U.S. EPA Ambient Air Monitoring Protocol Gas Verification Program

Annual Report CY 2019

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U.S. EPA Ambient Air Monitoring Protocol Gas Verification Program
Annual Report CY 2019

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
COC	Chain of Custody
EPA	Environmental Protection Agency
GMIS	Gas Manufacturer's Internal Standard
MQO	measurement quality objective
NIST	National Institute of Standards and Technology
NMI	Netherlands Measurement Institute
NTRM	NIST Traceable Reference Material
OAQPS	Office of Air Quality Planning and Standards
OAP	Office of Atmospheric Programs
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
RO	Reporting Organization (subcomponent of PQAO)
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, 2012)[1] were developed jointly by EPA, the National Bureau of Standards (now National Institute of Standards and Technology [NIST]), and specialty gas producers over 40 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

[1] EPA-600/R-12/531

[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

accompanying certificates of analysis for completeness and accuracy. The producers were not aware that EPA had procured the gases for these audits.

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 two EPA Regional Offices, developed an Ambient Air Protocol Gas Verification Program (AA-PGVP). The program established two gas metrology laboratories 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 2019 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].

2.0 Implementation Summary

Since the program implementation started in 2010, when most of the initial preparation work took place, no major "new" implementation activities took place. However, EPA regional realignments and aging infrastructure reduced the capabilities of this program. Due to these constraints, in 2019 the EPA Region 2 Regional Analytical Verification Laboratory (RAVL) ceased its active participation in the AA-PGVP. During 2019, the AA-PGVP operated with only the Region 7 RAVL. Operations with only a single RAVL resulted in the AA-PGVP unable to swap internal quality control samples and cylinders needing confirmatory assay between two independent RAVLs. During 2020 and 2021 EPA will begin reengineering the AA-PGVP and attempt to find an additional EPA regional laboratory to serve as a RAVL in place of EPA Region 2.

The following provides a brief explanation of the 2019 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 began work with Research Triangle Institute to develop a web-based survey that one point of contact for each monitoring organization could access. The intent was to make recording and evaluation of the survey information easier for the

[5] www.epa.gov/amtic/ambient-air-protocol-gas-verification-program

monitoring organizations and EPA. This contracted survey work has since migrated to Battelle. Based on the information obtained from monitoring organization surveys, EPA would develop a list of the specialty gas producers being used by the monitoring organizations. From this list, EPA would attempt to perform representative sampling of the standards from protocol gas production facilities by identifying regulatory monitoring agencies that use standards from each of these producers. However, only two agencies participating in the survey for 2019. Without the survey results, a systematic selection of producers could not be performed. The AA-PGVP performed assays on all cylinders submitted by regulatory monitoring agencies. Representative sampling was not attempted for CY-2019. OAQPS is in the process of developing an Air Quality System (AQS) database solution to upgrade and replace the specialty gas usage information that is currently acquired through the contractor based annual questionnaire.

AA-PGVP Verification Dates – OAQPS worked with the Region 7 Regional Analytical Verification Laboratory (RAVL) to establish verification dates as indicated in Table 1.

Table 1. RAVL Verification Dates

Quarter	Region 7	
	Cylinder Receipt	**Analysis**
1	N/A	N/A
2	No later than June 17	June 24 – July 5
3	No later than Sept 3	Sept 9 – Sept 20
4	No later than Nov 25	Dec 2 – Dec 13
Open House	TBD	

TABLE 1. RAVL VERIFICATION DATES

Table 1 RAVL Open House – During Open House the RAVL allows specialty gas producers to visit and ask questions regarding the laboratory processes and operations. During 2019 no specialty gas producers visited the Region 7 RAVL.

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.

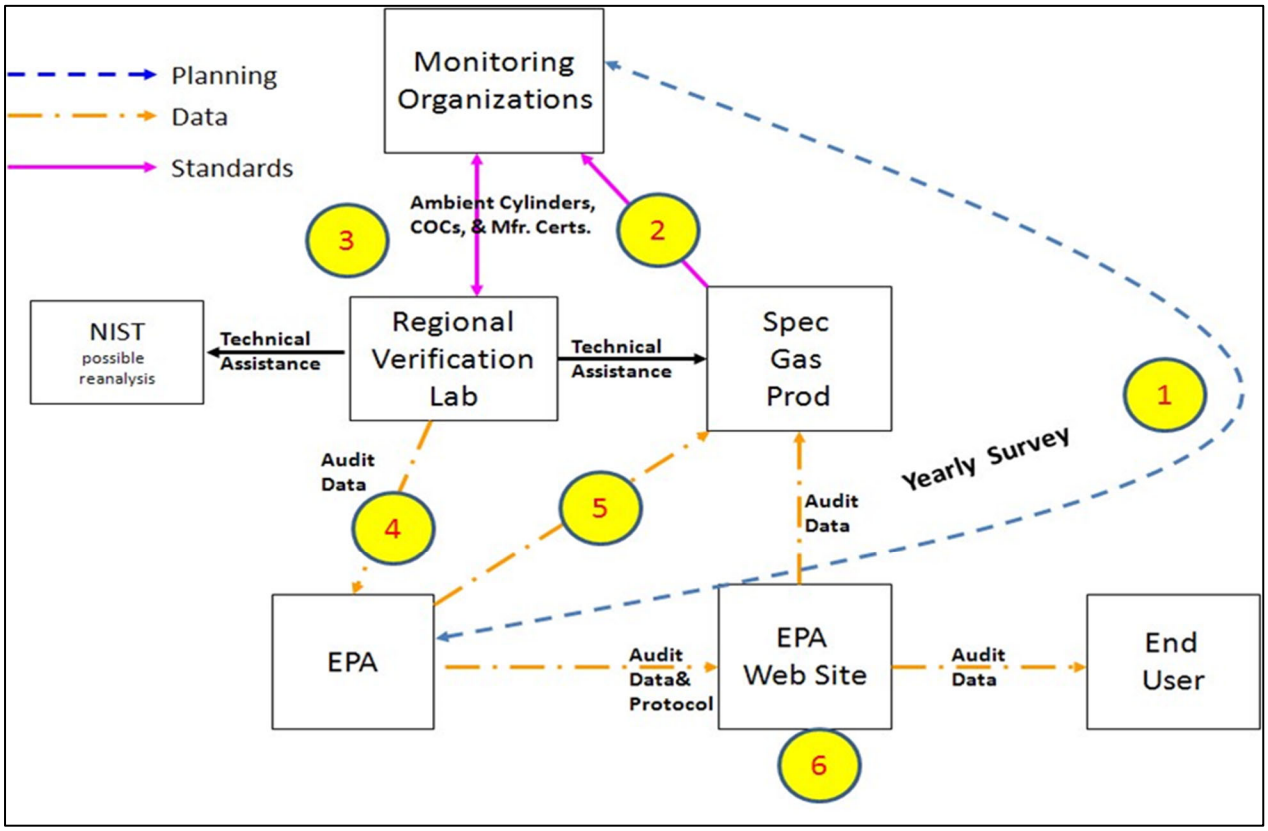

FIGURE 1. AA-PGVP FLOW CHART

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 assess which specialty gas producers are used by the monitoring organizations, EPA annually uses a web-based survey that each monitoring organization completes. Since 2016, EPA regulations found in 40 CFR Part 58 Appendix A 2.6.1 require monitoring organizations to annually provide this information. However, as can be seen from Figure 2 participation in the annual survey has not improved since the 2016 monitoring rule revisions. Also, as discussed in Section 2, participation in the annual survey dropped to only two monitoring programs in 2019.

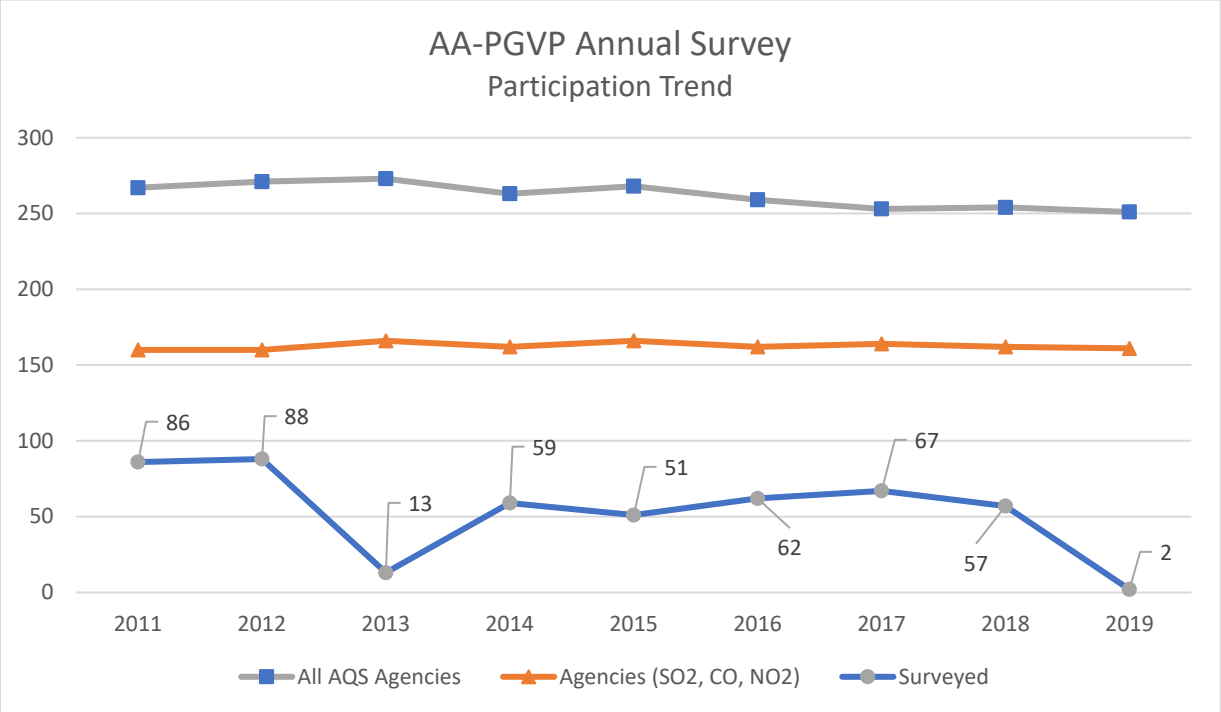

FIGURE 2. ANNUAL SURVEY

Table 2. Gas Standards Sent to RAVLs in Calendar Year 2019

Qtr	Cylinder ID	Pollutant	Lab	Producer	Facility	Agency
2	CC143319	SO2	7	Linde	Alpha, NJ	Albuquerque Environmental Health And Energy Department
2	CC703098*	NO, NOx	7	PraxAir	Los Angeles, CA	San Diego County Air Pollution Control District
2	CC78206**	CO	7	PraxAir	Los Angeles, CA	(Sent by Producer)
3	CC28869	CO	7	AirGas	Chicago, IL	Missouri Laboratory Services Program
3	SD10801	NO, NOx	7	Matheson	Waverly, TN	Kansas Department Of Health And Environment
3	SD15146	NO, NOx	7	Matheson	Waverly, TN	Kansas Department Of Health And Environment
3	LL126837	SO2	7	PraxAir	Toledo, OH	University Hygenic Laboratory
4	FF528545	NO, NOx	7	Tier 5 Labs.	Indianapolis, IN	Wisconsin Dept Of Natural Resources, Air Monitoring Section

TABLE 2. GAS STANDARDS SENT TO RAVLS

Notes: * Cylinder opened prior to submission to EPA

** Direct submission by producer, assay results not blind to 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

TABLE 3. MQOS FOR THE AA-PGVP

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

Table 4. 2019 AA-PGVP CO and SO_2 Verifications‡

Qtr	Lab	Producer	Facility	Cylinder ID	Pollutant	Assay Conc	Producer Conc	% Bias	95% Uncertainty
3	7	AirGas	Chicago, IL	CC28869	CO	223.45	223.8	-0.16	0.23
2	7	PraxAir	Los Angeles, CA	CC78206*	CO	3002.28	3002	0.01	0.21
2	7	Linde	Alpha, NJ	CC143319	SO2	4.99	4.9	1.91	0.26
3	7	PraxAir	Toledo, OH	LL126837	SO2	28.92	29	-0.29	0.14

TABLE 4. AA-PGVP CO AND SO2 VERIFICATIONS

Notes: * Cylinder Sent Directly by Producer
‡ An Estimate for the national usage for specific protocol gas producers cannot be determined due to lack of participation in annual survey

Table 5. 2019 AA-PGVP NO and NO_x Verifications‡

Qtr	Lab	Producer	Facility	Cylinder ID	Pollutant	Assay Conc	Producer Conc	% Bias	95% Uncertainty
4	7	Tier 5 Labs	Indianapolis, IN	FF528545	NO	17.9	19.2	6.79	0.39
3	7	Matheson	Waverly, TN	SD15146	NO	30.06	30.33	-0.88	0.36
3	7	Matheson	Waverly, TN	SD10801	NO	30.21	30.38	-0.55	0.36
2	7	PraxAir	Los Angeles CA	CC703098*	NO	18.25	15.78	15.68	0.17
4	7	Tier 5 Labs.	Indianapolis, IN	FF528545	NOx	19.27	19.4	-0.69	0.29
3	7	Matheson	Waverly, TN	SD10801	NOx	30.38	30.38	0.01	0.34
3	7	Matheson	Waverly, TN	SD15146	NOx	30.06	30.36	-0.97	0.34
2	7	PraxAir	Los Angeles CA	CC703098*	NOx	18.17	15.78	15.16	0.16

TABLE 5. AA-PGVP NO AND NOX VERIFICATIONS

Notes: * Cylinder was opened prior to submission to EPA.
‡ An Estimate for the national usage for specific protocol gas producers cannot be determined due to lack of participation in annual survey

Eight cylinders were received by the AA-PGVP during calendar year 2019. Seven of these cylinders were received from regulatory monitoring agencies to support the AA-PGVP. One of the cylinders was directly submitted from a protocol gas producer. The assay results for all cylinders are included in Tables 4 and 5 but some are qualified with footnotes to denote that they do not fully meet the assessment requirements for the AA-PGVP. The CO cylinder directly submitted by Praxair was not blind to the producer. The NO cylinder provided by San Diego County Air Pollution Control District (SDAPCD) was opened by the agency prior to shipment to EPA. AA-PGVP requires that cylinders be unopened prior to receipt at the RAVL. While opened prior to receipt at the RAVL, the Praxair cylinder from SDAPCD is not considered to have been contaminated or diluted based on a comparison of the assay results to the producer certified concentrations.

All results for the CO and SO_2 standards were within the ±2% acid rain criteria acceptance criterion. One of the three protocol gas cylinder standards assayed for NO/NOx (Cylinder ID: FF528545) did not meet the ±2% acid rain criteria acceptance criterion and ±4% AA-PGVP action level criteria. The 4th cylinder for NO/NOx (Cylinder ID CC703098) also did not meet the ±4% AA-PGVP action level criteria and is qualified as being open prior to the RAVL's assay.

In 2019 the AA-PGVP operated with a single RAVL. As such, the quality assurance designated for the laboratory intercomparison of the internal standards could not be performed. The Region 7 RAVL assayed its own internal standard (Praxair Cylinder ID CB11278) and all results were within the ±2% acceptance criteria, but independent analysis was not performed. Additionally, due to the delay of issuing this annual report, the opportunity to contact the protocol gas producers to offer confirmatory assay of the cylinders was not possible. Protocol gas production facilities were notified of the failing verifications by their regulatory monitoring program customers.

4.0 Summary and Conclusions

General –
The AA-PGVP is 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 8 protocol gas cylinder standards submitted for analysis only one cylinder was directly submitted by a gas producer.

While the program is successfully implementing a blind verification process, only 8 cylinders were analyzed in 2019 or 10% of the AA-PGVP goal of 80 cylinders annually. One of the 8 cylinders was sent direct from the producer and another cylinder was opened by the submitting agency before sent to EPA. These eight-cylinder submissions resulted in only 12 verifications performed in 2019 (some cylinders are a blend of multiple gas standards). Results show that 3 of the 12 verifications (25%) failed the ±2% Acid Rain Program criteria and the ±4% AA-PGVP action level. It is difficult to assess the extent to which this issue impacts our ambient air monitoring networks in 2019 due to the low utilization of the RAVLs by our monitoring programs and low participation rate in the annual protocol gas questionnaire. In 2019 there were 28 EPA protocol gas production facilities in operation nationally. It is uncertain how many of these facilities were used in the ambient air monitoring networks in 2019. Additionally, of the 28 protocol gas production facilities operating, only 6 were verified by our ambient air monitoring program in calendar year 2019.

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 protocol gas producers 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 dropped to only 2 monitoring agency participating in the online questionnaire in calendar year 2019. OAQPS is actively assessing EPA's AQS database as an alternative solution to gather this information. 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 Primary Quality Assurance Organization (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 calendar year 2019. Only seven protocol gas cylinder standards were submitted by six PQAOs in 2019 to support this national program. Region 7 assayed all the cylinders received in 2019. Four of the six monitoring programs submitting protocol gas cylinders for the AA-PGVP were clustered in proximity to the Region 7 laboratory. A better national sampling of monitoring programs and protocol gas producers continues to be needed. Diminished assay capacity was in part due to the Region 2 laboratory ceasing RAVL operations due to staffing and resource limitations. OAQPS is working to replace this assay capacity with the Region 4 laboratory.

Quality System Improvement –

The Quality Assurance Project Plan (QAPP) has 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. OAQPS will begin reviewing and revising the QAPP for this program in 2020 with a goal of finalizing the revised QAPP by the end of 2021. During calendar year 2021, OAQPS will reach out to AA-PGVP stakeholders in the regulated community and protocol gas producers to solicit feedback on revisions to this program.

In 2019, the AA-PGVP operated with a single RAVL. As such, the quality assurance designated for the laboratory intercomparison of the internal standards could not be performed. OAQPS is currently working with EPA Region 4 to begin using their laboratory as a second RAVL. The Region 4 RAVL is scheduled to become operational in calendar year 2021.

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 with respect to monitoring organization, PQAO, and producer production facility. Data entry errors on the annual survey and chain of custody forms and the lack of key fields impede analysis of the information collected for this program.

OAQPS is actively investigating an AQS database solution to replace some of the data management practices historically performed in the program. This includes assessing the feasibility of making 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. Utilizing this modified 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 and only captured the input of two agencies in calendar year 2019.

Appendix A QA Reports from Measurement Data Worksheets for 2019

Ambient Air Protocol Gas Verification Program
QA Reports from Measurement Data Worksheets for 2019

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 2019.

QA Requirements Summary, Region 7 - 2nd Quarter of 2019

	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	10-Jan-20	Standard OK
	Low Flow Standard Expiration Date	10-Jan-20	Standard OK
	Flow Standard Base Unit Expiration Date	10-Jan-20	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	23-Jun-19	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	0.9999915	Low MFC OK
Carbon Monoxide Gas Analyzer	Analyzer Calibration within 2 week of assay	23-Jun-19	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	0.36%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.42%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.76%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9989	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	24-Jun-19	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.017%	Dilution Check RSD is OK

QA Requirements Summary, Region 7 - 2nd Quarter of 2019

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	1-Feb-24	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	1750	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	10-Jan-20	Standard OK
	Low Flow Standard Expiration Date	10-Jan-20	Standard OK
	Flow Standard Base Unit Expiration Date	10-Jan-20	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	23-Jun-19	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 -1. 0	0.9999996	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 -1. 0	0.9999915	Low MFC OK
Oxides of Nitrogen Gas Analyzer NO Portion	Analyzer Calibration within 2 weeks of assay	26-Jun-19	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	0.13%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.15%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.20%	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	0.9964	Analyzer Slope is acceptable
Oxides of Nitrogen Gas Analyzer NOx Portion	Analyzer Calibration within 2 week of assay	26-Jun-19	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	0.13%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.15%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.20%	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	0.9980	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	24-Jun-19	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.017%	Dilution Check RSD is OK

QA Requirements Summary, Region 7 - 2nd Quarter of 2019

	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-Apr-22	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	10-Jan-20	Standard OK
	Low Flow Standard Expiration Date	10-Jan-20	Standard OK
	Flow Standard Base Unit Expiration Date	10-Jan-20	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	23-Jun-19	Calibrator flow calibration within 1 month 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	0.9999915	Low MFC OK
Sulfur Dioxide Gas Analyzer	Analyzer Calibration within 2 weeks of assay	27-Jun-19	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.14%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.15%	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	0.19%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.35%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	1.0034	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	24-Jun-19	Dilution check within 1 month of assay
	Dilution Check Relative % Difference < 1%	0.017%	Dilution Check RSD is OK

QA Requirements Summary, Region 7 - 3rd Quarter of 2019

	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	1000	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	2100	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	10-Jan-20	Standard OK
	Low Flow Standard Expiration Date	10-Jan-20	Standard OK
	Flow Standard Base Unit Expiration Date	10-Jan-20	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	7-Sep-19	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999973	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999861	Low MFC OK
Carbon Monoxide Gas Analyzer	Analyzer Calibration within 2 week of assay	7-Sep-19	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.25%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.26%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.27%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.28%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.30%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	1.0023	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	8-Sep-19	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.347%	Dilution Check RSD is OK

QA Requirements Summary, Region 7 - 3rd Quarter of 2019

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	1-Feb-24	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	1000	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	1000	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	10-Jan-20	Standard OK
	Low Flow Standard Expiration Date	10-Jan-20	Standard OK
	Flow Standard Base Unit Expiration Date	10-Jan-20	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	7-Sep-19	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999973	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999861	Low MFC OK
Oxides of Nitrogen Gas Analyzer NO Portion	Analyzer Calibration within 2 weeks of assay	9-Sep-19	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	0.45%	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	0.9977	Analyzer Slope is acceptable
Oxides of Nitrogen Gas Analyzer NOx Portion	Analyzer Calibration within 2 week of assay	9-Sep-19	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.35%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.36%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.37%	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)	0.42%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9963	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	8-Sep-19	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.347%	Dilution Check RSD is OK

QA Requirements Summary, Region 7 - 3rd Quarter of 2019

	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-Apr-22	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	10-Jan-20	Standard OK
	Low Flow Standard Expiration Date	10-Jan-20	Standard OK
	Flow Standard Base Unit Expiration Date	10-Jan-20	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	7-Sep-19	Calibrator flow calibration within 1 month of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999973	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999861	Low MFC OK
Sulfur Dioxide Gas Analyzer	Analyzer Calibration within 2 weeks of assay	9-Sep-19	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.21%	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)	0.25%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9996	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	8-Sep-19	Dilution check within 1 month of assay
	Dilution Check Relative % Difference < 1%	0.347%	Dilution Check RSD is OK

QA Requirements Summary, Region 7 - 4th Quarter of 2019

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	8-Aug-23	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	900	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	1500	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	10-Jan-20	Standard OK
	Low Flow Standard Expiration Date	10-Jan-20	Standard OK
	Flow Standard Base Unit Expiration Date	10-Jan-20	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	30-Nov-19	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999983	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999624	Low MFC OK
Oxides of Nitrogen Gas Analyzer NO Portion	Analyzer Calibration within 2 weeks of assay	2-Dec-19	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.44%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.46%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.48%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.51%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.55%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9983	Analyzer Slope is acceptable
Oxides of Nitrogen Gas Analyzer NOx Portion	Analyzer Calibration within 2 week of assay	2-Dec-19	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.36%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.37%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.38%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.41%	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	0.9995	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	1-Dec-19	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	-0.163%	Dilution Check RSD is OK

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