U.S. EPA
Ambient Air Protocol Gas Verification Program

Annual Report CY 2021

EPA-454/R-22-004
June 2022

U.S. EPA Ambient Air Protocol Gas Verification Program
Annual Report CY 2021

U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Air Quality Assessment Division
Research Triangle Park, North Carolina

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Acknowledgements

The following individuals and organizations are acknowledged for their contributions to this project:

US EPA, Office of Air Quality Planning and Standards
Douglas Jager

US EPA, Office of Research and Development
Bob Wright

US EPA Region 7
Michael Davis Thien Bui James Regehr

Monitoring Organizations
EPA acknowledges the monitoring organizations that supported the AA-PGVP Annual Survey. They include:

Forsyth County Environmental Affairs Department
Kentucky Division for Air Quality
Maryland Department of the Environment
North Carolina Dept of Environmental Quality

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
CO	Carbon Monoxide
COC	Chain of Custody
CONC	Concentration
COVID-19	Coronavirus Disease 2019
EPA	Environmental Protection Agency
GMIS	Gas Manufacturer's Internal Standard
ID	Identification
MFC	Mass Flow Controller
NIST	National Institute of Standards and Technology
NMI	National Metrology Institute
NO2	Nitrogen Dioxide
NOx	Nitrogen Oxides
MQO	Measurement Quality Objective
NTRM	NIST Traceable Reference Material
NVLAP	National Voluntary Laboratory Accreditation Program
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
PRM	Primary Reference Material
PSI	Pounds per Square Inch
PSIG	Pounds per Square Inch Gauge
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QTR	Quarter
RAVL	Regional Analytical Verification Laboratory
RD	Relative Difference
RPD	Relative Percent Difference
SI	International System of Units
SO2	Sulfur Dioxide
SOP	Standard Operating Procedure
SRM	Standard Reference Material
URL	Upper Range Limit
VSL	Netherland’s National Metrology Institute; Dutch Von Swinden Laboratorium

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 2021 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, the EPA Region 2 Regional Analytical Verification Laboratory (RAVL) ceased its active participation in the AA-PGVP in calendar year 2019. During 2020 the AA-PGVP began transitioning Region 2 operations to the Region 4 laboratory. However, during 2020 and 2021 the AA-PGVP continued to operate 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 through 2021 EPA began reengineering the AA-PGVP. As part of that process, EPA began assisting the EPA Region 4 laboratory to serve as a replacement RAVL.

The following provides a brief overview of the ambient air protocol gas verification program.

Producer Information Data Collection – Beginning 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

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

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 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, for calendar year 2021 only 4 agencies participated in the survey. With only limited survey results, a systematic selection of producers could not be performed. For calendar year 2021 the AA-PGVP performed assays on all cylinders submitted by regulatory monitoring agencies. Representative sampling was not attempted for CY-2021. OAQPS continues to develop 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. At the time of this report, Oracle tables and a cylinder metadata entry form to support the AA-PGVP are now created in AQS and are in testing. EPA anticipates that in CY-2022 that cylinder usage data that was historically collected via the annual survey will begin to be collected via AQS.

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	No later than Feb 10	Feb 15 – Feb 26
2	No later than May 5	May 10 – May 21
3	No later than Aug 18	Aug 23 – Sept 3
4	No later than Nov 3	Nov 8 – Nov 19
Open House	December 16, 2021	

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 2021 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.

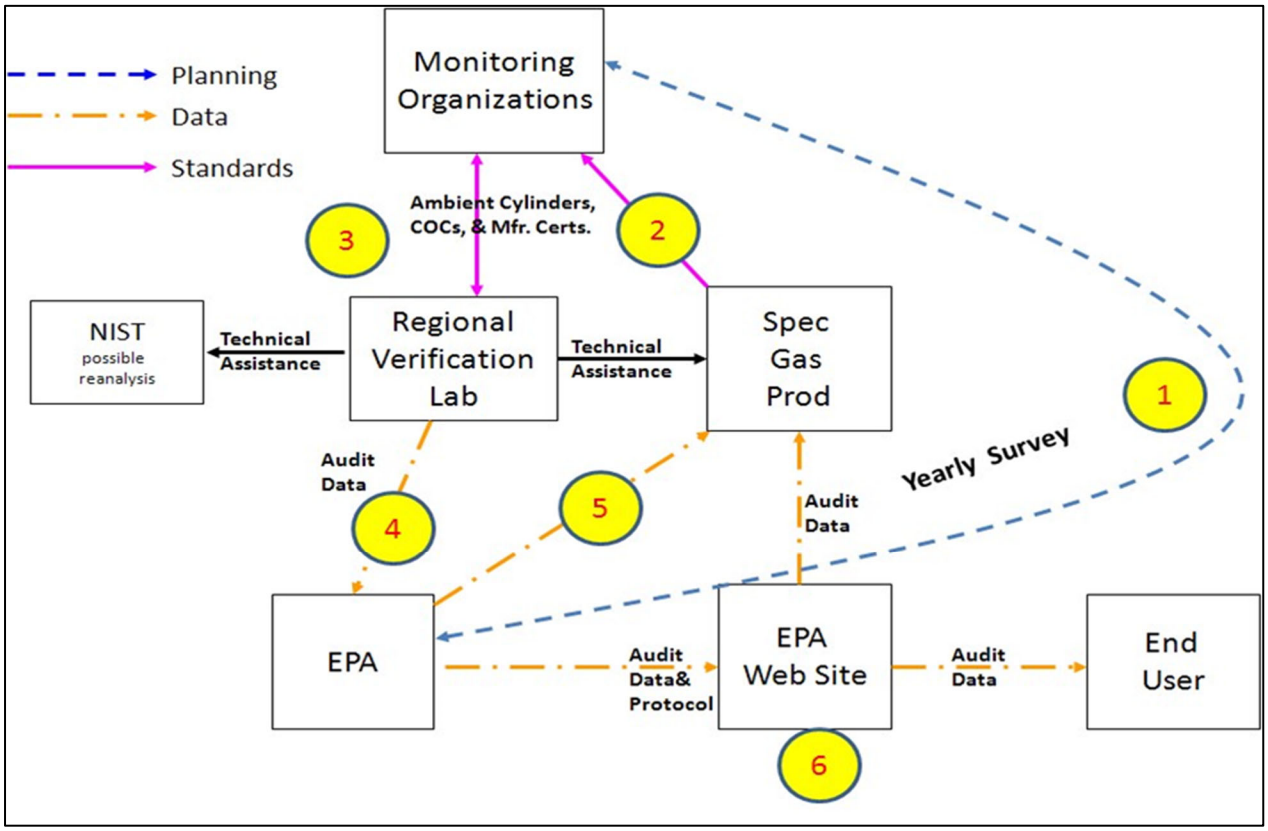

FIGURE 1. AA-PGVP FLOW CHART

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.
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 monitoring organizations. Specialty gas vendors are notified if the certified concentration of their standard is greater than ±4% of EPA's assay verification results, or greater than ±2% when the expanded measurement uncertainty is included.
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 uses a web-based survey that each monitoring organization completes annually. 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.

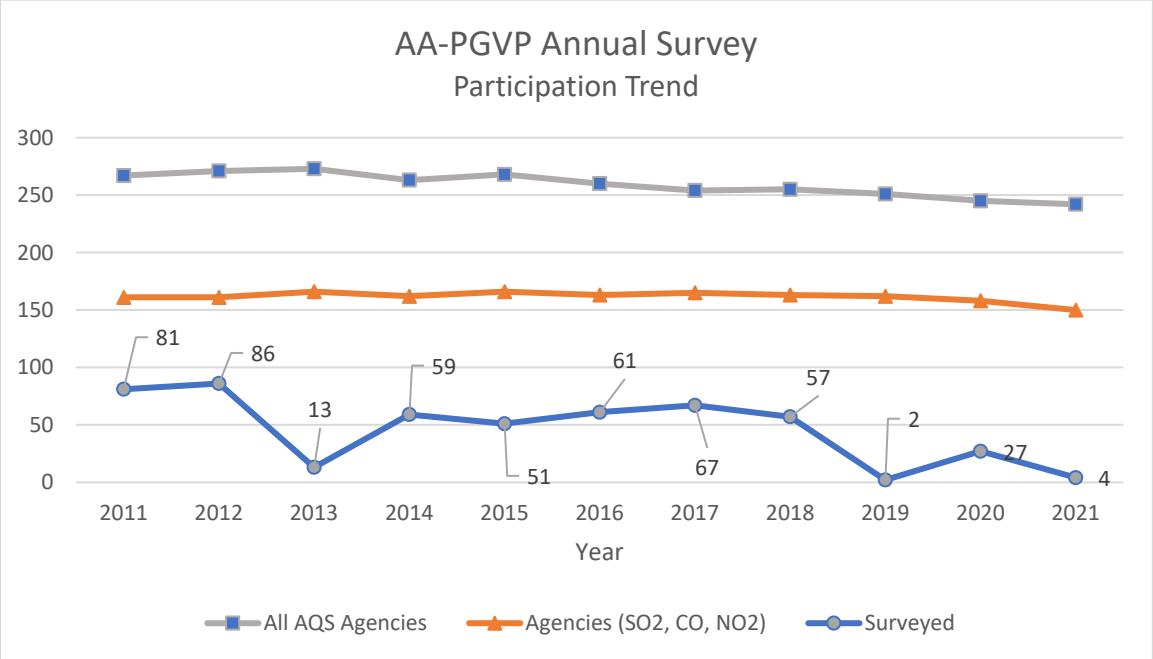

FIGURE 2 ANNUAL SURVEY

Table 2. Gas Standards Sent to RAVLs in Calendar Year 2021

Qtr	Cylinder ID	Pollutant	Lab	Producer	Facility	Agency
1	EA0027587	CO	7	Airgas	Tooele UT	Oregon DEQ
1	FF19553	SO2	7	Airgas	Tooele UT	Oregon DEQ
1	CLM09545	NO,NOX	7	Airgas	Tooele UT	Oregon DEQ
2	BR0011385	CO	7	Global Calibration Gases	Sarasota FL	North Carolina DEQ
1	ET0032606	SO2	7	Matheson	Waverly TN	Kansas DHE
1	ET0033881	SO2	7	Matheson	Waverly TN	Kansas DHE
2	EB0051619	SO2	7	Global Calibration Gases	Sarasota FL	North Carolina DEQ
1	FF42766	CO	7	Linde	Los Angeles CA	Oregon DEQ
2	DT0008471 Ω	CO,NO,NOX, SO2	7	Linde	Los Angeles CA	National Park Service
1	FF524605	CO	7	Linde	Toledo OH	Indiana DEM
1	FF64232	SO2	7	Linde	Toledo OH	Indiana DEM
1	FF62591 Ω	NO,NOX	7	Linde	Toledo OH	Indiana DEM
4	LL23399	CO,NO,NOX	7	Airgas	Los Angeles CA	South Coast AQMD

TABLE 2. GAS STANDARDS SENT TO RAVLS

Notes: **Ω** NO_X concentration provided by Producer as "informational only"; concentration not certified 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 an individual protocol gas standard concentration was within ±2% of the certified value. The Ambient Air Protocol Gas Verification Program has never identified an acceptance criterion for the protocol gases. Since the AA-PGVP does not sample enough cylinder standards to provide a statistically rigorous assessment of any specialty gas producer, the RAVLs report all valid results as analyzed without declaring a pass or fail determination for individual specialty gas producers. However, it is suggested that any observed assay verification results with a 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 and NO_x verification results. Tables 4 and 5 are grouped by pollutant standard and then sorted by absolute Bias of the assay result.

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. 2021 AA-PGVP CO and SO_2 Verifications‡

Producer	Facility	Cylinder ID	Pollutant	Assay Conc	Producer Conc	% Bias*	95% Uncertainty**
Airgas	Tooele UT	EA0027587	CO	100.14	99.01	-1.1	0.36
Global Cal. Gases	Sarasota FL	BR0011385	CO	199.7	198	-0.9	0.37
Linde	Los Angeles CA	FF42766	CO	19.48	19.51	0.2	0.21
Linde	Los Angeles CA	DT0008471	CO	160.9	160.6	-0.2	0.36
Linde	Toledo OH	FF524605	CO	2026.52	2025	-0.1	0.21
Airgas	Los Angeles CA	LL23399	CO	913.7	912.9	-0.1	0.24
Matheson	Waverly TN	ET0032606	SO_2	9.94	10.2	2.6	0.16
Matheson	Waverly TN	ET0033881	SO_2	10.02	10.2	1.8	0.13
Global Cal. Gases	Sarasota FL	EB0051619	SO_2	19.67	20	1.7	0.16
Linde	Los Angeles CA	DT0008471	SO_2	24.44	24.1	-1.4	0.15
Airgas	Tooele UT	FF19553	SO_2	10	10.07	0.7	0.16
Linde	Toledo OH	FF64232	SO_2	50.39	50.4	0	0.12

TABLE 4. AA-PGVP CO AND SO_2 VERIFICATIONS

Notes: * Table grouped by Pollutant and sorted by absolute Bias
** Analytical measurement uncertainty of the RAVL. This value is not the expanded measurement uncertainty.
‡ An Estimate for the national usage for specific protocol gas producers cannot be determined due to lack of participation in annual survey

Table 5. 2021 AA-PGVP NO and NO_x Verifications‡

Producer	Facility	Cylinder ID	Pollutant	Assay Conc	Producer Conc	% Bias*	95% Uncertainty**
Linde	Toledo OH	FF62591	NO	45.22	45.7	1.1	0.33
Airgas	Tooele UT	CLM09545	NO	20.35	20.31	-0.2	0.33
Airgas	Los Angeles CA	LL23399	NO	44.92	45.03	0.2	0.23
Linde	Los Angeles CA	DT0008471	NO	37.21	37.2	0	0.28
Linde	Toledo OH	FF62591 Ω	NO_X	45.3	46.1	1.8	0.33
Linde	Los Angeles CA	DT0008471 Ω	NO_X	37.21	37.3	0.2	0.36
Airgas	Tooele UT	CLM09545	NO_X	20.35	20.38	0.1	0.33
Airgas	Los Angeles CA	LL23399	NO_X	45.09	45.1	0	0.22

TABLE 5. AA-PGVP NO AND NOX VERIFICATIONS

Notes: * Table grouped by Pollutant and sorted by absolute Bias
** Analytical measurement uncertainty of the RAVL. This value is not the expanded measurement uncertainty.
‡ An Estimate for the national usage for specific protocol gas producers cannot be determined due to lack of participation in annual survey
Ω NO_X concentration provided by Producer as "informational only"; concentration not certified by Producer.

The AA-PGVP received 13 cylinders for assay verification during calendar year 2021. The assay results for these cylinders are included in Tables 4 and 5.

All but one of the results for the CO and SO_2 standards were within the ±2% acid rain criteria acceptance criterion. None of the CO and SO_2 standards were outside of the ±2% criteria when the expanded uncertainty is included. Additionally, none of the CO and SO_2 standards were outside of the ±4% criteria that the AA-PGVP considers a cause for concern. All results for the NO and NO_X standards were within the ±2% acid rain criteria acceptance criterion.

In 2021 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.

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 the goals for the AA-PGVP as defined in the ambient air monitoring rule (published March 28, 2016) was for the verifications performed by the RAVLs to be focused more on the 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 (verifications of gas cylinders that are blind to the producers) cannot be accomplished if EPA relies on the specialty gas producers to submit cylinders for the assessment. All 13 of the protocol gas cylinder standards submitted for analysis were submitted by SLT ambient air monitoring programs.

While the program is successfully implementing a blind verification process, only 13 cylinders were analyzed in 2021 or 15% of the AA-PGVP goal of 80 cylinders annually. These 13-cylinder submissions resulted in only 20 verifications performed in 2021 (some cylinders are a blend of multiple gas standards). None of the assay verification results were greater than the AA-PGVP action level for concern (±4%). It is difficult to assess whether these results are representative of the quality of the standards used in the national ambient air monitoring networks during 2021 due to the low utilization of the RAVL by the monitoring programs and low participation rate in the annual protocol gas questionnaire. In 2021 there were 23 commercially operated EPA protocol gas production facilities. It is uncertain how many of these facilities were used in the ambient air monitoring networks in 2021. Additionally, of the 23 protocol gas production facilities operating, only five were verified by EPA's ambient air protocol gas verification program during calendar year 2021.

Survey Participation Improvement –
Since its inception, the AA-PGVP has relied on an annual survey to determine which gas production facilities are used by the SLTs for generating CO, SO_2, and NO_2 calibration test atmospheres. 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 ambient air

monitoring programs using protocol gases were required to annually complete the survey. While it was thought at the time that this regulatory requirement would increase the participation rate and create a comprehensive list of the protocol gas producers used in the national network, the survey participation rate did not improve. In calendar year 2021 participation in the annual questionnaire was about 3% of the monitoring agencies that operate CO, SO_2, and NO_2 ambient air analyzers. The limited utilization of the annual questionnaire in 2021 was in part due to EPA contractual issues that resulted in a work stoppage by EPA's contractor that hosts the website and database for the annual questionnaire. 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 2016 revisions of the monitoring rule, the AA-PGVP continues to achieve blind verifications of the protocol gas cylinders used in our ambient air monitoring networks. However, the program still does 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 representatively assess the quality of the routine measurement data for the national ambient air monitoring networks was not achieved in calendar year 2021. Only twelve protocol gas cylinder standards were submitted by six PQAOs in 2021 to support this national program. Region 7 assayed all the cylinders received during this calendar year. A better national sampling of monitoring programs and protocol gas producers continues to be needed.

The limited verifications performed in 2021 was partially due to the lack of low concentration SRMs currently available from NIST. This has led to cases where the EPA was forced to decline low concentration cylinder standards offered by SLT regulatory ambient air monitoring programs for assay verification. OAQPS is working to add assay capacity in 2022 and 2023 by using the Region 4 laboratory as an additional RAVL. OAQPS is also investigating the feasibility of obtaining primary reference materials (PRM) from the Netherland's National Metrology Institute; Dutch Von Swinden Laboratorium (VSL) for low concentration Primary Reference Materials (PRMs).

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. During calendar year 2022 EPA intends to begin updating the analytical SOP for the assay verification.

In 2021, 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. Once operational, Region 4 RAVL will allow for both increased assay capacity for the AA-PGVP and provide additional internal quality control between the two RAVLs.

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. Historically data entry errors on the annual survey and chain of custody forms and the lack of key fields between these systems have impeded analysis of the information collected for this program. During calendar 2021, a revised spreadsheet based COC form was used that incorporated basic data validation for these key fields. Since the adoption of the revised COC, data entry errors for agency name, PQAO, and Protocol Gas Producers have ceased.

During calendar 2021 OAQPS continued to actively pursue an AQS database solution to replace some of the data management practices historically performed by EPA's contractor. This includes modifications to the current AQS "QA-Transaction" file format for the single point quality control checks and annual performance audits. The modifications being developed would allow for documenting the protocol gas production 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 22% effective between 2016-2021. To facilitate these enhancements, a beta AQS entry form for submission of cylinder metadata was developed in calendar year 2021 and is being tested internally by OAQPS. AQS now has the capability to track the active protocol gas production facilities that are managed by the Clean Air Markets Division. During Calendar Year 2022 SLT monitoring programs should begin utilizing this new AQS capability to track EPA protocol gas pollutant cylinder standards. Progress continues with merging the cylinder metadata with the data stream containing the single point quality control checks and annual performance audits that are submitted by SLT monitoring programs to AQS. EPA's goal is to have both these new AA-PGVP systems operational in AQS during calendar 2022.

Appendix A QA Reports from Measurement Data Worksheets for 2021

Ambient Air Protocol Gas Verification Program
QA Reports from Measurement Data Worksheets for 2021

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 2021.

QA Requirements Summary

	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	1050	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	1825	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	30-Dec-21	Standard OK
	Low Flow Standard Expiration Date	30-Dec-21	Standard OK
	Ultra Low Flow Standard Expiration Date	6-Jan-22	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	28-Feb-21	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.0	0.9999994	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.0	0.9999919	Low MFC OK
Carbon Monoxide Gas Analyzer	Analyzer Calibration within 2 week of assay	28-Feb-21	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL	0.34%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.35%	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	0.39%	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	1.0007	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	1-Mar-21	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.119%	Dilution Check RSD is OK
Day of Assay Zero/Span Check	Day of Assay Zero Check - Std. Error < 1%	Std. Error is okay.	Zero Gas Std. Error is OK
	Day of Assay Zero Check - Relative Difference < 5%	RD is okay.	Zero Gas RD is OK
	Day of Assay Span Check - Std. Error < 1%	Std. Error is okay.	Span Gas Std. Error is OK
	Day of Assay Span Check - Relative Difference <5%	RD is okay.	Span Gas RD is OK
Challenge Standard #1 Assay	Challenge Standard #1 Std. Error < 1%	The standard error is okay.	Challenge Standard #1 Std. Error is OK
	Challenge Standard #1 vendor certificate bias	0.07%	Challenge Std. #1 vendor certificate bias < 2%
Challenge Standard #2 Assay	Challenge Standard #2 Std. Error < 1%	The standard error is okay.	Challenge Standard #2 Std. Error is OK
	Challenge Standard #2 vendor certificate bias	-0.16%	Challenge Std. #2 vendor certificate bias < 2%

QA Requirements Summary

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	13-Apr-24	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	1900	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	550	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	30-Dec-21	Standard OK
	Low Flow Standard Expiration Date	30-Dec-21	Standard OK
	Ultra Low Flow Standard Expiration Date	6-Jan-22	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	28-Feb-21	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.0	0.9999994	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.0	0.9999919	Low MFC OK
Carbon Monoxide Gas Analyzer	Analyzer Calibration within 2 week of assay	1-Mar-21	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL	0.33%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.34%	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	0.38%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL	0.41%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	1.0030	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	2-Mar-21	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	-0.155%	Dilution Check RSD is OK
Day of Assay Zero/Span Check	Day of Assay Zero Check - Std. Error < 1%	Std. Error is okay.	Zero Gas Std. Error is OK
	Day of Assay Zero Check - Relative Difference < 5%	RD is okay.	Zero Gas RD is OK
	Day of Assay Span Check - Std. Error < 1%	Std. Error is okay.	Span Gas Std. Error is OK
	Day of Assay Span Check - Relative Difference <5%	RD is okay.	Span Gas RD is OK
Challenge Standard #1 Assay	Challenge Standard #1 Std. Error < 1%	The standard error is okay.	Challenge Standard #1 Std. Error is OK
	Challenge Standard #1 vendor certificate bias	1.14%	Challenge Std. #1 vendor certificate bias < 2%

QA Requirements Summary

	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	375	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	800	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	30-Dec-21	Standard OK
	Low Flow Standard Expiration Date	30-Dec-21	Standard OK
	Ultra Low Flow Expiration Date	6-Jan-22	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	28-Feb-21	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.0	0.9999994	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.0	0.9999919	Low MFC OK
Oxides of Nitrogen Gas Analyzer NO Portion	Analyzer Calibration within 2 weeks of assay	7-Mar-21	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL	0.43%	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	0.49%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL	0.54%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9966	Analyzer Slope is acceptable
Oxides of Nitrogen Gas Analyzer NOx Portion	Analyzer Calibration within 2 week of assay	7-Mar-21	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL	0.49%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.51%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.53%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.57%	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	0.9952	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	1-Mar-21	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.119%	Dilution Check RSD is OK
Day of Assay Zero/Span Check NO Portion	Day of Assay Zero Check - Std. Error < 1%	Std. Error is okay.	Zero Gas Std. Error is OK
	Day of Assay Zero Check - Relative Difference < 5%	RD is okay.	Zero Gas RD is OK
	Day of Assay Span Check - Std. Error < 1%	Std. Error is okay.	Span Gas Std. Error is OK
	Day of Assay Span Check - Relative Difference <5%	RD is okay.	Span Gas RD is OK
Day of Assay Zero/Span Check NOx Portion	Day of Assay Zero Check - Std. Error < 1%	Std. Error is okay.	Zero Gas Std. Error is OK
	Day of Assay Zero Check - Relative Difference < 5%	RD is okay.	Zero Gas RD is OK
	Day of Assay Span Check - Std. Error < 1%	Std. Error is okay.	Span Gas Std. Error is OK
	Day of Assay Span Check - Relative Difference <5%	RD is okay.	Span Gas RD is OK
Challenge Standard #1 NO Assay	Challenge Standard #1 Std. Error < 1%	The standard error is okay.	Challenge Standard #1 Std. Error is OK
	Challenge Standard #1 vendor certificate bias	-1.04%	Challenge Std. #1 vendor certificate bias < 2%
Challenge Standard #1 NOx Assay	Challenge Standard #1 Std. Error < 1%	The standard error is okay.	Challenge Standard #1 Std. Error is OK
	Challenge Standard #1 vendor certificate bias	-1.73%	Challenge Std. #1 vendor certificate bias < 2%
Challenge Standard #2 NO Assay	Challenge Standard #2 Std. Error < 1%	The standard error is okay.	Challenge Standard #2 Std. Error is OK
	Challenge Standard #2 vendor certificate bias	0.21%	Challenge Std. #2 vendor certificate bias < 2%
Challenge Standard #2 NOx Assay	Challenge Standard #2 Std. Error < 1%	The standard error is okay.	Challenge Standard #2 Std. Error is OK
	Challenge Standard #2 vendor certificate bias	-0.15%	Challenge Std. #2 vendor certificate bias < 2%

QA Requirements Summary

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	27-Jun-23	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	1200	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	30-Dec-21	Standard OK
	Low Flow Standard Expiration Date	30-Dec-21	Standard OK
	Ultra Low Flow Standard Expiration Date	6-Jan-22	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	28-Feb-21	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.0	0.9999994	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.0	0.9999919	Low MFC OK
Sulfur Dioxide Gas Analyzer	Analyzer Calibration within 2 weeks of assay	2-Mar-21	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	0.15%	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	0.18%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	1.0003	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	1-Mar-21	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.119%	Dilution Check RSD is OK
Day of Assay Zero/Span Check	Day of Assay Zero Check - Std. Error < 1%	Std. Error is okay.	Zero Gas Std. Error is OK
	Day of Assay Zero Check - Relative Difference < 5%	RD is okay.	Zero Gas RD is OK
	Day of Assay Span Check - Std. Error < 1%	Std. Error is okay.	Span Gas Std. Error is OK
	Day of Assay Span Check - Relative Difference <5%	RD is okay.	Span Gas RD is OK
Challenge Standard #1 Assay	Challenge Standard #1 Std. Error < 1%	The standard error is okay.	Challenge Standard #1 Std. Error is OK
	Challenge Standard #1 vendor certificate bias	-0.02%	Challenge Std. #1 vendor certificate bias < 2%
Challenge Standard #2 Assay	Challenge Standard #2 Std. Error < 1%	The standard error is okay.	Challenge Standard #2 Std. Error is OK
	Challenge Standard #2 vendor certificate bias	-1.77%	Challenge Std. #2 vendor certificate bias < 2%

QA Requirements Summary

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	27-Jun-23	
	Primary SRM Cylinder Pressure >150 psi	1200	
	SRM Dilution Check Cylinder Expiration Date	5-Apr-22	
	Dilution Check SRM Cylinder Pressure >150 psi	1625	
Laboratory Flow Standard	High Flow Standard Expiration Date	30-Dec-21	
	Low Flow Standard Expiration Date	30-Dec-21	
	Ultra Low Flow Standard Expiration Date	6-Jan-22	
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	28-Feb-21	
	Calibrated High Flow MFC Slope Range = 0.99 - 1.0	0.9999994	
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.0	0.9999919	
Sulfur Dioxide Gas Analyzer	Analyzer Calibration within 2 weeks of assay	2-Mar-21	
	Estimate of Uncetainty < 1% at point #1 (>80% URL	0.14%	
	Estimate of Uncetainty < 1% at point #2	0.15%	
	Estimate of Uncetainty < 1% at point #3	0.15%	
	Estimate of Uncetainty < 1% at point #4	0.16%	
	Estimate of Uncetainty < 1% at point #5 (~50% URL	0.18%	
	Analyzer slope is within 0.98-1.02	1.0003	
Dilution Check	Dilution Check Date within 2 weeks of assay	1-Mar-21	
	Dilution Check Relative % Difference < 1%	0.119%	Dilution Check RSD is OK
Day of Assay Zero/Span Check	Day of Assay Zero Check - Std. Error < 1%	Std. Error is okay.	Zero Gas Std. Error is OK
	Day of Assay Zero Check - Relative Difference < 5%	RD is okay.	Zero Gas RD is OK
	Day of Assay Span Check - Std. Error < 1%	Std. Error is okay.	Span Gas Std. Error is OK
	Day of Assay Span Check - Relative Difference <5%	RD is okay.	Span Gas RD is OK
Challenge Standard #1 Assay	Challenge Standard #1 Std. Error < 1%	The standard error is okay.	Challenge Standard #1 Std. Error is OK
	Challenge Standard #1 vendor certificate bias	-2.57%	Challenge Std. #1 vendor certificate bias between 2-4%
Challenge Standard #2 Assay	Challenge Standard #2 Std. Error < 1%	The standard error is okay.	Challenge Standard #2 Std. Error is OK
	Challenge Standard #2 vendor certificate bias	-0.71%	Challenge Std. #2 vendor certificate bias < 2%

QA Requirements Summary

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	13-Apr-24	
	Primary SRM Cylinder Pressure >150 psi	1900	
	SRM Dilution Check Cylinder Expiration Date	20-Sep-21	
	Dilution Check SRM Cylinder Pressure >150 psi	550	
Laboratory Flow Standard	High Flow Standard Expiration Date	30-Dec-21	
	Low Flow Standard Expiration Date	30-Dec-21	
	Ultra Low Flow Standard Expiration Date	6-Jan-22	
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	9-May-21	
	Calibrated High Flow MFC Slope Range = 0.99 - 1.0	0.9999997	
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.0	0.9999821	
Carbon Monoxide Gas Analyzer	Analyzer Calibration within 2 week of assay	9-May-21	
	Estimate of Uncetainty < 1% at point #1 (>80% URL	0.47%	
	Estimate of Uncetainty < 1% at point #2	0.48%	
	Estimate of Uncetainty < 1% at point #3	0.51%	
	Estimate of Uncetainty < 1% at point #4	0.54%	
	Estimate of Uncetainty < 1% at point #5 (~50% URL	0.59%	
	Analyzer slope is within 0.98-1.02	1.0071	
Dilution Check	Dilution Check Date within 2 weeks of assay	10-May-21	
	Dilution Check Relative % Difference < 1%	-0.701%	Dilution Check RSD is OK
Day of Assay Zero/Span Check	Day of Assay Zero Check - Std. Error < 1%	Std. Error is okay.	Zero Gas Std. Error is OK
	Day of Assay Zero Check - Relative Difference < 5%	RD is okay.	Zero Gas RD is OK
	Day of Assay Span Check - Std. Error < 1%	Std. Error is okay.	Span Gas Std. Error is OK
	Day of Assay Span Check - Relative Difference <5%	RD is okay.	Span Gas RD is OK
Challenge Standard #1 Assay	Challenge Standard #1 Std. Error < 1%	The standard error is okay.	Challenge Standard #1 Std. Error is OK
	Challenge Standard #1 vendor certificate bias	0.20%	Challenge Std. #1 vendor certificate bias < 2%
Challenge Standard #2 Assay	Challenge Standard #2 Std. Error < 1%	The standard error is okay.	Challenge Standard #2 Std. Error is OK
	Challenge Standard #2 vendor certificate bias	0.84%	Challenge Std. #2 vendor certificate bias < 2%

QA Requirements Summary

	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	500	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	500	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	30-Dec-21	Standard OK
	Low Flow Standard Expiration Date	30-Dec-21	Standard OK
	Ultra Low Flow Expiration Date	6-Jan-22	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	9-May-21	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.0	0.9999997	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.0	0.9999821	Low MFC OK
Oxides of Nitrogen Gas Analyzer NO Portion	Analyzer Calibration within 2 weeks of assay	12-May-21	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL	0.45%	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	0.49%	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	0.57%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9979	Analyzer Slope is acceptable
Oxides of Nitrogen Gas Analyzer NOx Portion	Analyzer Calibration within 2 week of assay	12-May-21	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL	0.58%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.59%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.62%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.66%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL	0.72%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9965	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	10-May-21	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	-0.701%	Dilution Check RSD is OK
Day of Assay Zero/Span Check NO Portion	Day of Assay Zero Check - Std. Error < 1%	Std. Error is okay.	Zero Gas Std. Error is OK
	Day of Assay Zero Check - Relative Difference < 5%	RD is okay.	Zero Gas RD is OK
	Day of Assay Span Check - Std. Error < 1%	Std. Error is okay.	Span Gas Std. Error is OK
	Day of Assay Span Check - Relative Difference <5%	RD is okay.	Span Gas RD is OK
Day of Assay Zero/Span Check NOx Portion	Day of Assay Zero Check - Std. Error < 1%	Std. Error is okay.	Zero Gas Std. Error is OK
	Day of Assay Zero Check - Relative Difference < 5%	RD is okay.	Zero Gas RD is OK
	Day of Assay Span Check - Std. Error < 1%	Std. Error is okay.	Span Gas Std. Error is OK
	Day of Assay Span Check - Relative Difference <5%	RD is okay.	Span Gas RD is OK
Challenge Standard #1 NO Assay	Challenge Standard #1 Std. Error < 1%	The standard error is okay.	Challenge Standard #1 Std. Error is OK
	Challenge Standard #1 vendor certificate bias	0.02%	Challenge Std. #1 vendor certificate bias < 2%
Challenge Standard #1 NOx Assay	Challenge Standard #1 Std. Error < 1%	The standard error is okay.	Challenge Standard #1 Std. Error is OK
	Challenge Standard #1 vendor certificate bias	-0.25%	Challenge Std. #1 vendor certificate bias < 2%

QA Requirements Summary

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	27-Jun-23	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	1050	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	30-Dec-21	Standard OK
	Low Flow Standard Expiration Date	30-Dec-21	Standard OK
	Ultra Low Flow Standard Expiration Date	6-Jan-22	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	9-May-21	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.0	0.9999997	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.0	0.9999821	Low MFC OK
Sulfur Dioxide Gas Analyzer	Analyzer Calibration within 2 weeks of assay	11-May-21	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	0.22%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.23%	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	1.0018	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	10-May-21	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	-0.701%	Dilution Check RSD is OK
Day of Assay Zero/Span Check	Day of Assay Zero Check - Std. Error < 1%	Std. Error is okay.	Zero Gas Std. Error is OK
	Day of Assay Zero Check - Relative Difference < 5%	RD is okay.	Zero Gas RD is OK
	Day of Assay Span Check - Std. Error < 1%	Std. Error is okay.	Span Gas Std. Error is OK
	Day of Assay Span Check - Relative Difference <5%	RD is okay.	Span Gas RD is OK
Challenge Standard #1 Assay	Challenge Standard #1 Std. Error < 1%	The standard error is okay.	Challenge Standard #1 Std. Error is OK
	Challenge Standard #1 vendor certificate bias	1.40%	Challenge Std. #1 vendor certificate bias < 2%
Challenge Standard #2 Assay	Challenge Standard #2 Std. Error < 1%	The standard error is okay.	Challenge Standard #2 Std. Error is OK
	Challenge Standard #2 vendor certificate bias	-1.63%	Challenge Std. #2 vendor certificate bias < 2%

QA Requirements Summary

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	7-Feb-28	
	Primary SRM Cylinder Pressure >150 psi	2100	
	SRM Dilution Check Cylinder Expiration Date	30-Sep-27	
	Dilution Check SRM Cylinder Pressure >150 psi	1800	
Laboratory Flow Standard	High Flow Standard Expiration Date	30-Dec-21	
	Low Flow Standard Expiration Date	30-Dec-21	
	Ultra Low Flow Standard Expiration Date	6-Jan-22	
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	6-Nov-21	
	Calibrated High Flow MFC Slope Range = 0.99 - 1.0	0.9999994	
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.0	0.9999846	
Carbon Monoxide Gas Analyzer	Analyzer Calibration within 2 week of assay	8-Nov-21	
	Estimate of Uncetainty < 1% at point #1 (>80% URL	0.23%	
	Estimate of Uncetainty < 1% at point #2	0.25%	
	Estimate of Uncetainty < 1% at point #3	0.26%	
	Estimate of Uncetainty < 1% at point #4	0.28%	
	Estimate of Uncetainty < 1% at point #5 (~50% URL	0.30%	
	Analyzer slope is within 0.98-1.02	1.0000	
Dilution Check	Dilution Check Date within 2 weeks of assay	8-Nov-21	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.293%	Dilution Check RSD is OK
Day of Assay Zero/Span Check	Day of Assay Zero Check - Std. Error < 1%	Std. Error is okay.	Zero Gas Std. Error is OK
	Day of Assay Zero Check - Relative Difference < 5%	RD is okay.	Zero Gas RD is OK
	Day of Assay Span Check - Std. Error < 1%	Std. Error is okay.	Span Gas Std. Error is OK
	Day of Assay Span Check - Relative Difference <5%	RD is okay.	Span Gas RD is OK
Challenge Standard #1 Assay	Challenge Standard #1 Std. Error < 1%	The standard error is okay.	Challenge Standard #1 Std. Error is OK
	Challenge Standard #1 vendor certificate bias	-0.32%	Challenge Std. #1 vendor certificate bias < 2%
Challenge Standard #2 Assay	Challenge Standard #2 Std. Error < 1%	The standard error is okay.	Challenge Standard #2 Std. Error is OK
	Challenge Standard #2 vendor certificate bias	-1.39%	Challenge Std. #2 vendor certificate bias < 2%
Challenge Standard #3 Assay	Challenge Standard #3 Std. Error < 1%	The standard error is okay.	Challenge Standard #3 Std. Error is OK
	Challenge Standard #3 vendor certificate bias	-0.08%	Challenge Std. #3 vendor certificate bias < 2%

QA Requirements Summary

	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	450	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	450	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	30-Dec-21	Standard OK
	Low Flow Standard Expiration Date	30-Dec-21	Standard OK
	Ultra Low Flow Expiration Date	6-Jan-22	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	6-Nov-21	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.0	0.9999994	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.0	0.9999846	Low MFC OK
Oxides of Nitrogen Gas Analyzer NO Portion	Analyzer Calibration within 2 weeks of assay	10-Nov-21	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	0.25%	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	0.29%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL	0.31%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	1.0047	Analyzer Slope is acceptable
Oxides of Nitrogen Gas Analyzer NOx Portion	Analyzer Calibration within 2 week of assay	10-Nov-21	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	0.22%	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	0.28%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	1.0019	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	8-Nov-21	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.293%	Dilution Check RSD is OK
Day of Assay Zero/Span Check NO Portion	Day of Assay Zero Check - Std. Error < 1%	Std. Error is okay.	Zero Gas Std. Error is OK
	Day of Assay Zero Check - Relative Difference < 5%	RD is okay.	Zero Gas RD is OK
	Day of Assay Span Check - Std. Error < 1%	Std. Error is okay.	Span Gas Std. Error is OK
	Day of Assay Span Check - Relative Difference <5%	RD is okay.	Span Gas RD is OK
Day of Assay Zero/Span Check NOx Portion	Day of Assay Zero Check - Std. Error < 1%	Std. Error is okay.	Zero Gas Std. Error is OK
	Day of Assay Zero Check - Relative Difference < 5%	RD is okay.	Zero Gas RD is OK
	Day of Assay Span Check - Std. Error < 1%	Std. Error is okay.	Span Gas Std. Error is OK
	Day of Assay Span Check - Relative Difference <5%	RD is okay.	Span Gas RD is OK
Challenge Standard #1 NO Assay	Challenge Standard #1 Std. Error < 1%	The standard error is okay.	Challenge Standard #1 Std. Error is OK
	Challenge Standard #1 vendor certificate bias	0.24%	Challenge Std. #1 vendor certificate bias < 2%
Challenge Standard #1 NOx Assay	Challenge Standard #1 Std. Error < 1%	The standard error is okay.	Challenge Standard #1 Std. Error is OK
	Challenge Standard #1 vendor certificate bias	0.01%	Challenge Std. #1 vendor certificate bias < 2%

United States Environmental Protection Agency	Office of Air Quality Planning and Standards Air Quality Assessment Division Research Triangle Park, NC	Publication No. EPA-454/R-22-004 June 2022