	Producer Conc	% Bias	95% Uncert	Nat. Usage of Producer per Survey (%)
PraxAir	Los Angeles, CA	LL83903	NO	47.78	46.3	**3.2**	0.26	40%
PraxAir	Los Angeles, CA	SA14452	NO	13.22	12.7	**4.1**	0.12	40%
Air Gas	Richmond, VA	LL167081	NO	55.47	56.07	-1.08	0.45	31%
Air Gas	Chicago, IL	FF44751	NO	10.12	9.94	1.75	0.39	31%
Air Gas	Chicago, IL	CC409659	NO	10.46	10.27	1.86	0.38	31%
Matheson	Waverly, NE	SD14642	NO	26.86	29.52	**-9.03**	0.37	2%
Linde	Alpha, NJ	CC88635	NO	15.22	15.27	-0.34	0.44	2%
Red Ball	Shreveport, LA	EB0055421	NO	50.44	50.32	0.25	0.15	2%
Matheson	Twinsburg, OH	SD12125	NO	45.09	44.1	**2.23**	0.25	2%
PraxAir	Los Angeles, CA	SA14452	NOx	13.21	12.9	**2.41**	0.24	40%
PraxAir	Los Angeles, CA	LL83903	NOx	48.09	46.7	**2.97**	0.28	40%
Air Gas	Richmond, VA	LL167081	NOx	55.64	56.15	-0.91	0.45	31%
Air Gas	Chicago, IL	FF44751	NOx	10.13	10	1.28	0.53	31%
Air Gas	Chicago, IL	CC409659	NOx	10.47	10.3	1.65	0.52	31%
Matheson	Waverly, NE	SD14642	NOx	26.86	29.66	**-9.42**	0.5	2%
Red Ball	Shreveport, LA	EB0055421	NOx	50.48	51.25	-1.5	0.22	2%
Linde	Alpha, NJ	CC88635	NOx	15.22	15.28	-0.36	0.44	2%
Matheson	Twinsburg, OH	SD12125	NOx	45.53	44.2	**3**	0.28	2%

Out of the 31 verification results listed in Table 4 and Table 5, 10 were greater than the ±2% Acid Rain Program criteria and of those, 4 were greater than AA-PGVP criteria of ±4%. Linde cylinder (CC88510) and Matheson cylinder (SD14642) were verified by both RAVLs for confirmation.

The QC results for these internal standards showed very good agreement and were within the 2% relative percent difference (RPD) MQO. The RAVL internal standards, Scott-Marrin cylinders (CC327237, CC327233) and Air Gas cylinder (CC42619), were analyzed by both RAVLs and the intercomparison results are provided in Table 6. In addition to the internal standards, Linde cylinder (CC88510) is included in Table 6 since both RAVLs assessed this cylinder. The intercomparison results of the Matheson cylinder (SD14642) are not included in Table 6. The AA-PGVP SOP requires multiple upscale points to be generated from the protocol gas when verifying the standard. For the SD14642 cylinder intercomparison only a single concentration level was assessed for this cylinder. Resource limitations at the Region 2 RAVL limited the verification to this single verification point. Table 6 provides the relative percent differences (d_i) of the paired QC sample concentrations, and is defined as:

$$d_i = \frac{X_i - Y_i}{(X_i + Y_i)/2} \cdot 100$$

Where X_i = Region 2 RAVL concentration, and
Y_i = Region 7 RAVL concentration

Assignment of X_i and Y_i for the RAVLs was arbitrary.

Table 6. Relative Percent Difference of QC Cylinder

Cylinder	Pollutant	R2	R7	RPD (%)
CC42619	CO	492.45	498.07	-0.284
CC327237	SO2	50.24	50.08	0.080
CC88510	SO2	4.06	4.12	-0.367
CC327233	NO	49.51	49.93	-0.211
CC327233	NOx	49.59	49.99	-0.201

4.0 Summary and Conclusions

General –
The AA-PGVP is successfully implementing a verification process that is blind to the specialty gas producers. One of goals of the ambient air monitoring rule (published March 28, 2016) was for the verifications performed by the RAVLs to be focused more on our ambient air monitoring organizations rather than as a resource to be utilized by specialty gas producers for their own quality assurance. The purpose of the program (blind verification of gas cylinders provided by monitoring organizations) cannot be accomplished if EPA relies on the specialty gas producers to submit cylinders for assessment. Of the 18 protocol gas cylinder standards submitted for analysis only one cylinder was directly submitted by a gas producer. This ratio indicates that the program is successfully implementing a verification process that is blind to the specialty gas producers and is an improvement over AA-PGVP's past performance.

While the program is successfully implementing a blind verification process, only 18 cylinders were analyzed in 2018. EPA Regions 7 and 2 agreed to provide analytical services to support up to 40 cylinder verifications each year per lab for a total of 80 cylinder verifications/year for the national program. The ambient air monitoring rule changed the AA-PGVP from a voluntary program to a mandatory program but participation in the program continues to underutilize our testing capacity. These 18 cylinder submissions resulted in only 31 verifications (some cylinders are a blend of multiple gas standards) being performed. Results show that 10 of the 31 verifications (32%) failed the ±2% Acid Rain Program criteria and 4 of 31 verifications (13%) failed the ±4% AA-PGVP criteria. It is difficult to assess the extent to which this issue is impacting our ambient air monitoring networks due to the low utilization of the RAVLs by our monitoring programs.

The annual survey identified 19 specialty gas production facilities that are used for calibration standards by our monitoring programs. The underutilization of our RAVLs resulted in 13 of these facilities not being assessed. It is important to note that these 13 unverified facilities are likely not a comprehensive list of facilities that were not assessed from our verification program since the participation rate of the annual survey was only 35% of the monitoring programs that analyze for CO, SO_2, or NO_2.

The analysis of the same standard by both RAVLs continues to be a useful tool for checking the quality of EPA's AA-PGVP results. As seen by examination of Table 6, the agreement of the intercomparison results between Region 2 and Region 7 are all well under a 1% RPD. While improvement continues to be needed in determining which gas producers are used in our ambient air monitoring networks, as well as, ensuring that an adequate sampling of these gas manufacturers are assessed by our RAVLs, the 2018 laboratory intercomparison results demonstrate that the RAVL measurements are accurate and reproduceable.

The following lists some areas of the program that need improvement:

Survey Participation Improvement –
Since its inception, the AA-PGVP has relied on an annual survey to determine which gas producers and facilities are used for generating CO, SO_2, and NO_2 test atmospheres from protocol gas cylinder standards. Participation in the annual survey was initially voluntary. To improve the participation rate and to more completely document which gas producers and facilities are utilized by our ambient air monitoring organizations, in 2016 states using protocol gases were required to complete the survey every year. While it was thought at the time that this regulatory requirement would increase the participation and create a

comprehensive list of the protocol gas producers used in the national network, the survey participation rate has not improved and remains at about 35%. OAQPS is currently assessing other solutions to gather this information and augment the annual survey system currently used for the program. See Data Management Improvement section below for further details.

RAVL Participation Improvement –
Since the monitoring rule was revised in 2016, the AA-PGVP has made progress in achieving blind verifications of the protocol gas cylinders used in our ambient air monitoring networks. However, the program continues to not achieve its goal of having every PQAO submit an unused cylinder at least once every five years for verification. The AA-PGVP's goal to perform 80 protocol gas verifications each year and to strategically select these protocol cylinders to represent the national ambient air monitoring networks was not achieved in CY-2018. Only 17 protocol gas cylinder standards were submitted by 10 monitoring programs in 2018. Region 7 assessed all but one of the monitoring agencies that submitted cylinders in 2018. Five of the 10 monitoring programs submitting protocol gas cylinders for verification were clustered in proximity to the Region 7 laboratory. A better national sampling of monitoring programs and protocol gas producers is needed in the future. Further complicating the RAVL participation is that Region 2 informed OAQPS of its desire to cease RAVL operations due to staffing and resource limitations.

Quality System Improvement –
The Implementation Plan for the AA-PGVP and its Quality Assurance Project Plan have not been updated since the inception of the program in 2010. Since calendar year 2010, changes to the program have occurred, including regulatory changes in 2016. These documents need to be reconciled with current program practices and regulatory requirements.

Data Management Improvement –
The AA-PGVP has relied solely on the annual survey for determining which protocol gas standard producers are used in the national ambient air monitoring networks. The annual survey was originally a voluntary program and later in 2016 it became a regulatory requirement. Neither implementation of this process has proven to be fully effective. The data management practices for conducting the annual survey and storing its results are not optimized to be readily reconciled with the data produced by the RAVLs. Additionally, data validation and data entry business rules are needed to ensure the accuracy of the data submitted for both portions of this program (protocol gas survey and RAVL analytical results). Once accomplished this will enable both datasets to be readily assessed by monitoring organization, PQAO, and producer production facility. Data entry errors and the lack of key fields impede analysis of the information collected for this program.

As a potential solution OAQPS is investigating leveraging the AQS database to augment and replace some of the data management practices historically performed in the program. Initially OAQPS will focus on migrating the verification results from the RAVLs to the AQS database. OAQPS is also assessing the feasibility of making minor modifications to the current AQS "QA-Transaction" file format for the single point quality control checks and annual performance audits. The proposed modifications being investigated would allow for documenting the protocol gas producer and facility of the protocol gas cylinder used for generating the test atmospheres for each of these checks. Augmenting or replacing the annual survey through a modification of a routine AQS data submission process would allow EPA to document 100% of the protocol gas production facilities used in the ambient air monitoring networks as opposed to the current process which has only been 36% effective between 2014-2018.

Appendix A QA Reports from Measurement Data Worksheets for 2018

Ambient Air Protocol Gas Verification Program
QA Reports from Measurement Data Worksheets for 2018

During the verification process, the Regional Air Verification Laboratories perform a number of quality control checks that are recorded on the Measurement Data Worksheets. This information is reported and saved along with the verification reports. The following sheets represent the quality control for all verifications that were implemented in 2018.

Region 2: Quarters 1 – 4, pages 21 – 23

Region 7: Quarters 1 – 4, pages 24 – 30

Some quality control checks did not pass.

Region 2 QA Data

QA Requirements Summary, Region 2 - 4th Quarter of 2018

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	7-Jul-22	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	2000	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	23-Sep-18	Dilution Check SRM Gas Standard Expired
	Dilution Check SRM Cylinder Pressure >150 psi	1800	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	10-May-19	Standard OK
	Low Flow Standard Expiration Date	10-May-19	Standard OK
	Flow Standard Base Unit Expiration Date	10-May-19	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	11-Dec-18	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	1.0000000	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	1.0000000	Low MFC OK
Sulfur Dioxide Gas Analyzer	Analyzer Calibration within 2 weeks of assay	20-Dec-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.42%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.44%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.46%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.52%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.61%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	1.0022	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	12-Dec-18	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	-0.353%	Dilution Check RSD is OK

QA Requirements Summary, Region 2 - 4th Quarter of 2018

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	25-Jan-20	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	1800	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	25-Mar-19	Dilution Check SRM Gas Standard OK
	Dilution Check SRM Cylinder Pressure >150 psi	2100	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	10-May-19	Standard OK
	Low Flow Standard Expiration Date	10-May-19	Standard OK
	Flow Standard Base Unit Expiration Date	10-May-19	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	11-Dec-18	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	1.0000000	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	1.0000000	Low MFC OK
Oxides of Nitrogen Gas Analyzer NO Portion	Analyzer Calibration within 2 weeks of assay	12-Dec-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.00%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.21%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.21%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.22%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.22%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9997	Analyzer Slope is acceptable
Oxides of Nitrogen Gas Analyzer NOx Portion	Analyzer Calibration within 2 week of assay	12-Dec-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.00%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.33%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.34%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.35%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.36%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	1.0018	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	12-Dec-18	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	-0.353%	Dilution Check RSD is OK

QA Requirements Summary, Region 2 - 4th Quarter of 2018

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	25-Jan-20	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	1550	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	25-Mar-19	Dilution Check SRM Gas Standard OK
	Dilution Check SRM Cylinder Pressure >150 psi	1900	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	10-May-19	Standard OK
	Low Flow Standard Expiration Date	10-May-19	Standard OK
	Flow Standard Base Unit Expiration Date	10-May-19	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	11-Dec-18	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	1.0000000	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	1.0000000	Low MFC OK
Oxides of Nitrogen Gas Analyzer NO Portion	Analyzer Calibration within 2 weeks of assay	13-Dec-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.00%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.21%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.22%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.23%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.20%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	1.0000	Analyzer Slope is acceptable
Oxides of Nitrogen Gas Analyzer NOx Portion	Analyzer Calibration within 2 week of assay	13-Dec-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.00%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.32%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.36%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.37%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.39%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9969	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	12-Dec-18	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	-0.353%	Dilution Check RSD is OK

QA Requirements Summary, Region 2 - 4th Quarter of 2018

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	23-Mar-20	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	2000	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	5-Jan-19	Dilution Check SRM Gas Standard OK
	Dilution Check SRM Cylinder Pressure >150 psi	1500	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	10-May-19	Standard OK
	Low Flow Standard Expiration Date	10-May-19	Standard OK
	Flow Standard Base Unit Expiration Date	10-May-19	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	11-Dec-18	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	1.0000000	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	1.0000000	Low MFC OK
Sulfur Dioxide Gas Analyzer	Analyzer Calibration within 2 weeks of assay	17-Dec-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.15%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.16%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.16%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.17%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.18%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	1.0036	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	12-Dec-18	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	-0.353%	Dilution Check RSD is OK

QA Requirements Summary, Region 2 - 4th Quarter of 2018

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	23-Mar-20	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	2000	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	5-Jan-19	Dilution Check SRM Gas Standard OK
	Dilution Check SRM Cylinder Pressure >150 psi	1500	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	10-May-19	Standard OK
	Low Flow Standard Expiration Date	10-May-19	Standard OK
	Flow Standard Base Unit Expiration Date	10-May-19	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	0-Jan-00	Calibrator flow calibration not within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	#REF!	#REF!
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	#REF!	#REF!
Sulfur Dioxide Gas Analyzer	Analyzer Calibration within 2 weeks of assay	18-Dec-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.38%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.39%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.41%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.45%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.50%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	1.0128	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	#REF!	#REF!
	Dilution Check Relative % Difference < 1%	#REF!	#REF!

Region 7 QA Data

QA Requirements Summary, Region 7 - 1st Quarter of 2018

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	20-Sep-21	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	1500	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	26-Sep-21	Dilution Check SRM Gas Standard OK
	Dilution Check SRM Cylinder Pressure >150 psi	2100	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	11-Dec-18	Standard OK
	Low Flow Standard Expiration Date	11-Dec-18	Standard OK
	Flow Standard Base Unit Expiration Date	11-Dec-18	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	9-Mar-18	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999993	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999693	Low MFC OK
Carbon Monoxide Gas Analyzer	Analyzer Calibration within 2 week of assay	10-Mar-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.22%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.23%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.24%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.25%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.27%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	1.0007	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	10-Mar-18	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.200%	Dilution Check RSD is OK

QA Requirements Summary, Region 7 - 1st Quarter of 2018

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	25-Mar-19	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	800	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	1-Feb-24	Dilution Check SRM Gas Standard OK
	Dilution Check SRM Cylinder Pressure >150 psi	1750	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	11-Dec-18	Standard OK
	Low Flow Standard Expiration Date	11-Dec-18	Standard OK
	Flow Standard Base Unit Expiration Date	11-Dec-18	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	9-Mar-18	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999993	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999693	Low MFC OK
Oxides of Nitrogen Gas Analyzer NO Portion	Analyzer Calibration within 2 weeks of assay	12-Mar-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.12%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.12%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.12%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.13%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.14%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9980	Analyzer Slope is acceptable
Oxides of Nitrogen Gas Analyzer NOx Portion	Analyzer Calibration within 2 week of assay	12-Mar-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.24%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.24%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.25%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.27%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.29%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9990	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	Date of Dilution Check	#VALUE!
	Dilution Check Relative % Difference < 1%	0.000%	Dilution Check RSD is OK

QA Requirements Summary, Region 7 - 1st Quarter of 2018

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	22-Mar-19	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	800	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	5-Jan-19	Dilution Check SRM Gas Standard OK
	Dilution Check SRM Cylinder Pressure >150 psi	1625	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	11-Dec-18	Standard OK
	Low Flow Standard Expiration Date	11-Dec-18	Standard OK
	Flow Standard Base Unit Expiration Date	11-Dec-18	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	9-Mar-18	Calibrator flow calibration within 1 month of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999993	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999693	Low MFC OK
Sulfur Dioxide Gas Analyzer	Analyzer Calibration within 2 weeks of assay	11-Mar-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.12%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.12%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.12%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.13%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.14%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9993	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	10-Mar-18	Dilution check within 1 month of assay
	Dilution Check Relative % Difference < 1%	0.200%	Dilution Check RSD is OK

QA Requirements Summary, Region 7 - 2nd Quarter of 2018

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	20-Sep-21	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	2100	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	26-Sep-21	Dilution Check SRM Gas Standard OK
	Dilution Check SRM Cylinder Pressure >150 psi	1500	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	11-Dec-18	Standard OK
	Low Flow Standard Expiration Date	11-Dec-18	Standard OK
	Flow Standard Base Unit Expiration Date	11-Dec-18	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	7-Jul-18	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999993	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999977	Low MFC OK
Carbon Monoxide Gas Analyzer	Analyzer Calibration within 2 week of assay	8-Jul-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.16%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.14%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.13%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.16%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.20%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	1.0021	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	8-Jul-18	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.121%	Dilution Check RSD is OK

QA Requirements Summary, Region 7 - 2nd Quarter of 2018

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	25-Mar-19	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	1700	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	1-Feb-24	Dilution Check SRM Gas Standard OK
	Dilution Check SRM Cylinder Pressure >150 psi	1750	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	11-Dec-18	Standard OK
	Low Flow Standard Expiration Date	11-Dec-18	Standard OK
	Flow Standard Base Unit Expiration Date	11-Dec-18	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	7-Jul-18	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999993	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999977	Low MFC OK
Oxides of Nitrogen Gas Analyzer NO Portion	Analyzer Calibration within 2 weeks of assay	8-Jul-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.24%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.24%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.25%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.27%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.29%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	1.0021	Analyzer Slope is acceptable
Oxides of Nitrogen Gas Analyzer NOx Portion	Analyzer Calibration within 2 week of assay	8-Jul-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.31%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.31%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.32%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.34%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.37%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9992	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	8-Jul-18	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.121%	Dilution Check RSD is OK

QA Requirements Summary, Region 7 - 3rd Quarter of 2018

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	20-Sep-21	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	2050	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	26-Sep-21	Dilution Check SRM Gas Standard OK
	Dilution Check SRM Cylinder Pressure >150 psi	1350	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	11-Dec-18	Standard OK
	Low Flow Standard Expiration Date	11-Dec-18	Standard OK
	Flow Standard Base Unit Expiration Date	11-Dec-18	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	9-Sep-18	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999994	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999879	Low MFC OK
Carbon Monoxide Gas Analyzer	Analyzer Calibration within 2 week of assay	10-Sep-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.42%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.43%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.45%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.48%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.52%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9975	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	10-Sep-18	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.221%	Dilution Check RSD is OK

QA Requirements Summary, Region 7 - 3rd Quarter of 2018

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	25-Mar-19	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	1400	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	1-Feb-24	Dilution Check SRM Gas Standard OK
	Dilution Check SRM Cylinder Pressure >150 psi	1700	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	11-Dec-18	Standard OK
	Low Flow Standard Expiration Date	11-Dec-18	Standard OK
	Flow Standard Base Unit Expiration Date	11-Dec-18	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	9-Sep-18	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999994	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999879	Low MFC OK
Oxides of Nitrogen Gas Analyzer NO Portion	Analyzer Calibration within 2 weeks of assay	12-Sep-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.31%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.32%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.33%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.35%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.38%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9987	Analyzer Slope is acceptable
Oxides of Nitrogen Gas Analyzer NOx Portion	Analyzer Calibration within 2 week of assay	12-Sep-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.32%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.33%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.35%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.37%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.40%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9983	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	10-Sep-18	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.221%	Dilution Check RSD is OK

QA Requirements Summary, Region 7 - 3rd Quarter of 2018

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	25-Mar-19	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	1400	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	1-Feb-24	Dilution Check SRM Gas Standard OK
	Dilution Check SRM Cylinder Pressure >150 psi	1700	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	11-Dec-18	Standard OK
	Low Flow Standard Expiration Date	11-Dec-18	Standard OK
	Flow Standard Base Unit Expiration Date	11-Dec-18	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	9-Sep-18	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999994	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999879	Low MFC OK
Oxides of Nitrogen Gas Analyzer NO Portion	Analyzer Calibration within 2 weeks of assay	12-Sep-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.31%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.32%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.33%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.35%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.38%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9987	Analyzer Slope is acceptable
Oxides of Nitrogen Gas Analyzer NOx Portion	Analyzer Calibration within 2 week of assay	12-Sep-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.32%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.33%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.35%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.37%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.40%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9983	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	10-Sep-18	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.221%	Dilution Check RSD is OK

QA Requirements Summary, Region 7 - 3rd Quarter of 2018

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	22-Mar-19	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	800	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	5-Jan-19	Dilution Check SRM Gas Standard OK
	Dilution Check SRM Cylinder Pressure >150 psi	1625	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	11-Dec-18	Standard OK
	Low Flow Standard Expiration Date	11-Dec-18	Standard OK
	Flow Standard Base Unit Expiration Date	11-Dec-18	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	9-Sep-18	Calibrator flow calibration within 1 month of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999994	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999879	Low MFC OK
Sulfur Dioxide Gas Analyzer	Analyzer Calibration within 2 weeks of assay	11-Sep-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.23%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.23%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.24%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.26%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.28%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	1.0009	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	10-Sep-18	Dilution check within 1 month of assay
	Dilution Check Relative % Difference < 1%	0.221%	Dilution Check RSD is OK

QA Requirements Summary, Region 7 - 4th Quarter of 2018

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	26-Sep-21	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	1250	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	20-Sep-21	Dilution Check SRM Gas Standard OK
	Dilution Check SRM Cylinder Pressure >150 psi	2050	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	11-Dec-18	Standard OK
	Low Flow Standard Expiration Date	11-Dec-18	Standard OK
	Flow Standard Base Unit Expiration Date	11-Dec-18	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	3-Dec-18	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999996	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999889	Low MFC OK
Carbon Monoxide Gas Analyzer	Analyzer Calibration within 2 week of assay	4-Dec-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.29%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.30%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.32%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.38%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.43%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9994	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	4-Dec-18	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.768%	Dilution Check RSD is OK

QA Requirements Summary, Region 7 - 4th Quarter of 2018

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	7-Jul-22	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	1100	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	20-Sep-21	Dilution Check SRM Gas Standard OK
	Dilution Check SRM Cylinder Pressure >150 psi	2050	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	11-Dec-18	Standard OK
	Low Flow Standard Expiration Date	11-Dec-18	Standard OK
	Flow Standard Base Unit Expiration Date	11-Dec-18	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	3-Dec-18	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999996	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999889	Low MFC OK
Carbon Monoxide Gas Analyzer	Analyzer Calibration within 2 week of assay	7-Dec-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.29%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.30%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.33%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.39%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.44%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9984	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	4-Sep-18	Dilution check not within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	1.152%	Dilution Check RSD > 1%

QA Requirements Summary, Region 7 - 4th Quarter of 2018

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	25-Mar-19	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	1350	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	1-Feb-24	Dilution Check SRM Gas Standard OK
	Dilution Check SRM Cylinder Pressure >150 psi	1750	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	11-Dec-18	Standard OK
	Low Flow Standard Expiration Date	11-Dec-18	Standard OK
	Flow Standard Base Unit Expiration Date	11-Dec-18	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	3-Dec-18	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999996	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999889	Low MFC OK
Oxides of Nitrogen Gas Analyzer NO Portion	Analyzer Calibration within 2 weeks of assay	9-Dec-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.59%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.62%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.67%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.80%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.89%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	1.0029	Analyzer Slope is acceptable
Oxides of Nitrogen Gas Analyzer NOx Portion	Analyzer Calibration within 2 week of assay	9-Dec-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.50%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.52%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.57%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.67%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.75%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	1.0001	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	4-Dec-18	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.768%	Dilution Check RSD is OK

QA Requirements Summary, Region 7 - 4th Quarter of 2018

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	22-Mar-19	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	700	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	5-Jan-19	Dilution Check SRM Gas Standard OK
	Dilution Check SRM Cylinder Pressure >150 psi	1625	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	11-Dec-18	Standard OK
	Low Flow Standard Expiration Date	11-Dec-18	Standard OK
	Flow Standard Base Unit Expiration Date	11-Dec-18	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	3-Dec-18	Calibrator flow calibration within 1 month of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999997	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999875	Low MFC OK
Sulfur Dioxide Gas Analyzer	Analyzer Calibration within 2 weeks of assay	8-Dec-18	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.26%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.27%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.29%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.34%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.62%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9982	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	4-Dec-18	Dilution check within 1 month of assay
	Dilution Check Relative % Difference < 1%	0.796%	Dilution Check RSD is OK

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