U.S. EPA
Ambient Air Protocol Gas Verification Program
Annual Report, CY 2023

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U.S. EPA Ambient Air Protocol Gas Verification Program Annual Report CY 2023

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
CO	Carbon Monoxide
CONC	Concentration
CY	Calendar Year
DoE	Declaration of Equivalence with the National Institute of Standards and Technology
EPA	Environmental Protection Agency
GMIS	Gas Manufacturer's Intermediate 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 that the monitoring organizations implementing these programs ("the regulated community") to use EPA Protocol Gases as their calibration gases. EPA revised the protocol to establish detailed statistical procedures for estimating the total uncertainty of these gases. EPA's Acid Rain Program developed acceptance criteria for the uncertainty estimate[3].

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

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

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

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

[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

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

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.

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 designed to ensure that producers selling EPA Protocol Gases are evaluated by the AA-PGVP and provides end users with information about participating producers and verification results.

The EPA Ambient Air Monitoring Program's QA requirements, Section 2.6.1 of 40 CFR Part 58, Appendix A, are:

> *2.6.1 Gaseous pollutant concentration standards (permeation devices or cylinders of compressed gas) used to obtain test concentrations for CO, SO_2, NO, and NO_2 must be EPA Protocol Gases certified in accordance with one of the procedures given in Reference 4 of this appendix.*
>
> > *2.6.1.1 The concentrations of EPA Protocol Gas standards used for ambient air monitoring must be certified with a 95-percent confidence interval to have an analytical uncertainty of no more than ±2.0 percent (inclusive) of the certified concentration (tag value) of the gas mixture. The uncertainty must be calculated in accordance with the statistical procedures defined in Reference 4 of this appendix.*
> >
> > *2.6.1.2 Specialty gas producers 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 adhere to the regulatory requirements specified in 40 CFR 75.21(g) or not use "EPA" in any form of advertising. Monitoring organizations must provide information to the EPA on the specialty gas producers they use on an annual basis. PQAOs, when requested by the EPA, must participate in the EPA Ambient Air Protocol Gas Verification Program at least once every 5 years by sending a new unused standard to a designated verification laboratory.*

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. 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 to be used in the Acid Rain Program. The AA-PGVP adopted this criterion 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.

Purpose of this Document

The purpose of this document is to report the activities that occurred in 2023 and provide the results of the verifications performed.

Because the AA-PGVP does not sample enough cylinder standards annually 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 assay verification results with a difference more than ±4% is cause for concern. The AA-PGVP assay verifications are not intended to 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 evaluated by the program and provide information that may be helpful when selecting a producer.

This document will not explain the implementation of the AA-PGVP, the quality system or the verification procedures. That information has been documented in the Implementation Plan, Quality Assurance Project Plan (QAPP) and standard operating procedures (SOPs). These documents can be found on the AA-PGVP section on the Ambient Monitoring Technology Information Center (AMTIC)[5] website. The AA-PGVP SOPs are in the AA-PGVP QAPP as an appendix.

2.0 Implementation Summary

Since the program implementation in 2010, when most of the initial preparation work took place, no major new implementation activities have taken 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 (CY) 2019. In 2020 EPA began reengineering the AA-PGVP and transitioning Region 2 operations to the Region 4 laboratory. During 2023 the Region 4 RAVL began performing capability demonstrations and swapping internal quality control samples with the Region 7 RAVL. New AQS cylinder tracking features have been deployed as optional use for the SLT monitoring programs and some agencies have started to use these new AQS features.

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 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 2023 only 54 agencies participated in the survey. With only limited survey results, a systematic selection of producers could not be performed. During calendar year 2023 the AA-PGVP performed assays on all cylinders submitted by regulatory monitoring agencies. 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. During CY-2022 a cylinder metadata entry form to support the AA-PGVP was created in AQS. Cylinder usage data that was historically collected via the annual survey began to be collected via AQS. In CY-2022 only 2 agencies (North Dakota DEQ and California Air Resources Board) used AQS to report the specialty gas producers used for their calibration standards while the other agencies used EPA's deprecating annual survey system. In CY-2023 the number of agencies using the AQS Maintain Cylinder Form to

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

report the specialty gas producers used in their monitoring networks increased from these 2 agencies to 24 agencies. The total number of agencies meeting their protocol gas reporting requirement in calendar year 2023 was 54. Of the 24 agencies using the AQS Maintain Cylinder form, 14 of these agencies elected to solely use this AQS reporting system and have migrated away from using the annual survey system hosted by EPA's contractor on the AirQA website.

AA-PGVP Verification Dates

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

Quarter	Cylinder Receipt	Analysis
1	No later than Mar 10	Mar 20 – Mar 31
2	No later than May 26	Jun 5 – Jun16
3	No later than Sept 1	Sept 11 – Sept 22
4	No later than Nov 24	Dec 4 – Dec 15
Open House	December 13, 2023	NA

TABLE 1. RAVL VERIFICATION DATES

During Open House the RAVL allows specialty gas producers to visit and ask questions regarding the laboratory processes and operations. During 2023 no specialty gas producers visited the Region 7 RAVL.

Workflow 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.

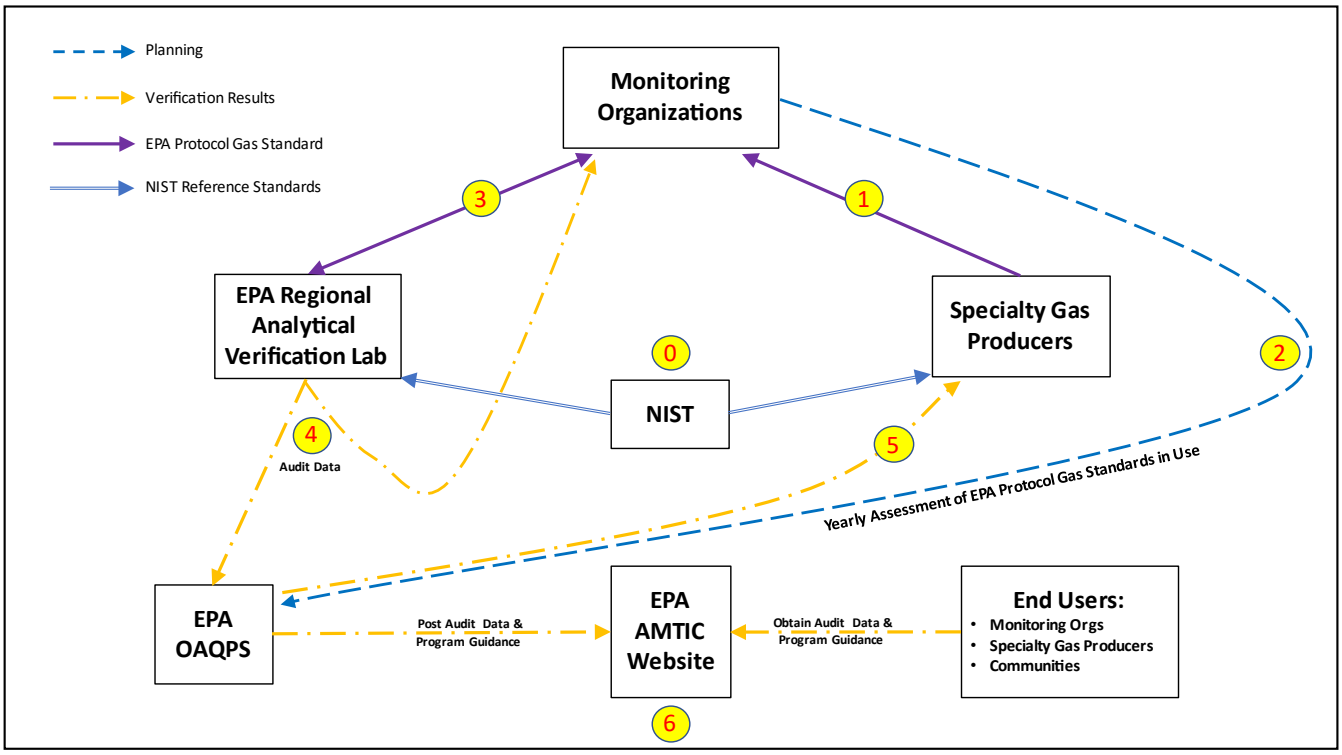

FIGURE 1. AA-PGVP FLOW CHART

0. Specialty Gas Producers procure standards from NIST, or an NMI with a DoE with NIST, to establish traceability of their EPA Protocol Gas Standards to the SI. RAVLs also procure NIST standards as part of the AA-PGVP.
1. Monitoring organizations order EPA Protocol Gas Standards as a normal course of business.
2. EPA sends reminder e-mails to the monitoring organization's points of contact to enter cylinder metadata in AQS or complete AA-PGVP's Survey. Based on an annual assessment of this information, monitoring organizations are selected to send cylinder standards to EPA for assay verification. Through consultation with the participating monitoring organization, EPA schedules the assay verifications.
3. The participating monitoring organizations send a new/unused standard, certificate of analysis, and chain of custody form to the RAVLs for the assay verification. Standards are returned to the monitoring organization along with the verification results for their standards.
4. The RAVLs provide the validated results to OAQPS.
5. When the assay verification results are greater than ±4% of the certified concentration, or greater than ±2% when the expanded measurement uncertainty is included, specialty gas producers are notified by OAQPS.
6. OAQPS compiles the year's verification results into an annual report and posts it to the AMTIC website.

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.

To assess which specialty gas producers are used in the national monitoring network, monitoring organizations can either complete a web-based survey annually or document the cylinders used at their sites in AQS. Since 2016, EPA regulations (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. The difference in the total surveyed and the AirQA Survey trendlines for CY-2023 (14 agencies) are the agencies that met this regulatory reporting requirement using AQS alone. EPA intends to phase out the AirQA survey system in favor of the AQS reporting mechanism. EPA anticipates that this transition to the AQS reporting system will be completed by July 1, 2025.

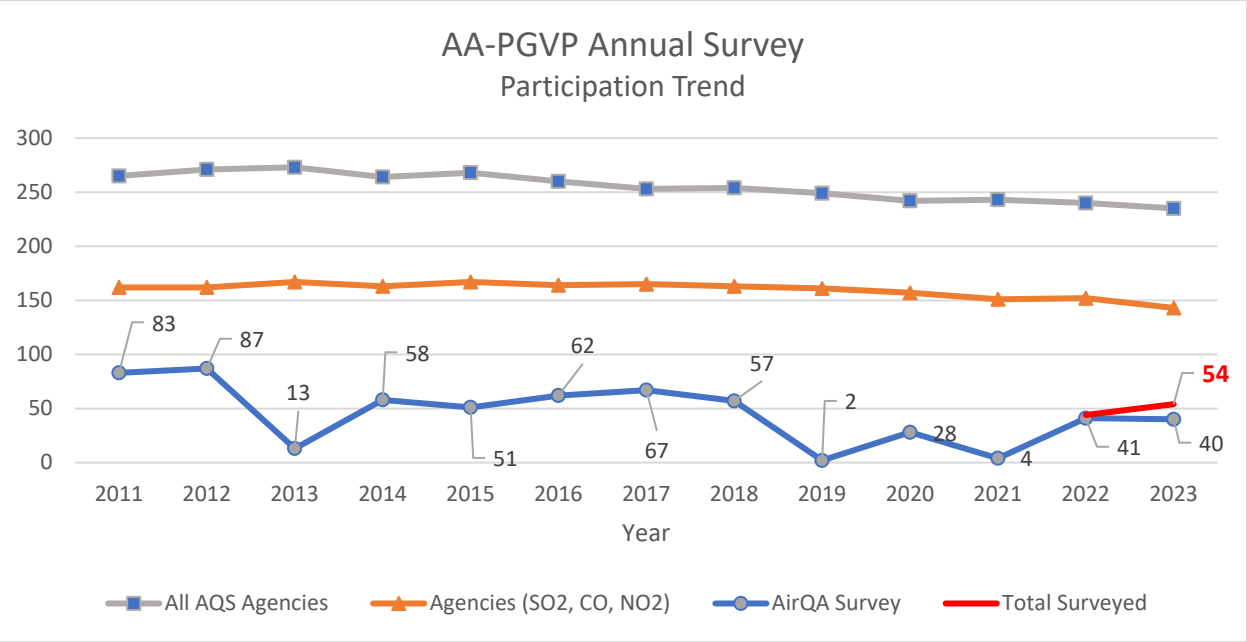

FIGURE 2. AA-PGVP ANNUAL SURVEY

Verification Results

The AA-PGVP received seven cylinders from SLT monitoring programs for assay verification during calendar year 2023. These seven cylinders received by the EPA are listed in Table 2. As can be seen from Table 2, some cylinders contain more than a single calibration gas standard. A summary of the assay results for these cylinders are provided in Tables 4 and 5.

Qtr	Cylinder ID	Pollutant	Lab	Producer	Facility	Agency
2	EB0086492	NO,NO_X	7	Airgas	Chicago IL	Missouri Laboratory Services Program
3	LL40350	CO	7	Airgas	Tooele UT	Colorado Department of Public Health & Environment
3	CC697663	NO,NO_X	7	Airgas	Tooele UT	Utah Department of Environmental Quality
3	CC697669	NO,NO_X	7	Airgas	Tooele UT	Utah Department of Environmental Quality

3	FF776	CO	7	Coastal Specialty Gas	Beaumont TX	Oregon Department of Environmental Quality
3	FF13090	NO,NO_X Ω	7	Coastal Specialty Gas	Beaumont TX	Oregon Department of Environmental Quality
4	EX0012199	NO,NO_X Ω	7	Linde	Toledo OH	Wisconsin Dept Of Natural Resources, Air Monitoring Section

Table 2. Gas Standards Sent to RAVLs in Calendar Year 2023

TABLE 2. GAS STANDARDS SENT TO RAVLS

Notes: Ω NO_X concentration provided by Producer as "informational only" without defining Uncertainty. Concentration not certified by Producer.

All standards verified in calendar year 2023 were observed to be less than the AA-PGVP action level for concern (±4%). Figure 3 provides a historical trend showing the improvement in the quality of EPA Protocol Gas Standards from the inception of the program to present.

Figure 3. Trend of Assay Verification Results performed by EPA ORD and OAQPS

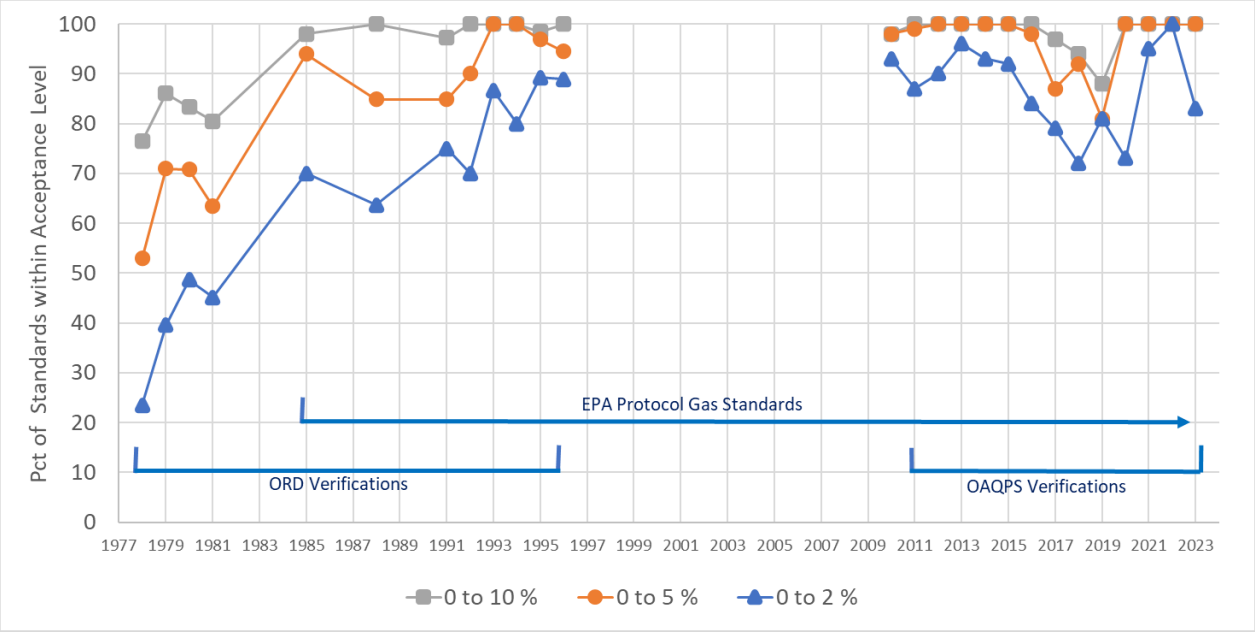

FIGURE 3. VERIFICATION TREND

Information related to the analytical reference standards, analytical instruments and methods used, the data reduction procedures, and the data assessment procedures are found in the AA-PGVP QAPP and SOP. The AA-PGVP QAPP is located on EPA's AMTIC website. The SOP can be found as an appendix in the QAPP. 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 is dedicated for the verification results for CO and SO_2. No SO_2 standards were submitted by SLTs for assessment in CY-2023 so only CO results are listed in Table 4. 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.

Two cylinders were received directly from specialty gas producers during 2023. The results are not provided in summary Tables 4 and 5 because the verifications of the cylinders were not performed blind to the producers but are

discussed here. Westair provided a direct cylinder submission for an NO standard that was certified at 90.2 ppm. EPA's verification result for this cylinder was 88.98 ppm (bias of 1.37%). Linde provided a direct cylinder submission for an SO2 standard that was certified at 40.3 ppm. EPA's verification result for this cylinder was 40.00 ppm (bias of 0.76%).

Table 3. MQOs for the AA-PGVP

Requirement	Frequency	Acceptance Criteria	Protocol Gas Doc. Reference	Comments
Completeness	All standards analyzed	95%	NA	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	NA	Sample run three times to verify value.
Lab Comparability	2/year	± 2 % RPD	NA	Sample run three average value used.
Primary flow standard	Annually certified by NVLAP accredited lab	0.4 %	NA	Compared to NIST Traceable
NIST SRMs	Day of Verification	SRM within certification period and Cylinder pressure > 150 psig	NA	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. 2023 AA-PGVP CO and SO_2 Verifications‡

Producer	Facility	Cylinder ID	Pollutant	Assay Conc	Producer Conc	% Bias*	95% Uncertainty**
Coastal Specialty Gas	Beaumont TX	FF776	CO	102.7	102	-0.7	0.6
Airgas USA	Tooele UT	LL40350	CO	298.2	298.4	0.1	0.18

TABLE 4. AA-PGVP CO AND SO_2 VERIFICATIONS

Notes: * Table grouped by Pollutant and sorted by absolute Bias
** Analyzer uncertainty, see Quality Assurance Requirements Section 13.7 of SOP.
(Analyzer uncertainty 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 and no SO2 verifications were performed during CY-2023

Table 5. 2023 AA-PGVP NO and NO_x Verifications‡

Producer	Facility	Cylinder ID	Pollutant	Assay Conc	Producer Conc	% Bias*	95% Uncertainty**
Coastal Specialty Gas	Beaumont TX	FF13090	NO	26.2	26.84	2.4	0.16
Airgas USA	Tooele UT	CC697663	NO	55.27	55.94	1.2	0.16
Linde Gas and Equipment Inc.	Toledo OH	EX0012199	NO	30.16	30.3	0.5	0.13
Airgas USA	Tooele UT	CC697669	NO	55.34	55.5	0.3	0.16
Airgas USA	Chicago IL	EB0086492	NO	31.95	31.96	0	0.35
Coastal Specialty Gas	Beaumont TX	FF13090	NOX	26.19	26.95	2.9	0.22
Airgas USA	Tooele UT	CC697669	NOX	55.96	55.51	-0.8	0.21
Airgas USA	Tooele UT	CC697663	NOX	55.68	56.14	0.8	0.22
Linde Gas and Equipment Inc.	Toledo OH	EX0012199	NOX	30.32	30.5	0.6	0.29
Airgas USA	Chicago IL	EB0086492	NOX	32.16	32.04	-0.4	0.25

TABLE 5. AA-PGVP NO AND NO_x VERIFICATIONS

Notes: * Table grouped by Pollutant and sorted by absolute Bias
** Analyzer uncertainty, see Quality Assurance Requirements Section 13.7 of SOP.
(Analyzer uncertainty 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.

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) is for the verifications performed by the RAVLs to be focused on the standards in use by 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 verification results presented in Tables 2, 4, and 5 of this annual report were submitted by SLT ambient air monitoring programs making the results blind to the specialty gas producers.

While the program is successfully implementing a blind verification process, only seven cylinders, or 9% of the AA-PGVP goal of 80 cylinders annually, were analyzed in 2023. These seven cylinder submissions resulted in 12 verifications (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%). While the results of the assay verifications demonstrate high quality standards being produced by the specialty gas producers, it is difficult to assess whether these results are representative of the overall quality of the standards used in the national ambient air monitoring networks during 2023. This is due to the low utilization of the RAVL by the SLT monitoring programs and low participation rate in the annual protocol gas questionnaire. In 2023 there were 26 commercially operated EPA protocol gas production facilities. It is uncertain how many of these facilities were used in the ambient air monitoring networks in 2023. Of the 26 protocol gas production facilities operating, only four were verified by EPA's ambient air protocol gas verification program.

Survey Participation –

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 regulations were revised to require programs using protocol gases 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 2023 SLT participation in the annual survey could be achieved through the AirQA website or by using AQS cylinder tracking features that were first deployed in calendar year 2022. These cylinder tracking features in AQS were deployed as optional use for the SLT monitoring programs in calendar year 2023. EPA plans to make the usage of these AQS cylinder tracking features required in the future.

SLT participation in reporting their EPA Protocol Gas standards increased from 29% in CY-2022 to 38% in CY-2023. In calendar year 2023, 10 of the 54 agencies participated by using both the AirQA website and AQS and 14 SLT agencies participated by solely using these newly developed AQS cylinder reporting features.

RAVLs –

Since the 2016 revisions of the monitoring rule, the AA-PGVP continues to achieve blind verifications of the protocol gas cylinders used in the 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 standards used in the national ambient air monitoring networks was not achieved in calendar year 2023. Only seven protocol gas cylinder standards were submitted by

three PQAOs in 2023 to support this national program. The Region 7 RAVL assayed all the cylinders received by SLTs during this calendar year. A better national sampling of monitoring programs and protocol gas producers continues to be needed.

The limited verifications performed in 2023 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 ambient air monitoring programs for assay verification. OAQPS is working to add assay capacity in the future by using the EPA Region 4 laboratory as an additional RAVL. OAQPS is also working collaboratively with NIST to develop solutions to the shortage of NIST SRMs available for purchase. In 2023, the EPA began of obtaining primary reference materials (PRM) from the Netherland's National Metrology Institute (MNI); Dutch Von Swinden Laboratorium (VSL). NIST has a Declaration of Equivalence (DoE) with VSL and the AA-PGVP will use PRMs from VSL while the NIST SRM inventory is being replenished.

Quality System –

The AA-PGVP Quality Assurance Project Plan (QAPP) and Standard Operating Procedure (SOP) were written in calendar year 2010. Changes to the program have occurred since 2010, including regulatory changes in 2016. During calendar year 2023 EPA was revising these quality system documents to better reconcile them with current operational practices and regulatory requirements. EPA Region 4 revised the SOP "*Standard Operating Procedures for the Verification of CO Concentrations in EPA Protocol Gas Mixtures*" in May 2023. OAQPS contracted Battelle to assist EPA in revising the AA-PGVP QAPP beginning calendar year 2024. EPA anticipates that revising the QAPP and remaining SOPs will be a multiyear process.

In 2023, the AA-PGVP operated with a single RAVL. As such, the quality assurance pertaining to the laboratory intercomparison could not be performed as design in the QAPP. OAQPS is working with EPA Region 4 to use their laboratory as a second RAVL which, in addition to increasing assay verification capacity, will allow for laboratory intercomparisons. EPA Region 4 performed multiple test assay verifications throughout calendar year 2023 to demonstrate competency and proficiency with the EPA ORD *Traceability Protocol for Assay and Certification of Gaseous Calibration Standards.* One of the cylinders assayed by the Region 4 RAVL had previously been certified by EPA Region 7. The agreement between the two labs was very good with only an 0.08% difference between the Region 7 certified CO standard (tag concentration of 4953 ppm) and Region 4 assay result (verified result of 4956.8 ppm). Once fully operational, the 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 –

The AA-PGVP has historically 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 voluntary and later in 2016 participation in the survey became a regulatory requirement. Neither implementation of this survey has proven to be fully effective. The data management practices for conducting the annual survey and storing its results were not optimized to be readily reconciled with the data produced by the RAVLs.

In response OAQPS developed an AQS database solution in 2022 to replace the data management practices historically performed by EPA's contractor. This includes an AQS form for SLT monitoring programs to submit their cylinder metadata; and modifications to the AQS "QA-Transaction" file format used for uploading 1-Point Quality Control check and Annual Performance Evaluation audit results. These AQS modifications allow for documenting the protocol gas standard used for generating the test atmosphere for the QA/QC check. Utilizing this modified AQS data submission process will allow EPA to document 100% of the protocol gas production facilities used in the ambient air monitoring networks compared to the historic process that has on average only been 29% effective since 2011. Two monitoring

programs used the AQS Cylinder maintain form in calendar year 2022. During calendar year 2023, 24 monitoring programs utilized the AQS maintain cylinder form. Of these 24 SLT monitoring programs, eight of these agencies began also including cylinder metadata with their QA/QC submissions to AQS. EPA's goal during CY-2024 is to see increased adoption of these AQS cylinder tracking features and to fully replace the historic annual survey system with these AQS cylinder tracking features in the future.

Appendix A

QA Reports from Measurement Data Worksheets for 2023

Ambient Air Protocol Gas Verification Program
QA Reports from Measurement Data Worksheets for 2023

During the verification process, the Regional Analytical Verification Laboratories perform quality control checks that are recorded on the Measurement Data Worksheets used to document these verifications. This information is reported and saved along with the verification reports. The following sheets represent the quality control for the verifications that were implemented in 2023.

QA Requirements Summary

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	14-Sep-25	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	1450	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	200	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	5-Dec-23	Standard OK
	Low Flow Standard Expiration Date	6-Dec-23	Standard OK
	Ultra Low Flow Expiration Date	9-Feb-24	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	5-Jun-23	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999986	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999990	Low MFC OK
Oxides of Nitrogen Gas Analyzer NO Portion	Analyzer Calibration within 2 weeks of assay	6-Jun-23	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.39%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.39%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.41%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.42%	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	0.9982	Analyzer Slope is acceptable
Oxides of Nitrogen Gas Analyzer NOx Portion	Analyzer Calibration within 2 week of assay	6-Jun-23	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.30%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.31%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.32%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.33%	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	0.9997	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	6-Jun-23	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.641%	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	-0.36%	Challenge Std. #1 vendor certificate bias < 2%

FIGURE 4. QA SUMMARY FOR TEST NO OF EB0086492 (STD #1)

QA Requirements Summary

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	30-Sep-27	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	1625	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	15-Mar-31	Dilution Check SRM Gas Standard OK
	Dilution Check SRM Cylinder Pressure >150 psi	1800	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	18-May-24	Standard OK
	Low Flow Standard Expiration Date	13-Jun-24	Standard OK
	Base	27-Jun-24	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	9-Sep-23	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999992	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999798	Low MFC OK
Carbon Monoxide Gas Analyzer	Analyzer Calibration within 2 week of assay	12-Sep-23	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	0.25%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.26%	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)	0.31%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	1.0018	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	12-Sep-23	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.353%	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	-0.08%	Challenge Std. #1 vendor certificate bias < 2%

FIGURE 5. QA SUMMARY FOR CO TEST OF LL40350 (STD #1)

QA Requirements Summary

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	15-Mar-31	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	1750	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	2-Jul-28	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	18-May-24	Standard OK
	Low Flow Standard Expiration Date	13-Jun-24	Standard OK
	Base	27-Jun-24	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	9-Sep-23	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999992	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999798	Low MFC OK
Carbon Monoxide Gas Analyzer	Analyzer Calibration within 2 week of assay	18-Sep-23	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.71%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.73%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.77%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.82%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.88%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	1.0021	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	18-Sep-23	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	-0.371%	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	0.68%	Challenge Std. #1 vendor certificate bias < 2%

FIGURE 6. QA SUMMARY FOR CO TEST OF FF776 (STD #1)

QA Requirements Summary

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	14-Sep-25	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	1350	Primary SRM cylinder pressure is OK
	SRM Dilution Check Cylinder Expiration Date	1-Feb-24	Dilution Check SRM Gas Standard OK
	Dilution Check SRM Cylinder Pressure >150 psi	200	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	5-Dec-23	Standard OK
	Low Flow Standard Expiration Date	6-Dec-23	Standard OK
	Ultra Low Flow Expiration Date	9-Feb-24	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	9-Sep-23	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999992	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999798	Low MFC OK
Oxides of Nitrogen Gas Analyzer NO Portion	Analyzer Calibration within 2 weeks of assay	13-Sep-23	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	0.24%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.26%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	1.0020	Analyzer Slope is acceptable
Oxides of Nitrogen Gas Analyzer NOx Portion	Analyzer Calibration within 2 week of assay	13-Sep-23	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	0.38%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.40%	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	1.0001	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	12-Sep-23	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.183%	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	0.29%	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	-0.80%	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	1.22%	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	0.82%	Challenge Std. #2 vendor certificate bias < 2%
Challenge Standard #3 NO 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	2.46%	Challenge Std. #3 vendor certificate bias between 2-4%
Challenge Standard #3 NOx 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	2.91%	Challenge Std. #3 vendor certificate bias between 2-4%

FIGURE 7. QA SUMMARY FOR NO TEST OF CC697669 (STD #1) , CC697663 (STD #2), FF13090 (STD #3)

QA Requirements Summary

	QA Requirement	Result	Status
SRM Gas Standards	Primary SRM Cylinder Expiration Date	14-Sep-25	Primary SRM Gas Standard OK
	Primary SRM Cylinder Pressure >150 psi	1200	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	200	Dilution check SRM cylinder pressure is OK
Laboratory Flow Standard	High Flow Standard Expiration Date	18-May-24	Standard OK
	Low Flow Standard Expiration Date	13-Jun-24	Standard OK
	Ultra Low Flow Expiration Date	27-Jun-24	Standard OK
Calibrator (mass flow controllers)	Calibrator Flow Calibration within 2 weeks of assay	2-Dec-23	Calibrator flow calibration within 2 weeks of assay
	Calibrated High Flow MFC Slope Range = 0.99 - 1.01	0.9999957	High MFC OK
	Calibrated Low Flow MFC Slope Range = 0.99 - 1.01	0.9999920	Low MFC OK
Oxides of Nitrogen Gas Analyzer NO Portion	Analyzer Calibration within 2 weeks of assay	4-Dec-23	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.08%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.08%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.09%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.09%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #5 (~50% URL)	0.09%	Assay may be conducted at this concentration
	Analyzer slope is within 0.98-1.02	0.9997	Analyzer Slope is acceptable
Oxides of Nitrogen Gas Analyzer NOx Portion	Analyzer Calibration within 2 week of assay	4-Dec-23	Analyzer calibration within 2 weeks of assay
	Estimate of Uncetainty < 1% at point #1 (>80% URL)	0.40%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #2	0.41%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #3	0.41%	Assay may be conducted at this concentration
	Estimate of Uncetainty < 1% at point #4	0.42%	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	0.9972	Analyzer Slope is acceptable
Dilution Check	Dilution Check Date within 2 weeks of assay	3-Dec-23	Dilution check within 2 weeks of assay
	Dilution Check Relative % Difference < 1%	0.459%	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	0.47%	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	0.58%	Challenge Std. #1 vendor certificate bias < 2%

FIGURE 8. QA SUMMARY FOR NO TEST OF EX0012199 (STD #1)

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-24-007 December 2024