



2024

Annual Data Quality Report

California Air Resources Board's Primary Quality Assurance Organization

Monitoring and Laboratory Division
Quality Management Branch

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Acronyms

%	Percent
1-pt QC Check	One-Point Quality Control Check
AMP	Air Monitoring Performance
APCD	Air Pollution Control District
AQDA	Air Quality Data Action
AQMD	Air Quality Management District
AQS	Air Quality System
ARD	Air Resources District
BAM	Beta Attenuation Monitor
CAN	Corrective Action Notification
CARB	California Air Resources Board
C.F.R.	Code of Federal Regulations
CL	Confidence Level
CO	Carbon Monoxide
CV	Coefficient of Variation
FEM	Federal Equivalent Method
FRM	Federal Reference Method
FRV	Flow Rate Verification
Hi-Vol	High Volume
Low-Vol	Low Volume
mm	Millimeter
MO	Monitoring Organization
MQO	Measurement Quality Objective
m/s	Meters per Second
NA	Not Applicable
NDA	No Certified Data Available
NO ₂	Nitrogen Dioxide
O ₃	Ozone
PE Audit	Performance Evaluation Audit
PEP	Performance Evaluation Program
PM	Particulate Matter
PM _{2.5}	Particulate Matter with Aerodynamic Diameter less than or equal to 2.5 Micrometers
PM ₁₀	Particulate Matter with Aerodynamic Diameter less than or equal to 10 Micrometers

Acronyms (cont.)

POC	Parameter Occurrence Code
ppb	Parts per Billion
ppm	Parts per Million
PQAO	Primary Quality Assurance Organization
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QMP	Quality Management Plan
SLAMS	State and Local Air Monitoring Stations
SO ₂	Sulfur Dioxide
SPM	Special Purpose Monitor
TEOM	Tapered Element Oscillating Microbalance
U.S. EPA	United States Environmental Protection Agency
µg/m ³	Microgram per Cubic Meter

Executive Summary

As stated in the Code of Federal Regulations (C.F.R.), the United States Environmental Protection Agency (U.S. EPA) has designated the California Air Resources Board (CARB) as one of seven Primary Quality Assurance Organizations (PQAO) in California responsible for monitoring air pollutants and assessing data quality. The purpose of this report is to provide ambient air quality data producers and users with a centralized review of the quality of data collected at monitoring sites within CARB's PQAO with respect to criteria defined by measurement quality objectives (MQO).¹ The specific MQOs reviewed in this report include:

- Ambient data capture rate, which is the percentage of ambient data collected and reported to U.S. EPA's Air Quality System (AQS)² compared to the total expected data.
- Precision, which is the degree of mutual agreement among repeated individual measurements of the same property.
- Bias, which is the systematic or persistent distortion of a measurement process which causes error in one direction.
- The amount of precision and bias data collected and reported.

The criteria by which the assessments are made are mostly dictated in Appendix A of 40 C.F.R. Part 58 ([1](#)) and U.S. EPA guidance ([2](#)) and are provided in Appendices A-C of this report. Details on the gaseous instruments and particulate matter (PM) samplers that did not meet certain criteria are provided in Appendices D-E of this report.

U.S. EPA has designated CARB, the Bay Area Air Quality Management District (Bay Area AQMD), South Coast Air Quality Management District (South Coast AQMD), San Diego County Air Pollution Control District (San Diego County APCD), National Park Service, Morongo Band of Mission Indians, and Pechanga Band of Luiseño Indians as their own PQAOs within California.³ This report focuses on four PQAOs (CARB, Bay Area AQMD, South Coast AQMD, and San Diego County APCD) which encompass most of the geographic area and population in the State. Where appropriate, results for CARB's PQAO are compared to results for these three other PQAOs and the

¹ MQOs are established to ensure that overall measurement uncertainty remains within the limits set by the Data Quality Objectives. They are defined in terms of data quality indicators such as completeness, precision, and bias. A detailed MQO definition can be found in the QA Handbook ([3](#)).

² AQS is U.S. EPA's repository of ambient air quality data collected by U.S. EPA, state, local, and tribal air pollution control agencies from over thousands of monitors ([4](#)).

³ Additional details on PQAOs within California (including information on data quality for these PQAOs, if available), may be found on each PQAO-specific webpage.

nationwide average.⁴ This assessment is solely based on certified data available in AQS.

The gaseous criteria pollutants (gaseous pollutants) assessed include carbon monoxide (CO), nitrogen dioxide (NO₂), ozone (O₃), and sulfur dioxide (SO₂). The ambient data capture rate represents the percentage of ambient data collected and reported to AQS compared to the total expected data. For gaseous pollutants, one-point quality control checks (1-pt QC check) are performed by respective monitoring organizations to confirm an instrument's ability to respond to a known concentration of gas. Precision represents the degree of variability among the 1-pt QC checks (i.e., how close they are to each other). These checks are also used to assess bias for each instrument by comparing how far the instrument's response is from the true value of a reference gas of known concentration.

The PM assessed include PM with an aerodynamic diameter less than or equal to 10 micrometers (PM₁₀) and PM with an aerodynamic diameter less than or equal to 2.5 micrometers (PM_{2.5}). Precision for most PM samplers is assessed by collocated sampling in which two samplers with identical method designations are operated side-by-side.⁵ Bias for PM samplers is assessed by using the routine flow rate verifications (FRV) performed by respective monitoring organizations. During an FRV, flow rate from a PM sampler is compared against the flow rate from a National Institute of Standards and Technology traceable reference standard. Total PM_{2.5} bias for a PQAO is also assessed through the Performance Evaluation Program (PEP) audit administered by U.S. EPA.

Bias for both gaseous instruments and PM samplers is further verified by CARB's performance evaluation audits (CARB's PE audit). CARB's PE audits include through-the-probe audits on gaseous instruments and flow rate audits on PM samplers (5). The ambient data capture rate and the accompanying precision and bias data for 2024 from both gaseous instruments and PM samplers are summarized below, followed with recommendations.

The statistics provided in this report are intended as assessment tools for the data producers and users to identify areas where program improvements can be made to meet all MQOs set by U.S. EPA or the data producers themselves. The 2024 ambient data in AQS for CARB's PQAO have been certified and are considered suitable for comparison to federal standards. Although C.F.R. criteria for precision and bias are generally applied and evaluated at the PQAO level, assessments at the monitoring organization or site level may differ and can be important as well. When certain C.F.R. criteria are not met, it does not necessarily mean that the corresponding air quality

⁴ Nationwide average includes State, county, monitoring organization, National Park Service, and tribal sites, including those in California.

⁵ Collocated sampling is required for all PM samplers, except continuous PM₁₀.

data cannot be used, but rather, the data may be used with the knowledge of the quality behind it.

All data in this report come from AQS. Data producers are encouraged to review their monitoring networks to ensure data correctly reflects the number of operational sites and instruments/samplers operating. This review would also ensure all required ambient, precision, and bias data collected are continually reported to AQS in a timely manner (within 90 days of the end of each quarter) ([1](#)).

Gaseous Instruments

Conclusions and recommendations pertaining to gaseous instruments and associated MQOs are highlighted below.

Conclusions

- Ambient data capture rate criteria of at least 75 percent were met by 92 percent of the gaseous instruments operating within CARB's PQAO in 2024.
- In 2024, 95 percent of the gaseous instruments operating within CARB's PQAO reported at least 75 percent of the required 1-pt QC checks. Additionally, more than 99 percent met the critical criteria⁶ for individual 1-pt QC checks for percent, absolute difference, and prescribed range, set by U.S. EPA ([2](#)) ([6](#)).
- CARB's PQAO met the C.F.R. criteria for precision and bias based on 1-pt QC checks ([1](#)).
- Data from CARB's PE audits indicate that 98 percent of all instruments met the audit acceptance criteria for CARB's PQAO. This is consistent with bias information obtained from 1-pt QC checks, and is consistent with 2023 data.

Recommendations

- Overall, the achievement of MQOs associated with the gaseous instruments declined compared to 2023 for CARB's PQAO. For example, several instances were identified in which instruments did not meet the MQO for ambient data capture rate or the submittal of required 1-pt QC checks due to various instrument issues, which resulted in a 5 percent decline. Monitoring organizations should evaluate their instrument replacement plans, continue to investigate why these objectives were not met for each instrument in their respective jurisdictions, and develop corrective actions, if appropriate, to meet them in subsequent years.

⁶ U.S. EPA describes "critical" criteria as criteria deemed critical to maintaining the integrity of a sample or group of samples ([2](#)).

Particulate Matter Samplers

Conclusions and recommendations pertaining to PM samplers and associated MQOs are highlighted below.

Conclusions

- Ambient data capture rate criteria of at least 75 percent were met by 99 percent of the PM samplers operating within CARB's PQAO in 2024.
- CARB's PQAO continued to meet the minimum 15 percent collocation requirement in the network of primary PM samplers, as indicated in CARB's Annual Network Plan ([7](#)).
- CARB's PQAO met precision completeness criteria of at least 75 percent for collocated PM samplers. The U.S. EPA guidance precision criteria of 10.1 percent upper bound for CARB's PQAO was not met for all PM₁₀ and for three of the five individual methods for PM_{2.5}.
- CARB's PQAO reported 100 percent for PM₁₀ high volume (Hi-Vol), more than 98 percent for PM₁₀ low volume (Low-Vol), and more than 99 percent for PM_{2.5} of the required FRVs performed. The results at the PQAO level indicate that the PM network exhibited low bias in 2024.
- CARB's PE audit data indicate that CARB's PQAO met audit criteria for flow rate audits. This is consistent with bias information from the routine FRV data, and is consistent with 2023 data.
- Total PM_{2.5} bias for CARB's PQAO, via PEP audits administered by U.S. EPA and based on limited mass samples, shows low bias, consistent with results determined by FRVs and CARB's PE audits for flow rate.

Recommendations

- In terms of precision, coefficient of variation (CV) values among collocated PM_{2.5} samplers within CARB's PQAO remain high for three of the five individual methods for PM_{2.5} in 2024. CARB explored potential causes behind low PM_{2.5} precision among some collocated PM_{2.5} samplers; however, no definitive source of the issue was identified. U.S. EPA is aware of the systemic issue of PM imprecision (in California and nationwide). The agency adopted new statistics for calculating CV in its *Reconsideration of the National Ambient Air Quality Standards for Particulate Matter* ([8](#)) in March 2024. However, AQS has not yet been updated to reflect the revised calculations. CARB should further evaluate the potential causes of elevated CV values, including low PM precision, collocation of non-identical methods, and geographic diversity within CARB's PQAO.
- There were instances of PM₁₀ and/or PM_{2.5} samplers not meeting the MQOs (e.g., ambient data capture rate, FRVs, etc.). Monitoring organizations should investigate why these objectives were not met for each sampler in their respective jurisdictions and develop corrective actions, if appropriate, to meet them in subsequent years.

I. Introduction

The California Air Resources Board (CARB) is the governmental agency delegated under State law with the authority and responsibility for collecting ambient air quality data as directed by the federal Clean Air Act of 1977 and Clean Air Act Amendments of 1990 ([9](#)). CARB and local air pollution control agencies operate ambient monitoring sites throughout the State. As stated in the Code of Federal Regulations (C.F.R.), the United States Environmental Protection Agency (U.S. EPA) has designated CARB, the Bay Area Air Quality Management District (Bay Area AQMD), South Coast Air Quality Management District (South Coast AQMD), San Diego County Air Pollution Control District (San Diego County APCD), National Park Service, Morongo Band of Mission Indians, and Pechanga Band of Luiseño Indians as their own Primary Quality Assurance Organizations (PQAO) within California.⁷ This report focuses on the four PQAOs (CARB, Bay Area AQMD, South Coast AQMD, and San Diego County APCD) which encompass most of the geographic area and population in the State.

A PQAO is a monitoring organization, or a coordinated aggregation of such organizations, responsible for a set of sites that monitors the same pollutants and for which data quality assessments can logically be pooled. Each criteria pollutant sampler/monitor at a monitoring site in the State and Local Air Monitoring Station (SLAMS) Network must be associated with only one PQAO.⁸

Factors defining a PQAO include:

- Operation by a common team of field operators according to a common set of procedures.
- Use of a common quality assurance project plan or standard operating procedures.
- Common calibration facilities and standards.
- Oversight by a common quality assurance organization.
- Support by a common management organization (i.e., state agency) or laboratory.

The purpose of this report is to provide ambient air quality data producers and users with a centralized review of the quality of data collected at monitoring sites within CARB's PQAO. Specifically, data from instruments measuring gaseous criteria pollutants (gaseous pollutants) and samplers measuring particulate matter (PM) are

⁷ Additional details on PQAOs within California (including information on data quality for these PQAOs, if available), may be found on each PQAO-specific webpage.

⁸ Samplers may also be identified as Special Purpose Monitors (SPM) or industrial monitors. There are a limited number of SPM and industrial monitors in California. The statistics provided in this report are predominantly the result of SLAMS monitors but also include a small number of SPM and industrial monitors subject to Appendix A of 40 C.F.R. Part 58 ([1](#)).

compared to measurement quality objectives (MQO).⁹ Where appropriate, comparisons to the nationwide average¹⁰ and other PQAOs are also made.

II. Quality Assurance

Quality assurance (QA) is an integrated system of management activities that involves planning, implementing, assessing, and assuring data quality through a process, item, or service that meets users' needs for quality, completeness, and representativeness. Known data quality enables users to make judgments about compliance with air quality standards, air quality trends, and health effects based on sound data with a known level of confidence.

Quality assurance is composed of two main activities: quality control (QC) and quality assessment. QC is composed of a set of internal tasks performed routinely at the instrument level that ensures accurate and precise measured ambient air quality data. QC tasks address sample collection, handling, analysis, and reporting. Examples include calibrations, routine service checks, chain-of-custody documentation, duplicate analyses, development and maintenance of standard operating procedures, and routine preparation of QC reports.

Quality assessment is a set of external and internal, quantitative tasks that provide certainty that the QC system is satisfactory and that the stated quantitative programmatic objectives for air quality data are met. Staff independent of data generators perform these external tasks, which include conducting regular performance audits, on-site system audits, inter-laboratory comparisons, and periodic evaluations of internal QC data.

The objective of QA is to provide accurate and precise data, minimize data loss and to assess the validity of the air monitoring data to provide representative and comparable data of known precision and bias. Precision is a measure of mutual agreement among repeated individual measurements of the same property, usually under prescribed similar conditions. It is a random component of error and is estimated by various techniques using some derivation of the standard deviation. Bias is the systematic or persistent distortion of a measurement process which causes error in one direction ([1](#)). It is determined by estimating the positive and negative deviation from the true value as a percentage of the true value. When a certain bias is detected, the measurement process is said to be "inaccurate." Precision is based on one-point quality control checks (1-pt QC check) for gaseous instruments and paired measurements from collocated samplers for PM. For precision, the statistic is the upper bound of the coefficient of variation (CV) or the standard deviation of the

⁹ MQOs are established to ensure that overall measurement uncertainty remains within the limits set by the Data Quality Objectives. They are defined in terms of data quality indicators such as completeness, precision, and bias. A detailed MQO definition can be found in the QA Handbook ([3](#)).

¹⁰ Nationwide average includes State, county, monitoring organization, National Park Service, and tribal sites, including those in California.

differences in measurements, which reflects the highest estimate of the variability in the instrument's measurements. The 1-pt QC checks for gaseous instruments are also used to estimate bias. For PM, bias can be estimated from flow rate verifications (FRV). The criteria for achieving precision and bias are mostly dictated in Appendix A of 40 C.F.R. Part 58 ([1](#)) and U.S. EPA guidance ([2](#)) and are provided in Appendices A-C of this report. Available tools for assessing precision and bias are summarized in Appendix B of this report, while details on instances where the criteria for precision or bias are not met can be found in Appendix E. Detailed descriptions of CV and the bias estimator, including the formula behind each calculation, can be found in U.S. EPA guidance for the use of precision and bias data ([10](#)).

Bias for both gaseous instruments and PM samplers is further verified by CARB's performance evaluation audits (CARB's PE audit). CARB's PE audits include through-the-probe audits on gaseous instruments and flow rate audits on PM samplers ([5](#)). Appendix C of this report lists CARB's PE audit acceptance criteria, which were developed to closely match the National Performance Audit Program ([11](#)).

This report also assesses the percentage of ambient air quality data produced by the instruments or samplers, consistent with assessing precision and bias. Ambient data capture rate is compiled as a percentage of the ambient data collected, depending on the sampling frequency of each respective instrument or sampler, over the total expected data.

An Air Quality Data Action (AQDA) is a key tool used by the Quality Management Branch of CARB's Monitoring and Laboratory Division to identify, document, and correct issues which would adversely affect the quality of the ambient data generated by the samplers. An AQDA is initiated by the Quality Management Branch upon a failed audit. After an AQDA has been issued, an investigation into the causes of the failure will determine an outcome on the possibly affected data. The data in question can be affected in two ways: released or invalidated. Data that are released meet compliance criteria and can be used in all aspects of decision making. In some instances, data are flagged with qualifier codes as they are released. Invalidated data are considered not for record, meaning the data set will not be utilized in any designation, enforcement, or regulatory decisions. As such, null codes are associated with invalidated data. The number of AQDAs issued and closed within CARB's PQAO is provided in Appendix E of this report.

Outside the AQDA process, data could be flagged with quality assurance qualifiers or also be flagged if monitoring organizations determine, and U.S. EPA concurs, the collected data were influenced by an exceptional or natural event. Additionally, there are informational flags that do not impact the usage of the data.

The implementation of a comprehensive corrective action system throughout CARB's PQAO is an essential component for improving data quality and facilitating continuous process improvement. The Corrective Action Notification (CAN) process is another key tool used to identify, document, and correct issues that impact, or

potentially impact, data quality, completeness, storage, or reporting ([12](#)). The goal of the CAN process is to investigate, correct, and reduce the recurrence of these issues. As such, the CAN process will identify issues not addressed by AQDAs, improve data quality, and help ensure compliance with State, federal, and local requirements. The number of CANs issued and closed within CARB's PQAO is provided in Appendix E of this report.

CARB's Quality Assurance Program is outlined in a five-volume Quality Assurance Manual ([13](#)), which guides the operation of the quality assurance programs used by CARB, monitoring organizations, and private industry in California.

There are more than 250 (SLAMS and SPM) air monitoring sites among the four California PQAOs operating in 15 separate air basins in California. Within CARB's PQAO, there are 22 monitoring organizations operating sites under CARB's guidance. Information about each air monitoring site audited by the Quality Management Branch is available online ([5](#)).

III. Data Quality - Statistical Summary Results

The results are presented for two groups of pollutants: gaseous and PM. For each group, the percentage of ambient data collected (or ambient data capture rate) is discussed first, followed by an assessment of the quality behind the data. Statistical results for 2024¹¹ reflect certified data available in U.S. EPA's Air Quality System (AQS)¹² as of July 2025. Statistical results for 2022 and 2023 in this report reflect certified data published in the 2023 Annual Data Quality Report ([14](#)). Additionally, the 2022 and 2023 Annual Data Quality Reports ([14](#)) may not reflect current information in AQS due to potential data reporting to AQS occurring after these reports were published. The monitoring organization responsible for the correction may recertify the data already submitted through a data certification process, depending on the nature of the data correction.

A. Gaseous Pollutants

The gaseous pollutants assessed in this report are carbon monoxide (CO), nitrogen dioxide (NO₂), ozone (O₃), and sulfur dioxide (SO₂).

Ambient Data Capture Rate

Ambient data capture rate, as described in this report, is derived from the AQS Air Monitoring Performance (AMP) 430 Data Completeness Report. The calculated number in AMP 430 represents the average of the monthly ambient data capture

¹¹ Statistical results for 2024 exclude 2024 data which were manually adjusted, as described in Appendix E, Table E-11 of this report.

¹² AQS is U.S. EPA's repository of ambient air quality data collected by U.S. EPA, state, local, and tribal air pollution control agencies from over thousands of monitors ([4](#)).

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rates for the calendar year and may not always be indicative of whether the 75 percent regulatory completeness requirement¹³ is met for a particular pollutant, considering the operational period in the year. This report focuses on a minimum ambient data capture rate of 75 percent reported to AQS.

Table 1 presents the percentage of instruments that reported at least 75 percent of the possible ambient data capture rate for each gaseous pollutant for each of the four PQAOs this report focuses on and the nationwide average. In 2024, 92 percent of the instruments within CARB's PQAO reported at least 75 percent of the required ambient data. Details on CARB's PQAO instruments not reporting at least 75 percent ambient data capture rate are provided in Appendices D-E of this report. Information for years 2022 and 2023 is only provided for historical perspective.

Table 1. Gaseous Instruments - Ambient Data Capture Rate Results (2022-2024)

Pollutant	PQAO	Year	Number of Instruments	Number of Instruments Reporting $\geq 75\%$ Ambient Data Capture Rate	Percent of Instruments Reporting $\geq 75\%$ Ambient Data Capture Rate
CO	CARB	2024	12	10	83
		2023	13	12	92
		2022	13	11	85
	Bay Area AQMD*	2024	NDA	NDA	NDA
		2023	NDA	NDA	NDA
		2022	14	14	100
	South Coast AQMD	2024	19	19	100
		2023	21	21	100
		2022	23	23	100
	San Diego County APCD	2024	3	3	100
		2023	3	3	100
		2022	2	2	100
	Nationwide*	2024	233	196	84
		2023	238	217	91
		2022	243	226	93

¹³ The ambient data from a given instrument or sampler must be at least 75 percent complete in a calendar year to be included in making regulatory decisions (e.g., attainment of National Ambient Air Quality Standards) (2). Detailed information on the calculations for meeting the regulatory completeness requirement, including specific consideration of seasons and exceptional events, are outside the scope of this report.

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Table 1. Gaseous Instruments - Ambient Data Capture Rate Results (2022-2024) (cont.)

Pollutant	PQAO	Year	Number of Instruments	Number of Instruments Reporting ≥ 75% Ambient Data Capture Rate	Percent of Instruments Reporting ≥ 75% Ambient Data Capture Rate
NO ₂	CARB	2024	39	37	95
		2023	39	38	97
		2022	40	37	93
	Bay Area AQMD*	2024	NDA	NDA	NDA
		2023	NDA	NDA	NDA
		2022	16	16	100
	South Coast AQMD	2024	26	26	100
		2023	27	27	100
		2022	28	28	100
	San Diego County APCD	2024	9	9	100
		2023	9	9	100
		2022	8	8	100
	Nationwide*	2024	452	413	91
		2023	436	421	97
		2022	441	416	94
O ₃	CARB	2024	94	87	93
		2023	99	96	97
		2022	98	96	98
	Bay Area AQMD*	2024	NDA	NDA	NDA
		2023	NDA	NDA	NDA
		2022	18	18	100
	South Coast AQMD	2024	24	24	100
		2023	24	24	100
		2022	27	27	100
	San Diego County APCD	2024	7	7	100
		2023	7	7	100
		2022	7	7	100
	Nationwide*	2024	1,190	1,135	95
		2023	1,176	1,146	97
		2022	1,180	1,152	98

Table 1. Gaseous Instruments - Ambient Data Capture Rate Results (2022-2024) (cont.)

Pollutant	PQAO	Year	Number of Instruments	Number of Instruments Reporting $\geq 75\%$ Ambient Data Capture Rate	Percent of Instruments Reporting $\geq 75\%$ Ambient Data Capture Rate
SO ₂	CARB	2024	7	6	86
		2023	7	7	100
		2022	7	5	71
	Bay Area AQMD*	2024	NDA	NDA	NDA
		2023	NDA	NDA	NDA
		2022	9	9	100
	South Coast AQMD	2024	4	4	100
		2023	4	4	100
		2022	4	4	100
	San Diego County APCD	2024	1	0	0
		2023	1	0	0
		2022	1	1	100
	Nationwide*	2024	351	329	94
		2023	361	355	98
		2022	378	363	96

- Source: AQS, AMP 430 Data Completeness Report, run July 2025.
- NDA means no certified data available in AQS.
- *2024: Bay Area AQMD's PQAO data are not reflected in this report (for PQAO and nationwide), as certified data were not available in AQS (Source: AMP 256 Data Quality Indicator Report, run July 2025). Bay Area AQMD is currently implementing new documentation and validation processes.
- 2023: Bay Area AQMD's PQAO data are not reflected in this report (for PQAO and nationwide), as certified data were not available in AQS (Source: AMP 256 Data Quality Indicator Report, run July 2024).
- 2022: Bay Area AQMD reported on October 15, 2025, that data presented for 2022 have not undergone the required validation process as described in C.F.R. or the review necessary prior to reporting to AQS.

Precision and Bias

The 1-pt QC checks are performed by respective monitoring organizations to confirm an instrument's ability to respond to a known concentration of gaseous pollutant. The degree of variability in each of these measurements is computed as the precision of that instrument's measurements. For precision, the statistic defined in Appendix A of 40 C.F.R. Part 58 (1) is the CV upper bound, an upper confidence limit of the standard deviation of the differences between the instrument's response and the known concentrations, which reflects the highest tolerable variability in the data. This CV upper bound is not to exceed 7.1 percent for O₃, 10.1 percent for CO and SO₂, or 15.1 percent for NO₂ (2).

The 1-pt QC checks are also used to estimate the bias inherent in the sampling system associated with each instrument. Appendix A of 40 C.F.R. Part 58 ([1](#)) outlines how bias is calculated based on 1-pt QC checks for gaseous pollutants. The bias estimator is the upper bound on the mean absolute value of the percent differences between the instrument's response and the true value of a known gaseous concentration. A sign (positive or negative) is applied when the 25th and 75th percentiles are of the same sign. In other words, when at least 75 percent of the differences are all positive or negative, the bias estimate has a sign. Otherwise, the bias is denoted with "±." For bias, the U.S. EPA guidance criteria are: ±7.1 percent for O₃, ±10.1 percent for CO and SO₂, and ±15.1 percent for NO₂ ([2](#)). A detailed description of the bias estimator, including the formula behind its calculation, can be found in U.S. EPA guidance for the use of precision and bias data ([10](#)).

C.F.R. requires 1-pt QC checks be performed at least once every 14 days on each automated instrument, which translates to a minimum of 26 checks per year for an instrument operating year-round. During data certification, U.S. EPA flags instruments that do not have at least 75 percent of the required 1-pt QC checks in AQS; thus, 75 percent is the criterion used in Table 2. A complete listing of all MQOs set forth by U.S. EPA can be found in Appendix A of 40 C.F.R. Part 58 ([1](#)) and the QA Handbook ([3](#)). Bias estimates are further verified via CARB's PE audits; details are in the Bias Assessment via Performance Audits section of this report.

Table 2 shows that CARB's PQAO (as well as most other California PQAOs) met precision and bias criteria in 2024 for gaseous pollutants required by C.F.R. (CO, NO₂, O₃, and SO₂). Information for years 2022 and 2023 is provided for a historical perspective only. In general, 2024 precision data and 2024 bias data are consistent with those in the previous two years, and 95 percent of the required number of 1-pt QC checks for gaseous instruments was met for CARB's PQAO. Table 2 also includes the number of gaseous instruments with at least 75 percent of the required 1-pt QC check data reported for 2024. Details on CARB's PQAO instruments not meeting precision and bias criteria are provided in Appendices D-E of this report, where applicable.

To provide decision makers with data of known quality, U.S. EPA provides a web-based tool for assessing data quality in terms of three data quality indicators in graphical format. Graphs from a U.S. EPA precision and bias report ([15](#)) provide detailed information on precision (CV), bias, and the number of 1-pt QC checks performed at each monitoring site each year.

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Table 2. Gaseous Instruments - Precision and Bias Results (2022-2024)

Pollutant	PQAO	Year	Number of Instruments	Number of Instruments with $\geq 75\%$ of Required 1-pt QC Checks	Upper Bound of CV (Precision)	C.F.R. Criteria for Precision Met?	Bias	C.F.R. Criteria for Bias Met?
CO	CARB	2024	12	10	4.87	Yes	± 4.16	Yes
		2023	13	12	4.16	Yes	± 3.37	Yes
		2022	14	12	3.96	Yes	± 3.06	Yes
	Bay Area AQMD*	2024	NDA	NDA	NDA	NDA	NDA	NDA
		2023	NDA	NDA	NDA	NDA	NDA	NDA
		2022	14	1	12.67	No	± 5.55	Yes
	South Coast AQMD	2024	19	19	2.89	Yes	± 2.27	Yes
		2023	21	21	3.76	Yes	± 2.64	Yes
		2022	23	23	3.41	Yes	± 2.45	Yes
	San Diego County APCD	2024	3	3	1.74	Yes	± 1.60	Yes
		2023	3	3	1.82	Yes	± 1.79	Yes
		2022	2	2	2.11	Yes	± 1.79	Yes
	Nationwide*	2024	238	203	3.61	Yes	± 3.60	Yes
		2023	243	213	3.65	Yes	± 3.51	Yes
		2022	250	213	4.00	Yes	± 3.75	Yes
NO ₂	CARB	2024	39	38	5.05	Yes	± 4.23	Yes
		2023	40	40	6.00	Yes	± 5.11	Yes
		2022	41	38	5.65	Yes	± 4.98	Yes
	Bay Area AQMD*	2024	NDA	NDA	NDA	NDA	NDA	NDA
		2023	NDA	NDA	NDA	NDA	NDA	NDA
		2022	16	15	2.44	Yes	± 2.01	Yes
	South Coast AQMD	2024	26	26	3.46	Yes	± 3.02	Yes
		2023	27	27	3.44	Yes	± 3.12	Yes
		2022	28	28	3.54	Yes	± 3.49	Yes
	San Diego County APCD	2024	9	9	2.46	Yes	± 2.32	Yes
		2023	9	9	1.77	Yes	± 2.15	Yes
		2022	8	8	2.28	Yes	± 2.65	Yes
	Nationwide*	2024	462	412	3.84	Yes	± 4.28	Yes
		2023	449	414	3.99	Yes	± 4.38	Yes
		2022	450	402	4.03	Yes	± 4.40	Yes

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**Table 2. Gaseous Instruments - Precision and Bias Results (2022-2024)
(cont.)**

Pollutant	PQAO	Year	Number of Instruments	Number of Instruments with $\geq 75\%$ of Required 1-pt QC Checks	Upper Bound of CV (Precision)	C.F.R. Criteria for Precision Met?	Bias	C.F.R. Criteria for Bias Met?
O ₃	CARB	2024	94	91	2.59	Yes	± 1.92	Yes
		2023	99	98	2.52	Yes	± 1.93	Yes
		2022	98	95	2.59	Yes	± 1.95	Yes
	Bay Area AQMD*	2024	NDA	NDA	NDA	NDA	NDA	NDA
		2023	NDA	NDA	NDA	NDA	NDA	NDA
		2022	18	18	1.84	Yes	± 1.49	Yes
	South Coast AQMD	2024	24	24	1.91	Yes	± 1.56	Yes
		2023	24	24	2.00	Yes	± 1.59	Yes
		2022	27	27	1.86	Yes	± 1.35	Yes
	San Diego County APCD	2024	7	7	1.24	Yes	± 1.13	Yes
		2023	7	7	1.64	Yes	± 1.45	Yes
		2022	7	7	1.18	Yes	-1.65	Yes
SO ₂	Nationwide*	2024	1,202	1,150	2.00	Yes	± 2.04	Yes
		2023	1,189	1,161	2.04	Yes	± 2.08	Yes
		2022	1,189	1,161	3.94	Yes	± 2.67	Yes
	CARB	2024	7	6	4.03	Yes	± 2.61	Yes
		2023	7	7	3.56	Yes	± 2.74	Yes
		2022	7	5	2.85	Yes	± 2.74	Yes
	Bay Area AQMD*	2024	NDA	NDA	NDA	NDA	NDA	NDA
		2023	NDA	NDA	NDA	NDA	NDA	NDA
		2022	9	9	4.27	Yes	± 1.80	Yes
	South Coast AQMD	2024	4	4	2.88	Yes	± 2.34	Yes
		2023	4	4	2.37	Yes	± 1.91	Yes
		2022	4	4	3.33	Yes	± 2.99	Yes
	San Diego County APCD	2024	1	1	1.89	Yes	-6.55	Yes
		2023	1	1	2.73	Yes	-8.14	Yes
		2022	1	1	3.52	Yes	-6.53	Yes
	Nationwide*	2024	356	330	2.83	Yes	± 3.19	Yes
		2023	369	350	3.17	Yes	± 3.30	Yes
		2022	384	358	2.99	Yes	± 3.16	Yes

- Source: AQS, AMP 256 Data Quality Indicator Report, run July 2025.
- NDA means no certified data available in AQS.
- Upper bound of CV (precision) is estimated by the upper confidence limit of the standard deviation of differences measured by 1-pt QC checks. Bias is estimated as the upper bound on the mean absolute value of the percent differences measured by 1-pt QC checks. C.F.R. criteria for precision and bias are provided in Appendix A of this report.
- Discrepancies may exist in the Number of Instruments listed in Table 1 compared to Table 2 of this report due to different report sources (AMP 256 and AMP 430).

Table 2. Gaseous Instruments - Precision and Bias Results (2022-2024) (cont.)

- *2024: Bay Area AQMD's PQAO data are not reflected in this report (for PQAO and nationwide), as certified data were not available in AQS (Source: AMP 256 Data Quality Indicator Report, run July 2025). Bay Area AQMD is currently implementing new documentation and validation processes.
2023: Bay Area AQMD's PQAO data are not reflected in this report (for PQAO and nationwide), as certified data were not available in AQS (Source: AMP 256 Data Quality Indicator Report, run July 2024).
2022: Bay Area AQMD's PQAO faced issues procuring the appropriate gas cylinders due to manufacturer supply delays. After installing the appropriate gas cylinders at the end of 2022, 1-pt QC checks met critical criteria. Bay Area AQMD reported on October 15, 2025, that data presented for 2022 have not undergone the required validation process as described in C.F.R. or the review necessary prior to reporting to AQS.

Assessment of Individual 1-pt QC Checks

In March 2018, U.S. EPA revised QA Handbook Volume II, Appendix D, Measurement Quality Objectives and Validation Templates with updated criteria for assessing individual 1-pt QC checks. Many monitoring organization-operated sites perform more frequent 1-pt QC checks than required by U.S. EPA. Some exceedances are associated with ambient data being affected by issues identified through the AQDA process, separate from the individual 1-pt QC checks not meeting the critical criteria. Table 3 presents results on individual 1-pt QC checks at the PQAO level. Overall, more than 99 percent of 1-pt QC checks performed for CARB's PQAO in 2024 meet the critical criteria. Details on CARB's PQAO instruments not meeting these criteria are provided in Appendices D-E of this report.

Individual 1-pt QC checks are to be performed within the prescribed ranges: 0.005 parts per million (ppm) to 0.08 ppm for NO₂, O₃, and SO₂; and 0.5 ppm to 5.0 ppm for CO. Table 4 provides individual 1-pt QC checks performed within the prescribed range for each PQAO and showcases the overall good reporting from most PQAOs. Details on CARB's PQAO instruments not meeting these criteria are provided in Appendices D-E of this report.

All monitoring organizations are reminded that the updates to AQS regarding 1-pt QC check requirements became effective on January 1, 2019. U.S. EPA also provided additional guidance and notification through webpages and newsletters ([6](#)) ([16](#)).

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Table 3. Gaseous Instruments - 1-pt QC Checks Individual Assessment (2024)

Pollutant	PQAO	Number of Instruments	Number of 1-pt QC Checks Performed	Number of 1-pt QC Checks Meeting Critical Criteria	Percent of 1-pt QC Checks Meeting Critical Criteria (%)
CO	CARB	12	1,654	1,647	99.6
	Bay Area AQMD*	NDA	NDA	NDA	NDA
	South Coast AQMD	19	6,838	6,838	100.0
	San Diego County APCD	3	896	896	100.0
NO ₂	CARB	39	8,906	8,901	99.9
	Bay Area AQMD*	NDA	NDA	NDA	NDA
	South Coast AQMD	26	9,433	9,433	100.0
	San Diego County APCD	9	2,743	2,743	100.0
O ₃	CARB	94	20,138	20,078	99.7
	Bay Area AQMD*	NDA	NDA	NDA	NDA
	South Coast AQMD	24	8,705	8,704	99.9
	San Diego County APCD	7	2,120	2,120	100.0
SO ₂	CARB	7	1,363	1,333	97.8
	Bay Area AQMD*	NDA	NDA	NDA	NDA
	South Coast AQMD	4	1,449	1,449	100.0
	San Diego County APCD	1	223	223	100.0

- Source: AQS, AMP 504 EXTRACT QA Data text file and AMP 251 AQ Raw Assessment Report, run July 2025.
- NDA means no certified data available in AQS.
- Criteria for assessing individual 1-pt QC checks are provided in Appendix A of this report.
- *Bay Area AQMD's PQAO 2024 data are not reflected in this report, as certified data were not available in AQS (Source: AMP 256 Data Quality Indicator Report, run July 2025). Bay Area AQMD is currently implementing new documentation and validation processes.

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Table 4. Gaseous Instruments - 1-pt QC Checks Individual Assessment on Prescribed Range (2024)

Pollutant	PQAO	Number of Instruments	Number of 1-pt QC Checks Performed	Number of 1-pt QC Checks within Prescribed Range	Percent of 1-pt QC Checks within Prescribed Range (%)
CO	CARB	12	1,654	1,629	98.5
	Bay Area AQMD*	NDA	NDA	NDA	NDA
	South Coast AQMD	19	6,838	6,776	99.1
	San Diego County APCD	3	896	888	99.1
NO ₂	CARB	39	8,906	8,803	98.8
	Bay Area AQMD*	NDA	NDA	NDA	NDA
	South Coast AQMD	26	9,433	9,390	99.5
	San Diego County APCD	9	2,743	2,725	99.3
O ₃	CARB	94	20,138	20,030	99.5
	Bay Area AQMD*	NDA	NDA	NDA	NDA
	South Coast AQMD	24	8,705	8,684	99.8
	San Diego County APCD	7	2,120	2,112	99.6
SO ₂	CARB	7	1,363	1,343	98.5
	Bay Area AQMD*	NDA	NDA	NDA	NDA
	South Coast AQMD	4	1,449	1,437	99.2
	San Diego County APCD	1	223	222	99.6

- Source: AQS, AMP 504 EXTRACT QA Data text file and AMP 251 AQ Raw Assessment Report, run July 2025.
- Prescribed ranges are provided in Appendix A of this report.
- NDA means no certified data available in AQS.
- *Bay Area AQMD's PQAO 2024 data are not reflected in this report, as certified data were not available in AQS (Source: AMP 256 Data Quality Indicator Report, run July 2025). Bay Area AQMD is currently implementing new documentation and validation processes.

Bias Assessment via Performance Audits

To further assess bias estimates from 1-pt QC checks, Appendix A of 40 C.F.R. Part 58 (1) requires that independent performance audits be conducted, and the percent differences be evaluated against established acceptance criteria. Bias is estimated as an average percent difference, which is the arithmetic mean of the combined differences from the known value of all the individual audit points over the range considered in the audits. Lower and upper confidence limits represent the range of all audit results across each PQAO. CARB's objective is to conduct CARB's PE audits for all sites within its PQAO annually, utilizing CARB's PE audit acceptance criteria (5). Other PQAOs are responsible for performing their own audits and may utilize different audit criteria.

Table 5 summarizes the 2024 performance audit results for gaseous instruments. The average percent differences at the PQAO level were well below the audit criteria for all gaseous pollutants. The control limits for CARB's PE audit acceptance criteria are: ± 10 percent for O_3 (with warning at ± 7 percent) and ± 15 percent for CO, NO_2 , and SO_2 (with warning at ± 10 percent) for each audit point (2). CARB's PE audit results show that, in general, all audited gaseous instruments within CARB's PQAO met CARB's PE audit acceptance criteria for bias.

CARB's PE audit results of gaseous instruments in 2024 corroborate what the 1-pt QC checks revealed: that CARB's PQAO is providing data of low bias for all gaseous pollutants. This is further strengthened since 98 percent of the audited instruments met CARB's PE audit acceptance criteria.

A complete listing of CARB's PE audit acceptance criteria is provided in Appendix C of this report. Details on CARB's PQAO instruments not meeting CARB's PE audit acceptance criteria are provided in Appendices D-E of this report.

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Table 5. Gaseous Instruments - Performance Audits Results (2024)

Pollutant	PQAO	Number of Instruments	Number of Instruments Audited	Number of Audits Not Meeting Criteria	Average Percent Difference** (%)	Confidence Limit	
						Lower	Upper
CO	CARB*	12	12	1	1.45	-8.12	10.55
	Bay Area AQMD***	NDA	NDA	NDA	NDA	NDA	NDA
	South Coast AQMD	19	19	1	2.91	-6.15	5.04
	San Diego County APCD	3	3	1	-3.66	-4.15	2.44
NO ₂	CARB*	39	37	0	-3.27	-8.44	11.17
	Bay Area AQMD***	NDA	NDA	NDA	NDA	NDA	NDA
	South Coast AQMD	26	26	0	-4.28	-5.20	8.25
	San Diego County APCD	9	9	1	-8.13	-3.10	6.36
O ₃	CARB*	94	94	1	-2.34	-4.80	5.29
	Bay Area AQMD***	NDA	NDA	NDA	NDA	NDA	NDA
	South Coast AQMD	24	24	1	0.86	-4.18	3.23
	San Diego County APCD	7	7	1	1.72	-2.92	1.86
SO ₂	CARB*	7	7	0	0.18	-7.41	8.00
	Bay Area AQMD***	NDA	NDA	NDA	NDA	NDA	NDA
	South Coast AQMD	4	4	0	-2.94	-5.92	5.08
	San Diego County APCD	1	1	1	-12.53	-9.82	-2.88

- Source: AQS, AMP 256 Data Quality Indicator Report, run July 2025.
- NDA means no certified data available in AQS.
- *CARB's PE audit acceptance criteria are provided in Appendix C of this report (2). Since the two lowest audit points for trace CO and trace SO₂ are U.S. EPA audit levels 1 and 2, and the lowest audit point for O₃ is U.S. EPA audit level 2, they were not subject to the AQDA process and were excluded from this analysis.
- **Bias is estimated as an average percent difference, which is the arithmetic mean of the combined differences from the known value of all the individual audit points over the range considered in the performance audits.
- ***Bay Area AQMD's PQAO 2024 data are not reflected in this report, as certified data were not available in AQS (Source: AMP 256 Data Quality Indicator Report, run July 2025). Bay Area AQMD is currently implementing new documentation and validation processes.

B. Particulate Matter

The PM assessed in this report are PM with an aerodynamic diameter less than or equal to 10 micrometers (PM₁₀) and PM with an aerodynamic diameter less than or equal to 2.5 micrometers (PM_{2.5}).

PM monitoring is performed using both manual and continuous type samplers. Manual samplers are operated on a daily, one-in-three-day, one-in-six-day, or one-in-twelve-day sampling schedule for PM₁₀, and a similar schedule for PM_{2.5}. Continuous samplers report hourly values.

Similar to the discussion of gaseous pollutants, ambient data capture rate is discussed first, followed with an assessment of the quality of the data captured.

Ambient Data Capture Rate

Ambient data capture rate, as described in this report, is derived from the AQS AMP 430 Data Completeness Report. The calculated number in AMP 430 represents the average of the monthly ambient data capture rates for the calendar year and may not always be indicative of whether the 75 percent regulatory completeness requirement¹⁴ is met for a particular pollutant. This report focuses on a minimum ambient data capture rate of 75 percent reported to AQS.

Table 6 presents the percentage of samplers that reported an ambient data capture rate of at least 75 percent for each of the four PQAOs this report focuses on and the nationwide average. Ninety-nine percent of the samplers within CARB's PQAO reported at least 75 percent of the required ambient data in 2024. Details on CARB's PQAO samplers not meeting criteria are provided in Appendices D-E of this report. Information for years 2022 and 2023 is only provided for historical perspective.

¹⁴ The ambient data from a given instrument or sampler must be at least 75 percent complete in a calendar year to be included in making regulatory decisions (e.g., attainment of National Ambient Air Quality Standards) (2). Detailed information on the calculations for meeting the regulatory completeness requirement, including specific consideration of seasons and exceptional events, are outside the scope of this report.

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Table 6. PM Samplers - Ambient Data Capture Rate Results (2022-2024)

Pollutant	PQAO	Year	Number of Samplers	Number of Samplers Reporting ≥ 75% Ambient Data Capture Rate	% of Samplers Reporting ≥ 75% Ambient Data Capture Rate
PM ₁₀	CARB	2024	87	86	99
		2023	89	88	99
		2022	93	91	98
	Bay Area AQMD*	2024	NDA	NDA	NDA
		2023	NDA	NDA	NDA
		2022	6	6	100
	South Coast AQMD	2024	22	22	100
		2023	26	26	100
		2022	32	32	100
	San Diego County APCD	2024	10	10	100
		2023	14	14	100
		2022	9	9	100
	Nationwide*	2024	614	596	97
		2023	661	639	97
		2022	626	611	98
PM _{2.5}	CARB	2024	89	88	99
		2023	89	87	98
		2022	91	86	95
	Bay Area AQMD*	2024	NDA	NDA	NDA
		2023	NDA	NDA	NDA
		2022	19	19	100
	South Coast AQMD	2024	29	29	100
		2023	26	26	100
		2022	36	34	94
	San Diego County APCD	2024	10	10	100
		2023	21	16	76
		2022	17	17	100
	Nationwide*	2024	1,495	1,436	96
		2023	1,838	1,475	80
		2022	1,745	1,660	95

- Source: AQS, AMP 430 Data Completeness Report, run July 2025.
- NDA means no certified data available in AQS.
- *2024: Bay Area AQMD's PQAO data are not reflected in this report (for PQAO and nationwide), as certified data were not available in AQS (Source: AMP 256 Data Quality Indicator Report, run July 2025). Bay Area AQMD is currently implementing new documentation and validation processes.
2023: Bay Area AQMD's PQAO data are not reflected in this report (for PQAO or nationwide), as certified data were not available in AQS (Source: AMP 256 Data Quality Indicator Report, run July 2024).
2022: Bay Area AQMD reported on October 15, 2025, that data presented for 2022 have not undergone the required validation process as described in C.F.R. or the review necessary prior to reporting to AQS.

Precision and Bias

PM is subject to MQOs in federal and State regulations. Appendix A of this report lists the MQOs stated in C.F.R. and U.S. EPA guidance (2). For all methods of collecting PM₁₀ and PM_{2.5}, U.S. EPA guidance specifies using the upper bound of CV to assess precision. This CV upper bound is not to exceed 10.1 percent. Collocated sampling is required to assess precision for manual PM₁₀ and both manual and continuous PM_{2.5} sampling. Each PQAO is required to have 15 percent of its primary monitors collocated to represent its monitoring network (1).¹⁵ From each pair of collocated samplers, a minimum of 75 percent of ambient data is required to be in AQS. CARB's Annual Network Plan (7) includes a discussion of collocated sampling and indicates CARB's PQAO continues to meet the 15 percent minimum collocation requirement (1) in 2024 for the network of primary PM samplers.

Precision of the data is based on the 90 percent confidence limit of the standard deviation of the percent differences of the mass concentrations of the two identical or equivalent collocated samplers. At low concentrations, precision based on the measurements of collocated samplers may be relatively poor. For this reason, collocated measurement pairs are selected for use in the precision calculations only when both measurements are equal to or above the following limits: PM₁₀ high volume (Hi-Vol): 15 microgram per cubic meter ($\mu\text{g}/\text{m}^3$); PM₁₀ low volume (Low-Vol): 3 $\mu\text{g}/\text{m}^3$; and PM_{2.5}: 3 $\mu\text{g}/\text{m}^3$. The collocated pairs of data that meet these limits are then used to calculate the upper bound of CV as an estimate of precision at each site. U.S. EPA guidance (2) requires that this upper bound of CV not exceed 10.1 percent for Hi-Vol PM₁₀ and all PM_{2.5} at the PQAO level. A detailed description of CV, including the formula for calculating it, can be found in U.S. EPA guidance for the use of precision and bias data (13). Table 7 shows the number of sites with collocated precision data reported in respective years.

Bias of all PM samplers is assessed using monthly FRVs and comparing the absolute bias upper bound against U.S. EPA guidance criterion of ± 4.1 percent difference. Detailed calculations are explained in U.S. EPA guidance for the use of precision and bias data (13). Total bias for each PQAO is also assessed through PEP audits administered by U.S. EPA.

Bias is further assessed via the semi-annual flow rate audit by comparing the instrument's flow rate to a certified orifice (e.g., PM₁₀ and total suspended particulates), or a calibrated mass flow meter (e.g., tapered element oscillating microbalance (TEOM), PM_{2.5}, and beta attenuation monitor (BAM) samplers) that is certified against a National Institute of Standards and Technology traceable flow device or calibrator. As listed in Appendix C of this report, CARB's PE audit acceptance criteria, based on the average percent difference during a semi-annual

¹⁵ For PM₁₀, 15 percent of the combined primary monitors (manual federal reference method (FRM) samplers only), must be collocated. For PM_{2.5}, 15 percent of monitors for each designation (federal equivalent method (FEM) or FRM), must be collocated.

flow rate audit, were ± 7 percent for PM₁₀ Hi-Vol and ± 4 percent for PM₁₀ Low-Vol and PM_{2.5}.

Precision Results

For the reported collocated sites, Appendix A of 40 C.F.R. Part 58 (1) requires that 30 paired observations per year (equivalent to 1-in-12 days) be collected from each site with collocated PM samplers operating the entire year. Table 7 displays precision percent completeness (measured as a percent of the collected samples over the required number of observations) in addition to the CV upper bound. Information for years 2022 and 2023 is provided for historical perspectives. Precision completeness of at least 75 percent for collocated PM samplers was met for CARB's PQAO. The U.S. EPA guidance (2) precision criteria of 10.1 percent CV upper bound for CARB's PQAO was not met for all PM₁₀ or for three of the five individual methods for PM_{2.5}. This is consistent compared to 2023 data. Details on CARB's PQAO samplers not meeting these criteria are provided in Appendices D-E of this report.

Notably, the high CV is also encountered nationwide, not just within CARB's PQAO. CARB has continued exploring the potential causes behind low PM_{2.5} precision among some of the collocated PM_{2.5} samplers within CARB's PQAO. The empirical analysis includes the evaluation of multiple years of data and a breakdown of results based on monitors that use FRM versus FEM. While no definitive source of the issue has been identified as a key contributing factor to the imprecision, monitoring organizations are encouraged to closely examine operational practices to help the PQAO meet the precision criteria for PM. During technical system audits, operational practices or other factors that may influence the low precision are often examined.

U.S. EPA is aware of the systemic issue of PM imprecision (in California and nationwide). The agency adopted new statistics for calculating CV in its *Reconsideration of the National Ambient Air Quality Standards for Particulate Matter* (8) in March 2024. However, these revisions are not reflected in this report, as AQS has not yet been updated to support the revised calculations.

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Table 7. PM Samplers - Precision Results Based on Available Collocated Samplers (2022-2024)

Pollutant	PQAO	Year	Measurement Method	Pairs of Collocated Samplers Reported	Percent Precision Completeness (%)	Upper Bound of CV (Precision)	C.F.R. Criteria for Precision Met?
PM ₁₀	CARB	2024	All	3*	100	17.37*	No
		2023	All	3*	100	<u>23.57*</u>	No
		2022	All	4	100	<u>20.31</u>	No
	Bay Area AQMD**	2024	All	NDA	NDA	NDA	NDA
		2023	All	NDA	NDA	NDA	NDA
		2022	All	1	100	3.02	Yes
	South Coast AQMD	2024	All	1	100	2.77	Yes
		2023	All	3	100	5.12	Yes
		2022	All	3	100	<u>12.57</u>	No
	San Diego County APCD	2024	All	NDA	NDA	NDA	NDA
		2023	All	2	100	3.05	Yes
		2022	All	1	100	3.93	Yes
	Nationwide**	2024	All	56**	98	9.41*	Yes
		2023	All	70*	97	9.52*	Yes
		2022	All	68	99	<u>10.66</u>	No
PM _{2.5}	CARB	2024	143	1	96	2.43	Yes
		2023	143	1	100	1.54	Yes
		2022	143	NDA	NDA	NDA	NDA
		2024	145	2	91	8.04	Yes
		2023	145	2	93	7.00	Yes
		2022	145	3	73	<u>26.25</u>	No
		2024	170	8	100	14.13	No
		2023	170	8	100	<u>14.33</u>	No
		2022	170	7	100	<u>15.32</u>	No
		2024	181	1	100	17.13	No
		2023	181	1	100	<u>12.45</u>	No
		2022	181	1	100	<u>17.38</u>	No
		2024	209	1	86	13.57	No
		2023	209	1	100	<u>12.45</u>	No
		2022	209	1	100	<u>26.84</u>	No
		2024	738***	NDA	NDA	NDA	NDA
		2023	238	1	100	8.32	Yes
		2022	238	1	100	<u>14.27</u>	No
	Bay Area AQMD**	2024	170	NDA	NDA	NDA	NDA
		2023	170	NDA	NDA	NDA	NDA
		2022	170	3	100	<u>10.41</u>	No

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Table 7. PM Samplers - Precision Results Based on Available Collocated Samplers (2022-2024) (cont.)

Pollutant	PQAO	Year	Measurement Method	Number Pairs of Collocated Samplers Reported	Percent Precision Completeness (%)	Upper Bound of CV (Precision)	C.F.R. Criteria for Precision Met?
PM _{2.5}	South Coast AQMD	2024	143	NDA	NDA	NDA	NDA
		2023	143	NDA	NDA	NDA	NDA
		2022	143	1	100	6.19	Yes
		2024	145	4	100	8.57	Yes
		2023	145	3	100	4.02	Yes
		2022	145	3	100	5.11	Yes
	South Coast AQMD	2024	170	1	100	14.22	No
		2023	170	1	96	<u>11.63</u>	No
		2022	170	2	100	<u>14.47</u>	No
		2024	183	NDA	NDA	NDA	NDA
		2023	183	NDA	NDA	NDA	NDA
		2022	183	1	100	<u>14.57</u>	No
		2024	209	1	86	15.52	No
		2023	209	1	83	<u>10.25</u>	No
		2022	209	1	100	<u>12.12</u>	No
	San Diego County APCD	2024	738***	NDA	NDA	NDA	NDA
		2023	238	1	100	<u>11.83</u>	No
		2022	238	1	100	<u>11.52</u>	No
		2024	545	NDA	NDA	NDA	NDA
		2023	545	1	100	3.81	Yes
		2022	545	1	100	4.69	Yes
	Nationwide**	2024	143	4	78	7.23	No
		2023	143	5	60	<u>10.05</u>	No
		2022	143	5	81	<u>11.59</u>	No
		2024	145	83	93	8.93	Yes
		2023	145	80	97	8.44	Yes
		2022	145	82	97	8.65	Yes
		2024	170	35	99	18.21	No
		2023	170	42	99	<u>16.26</u>	No
		2022	170	39	100	<u>17.60</u>	No
		2024	181	1	100	17.13	No
		2023	181	3	100	<u>11.12</u>	No
		2022	181	3	100	<u>18.52</u>	No
		2024	183	3	100	60.41	No
		2023	183	4	97	<u>14.46</u>	No
		2022	183	5	99	<u>15.20</u>	No

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Table 7. PM Samplers - Precision Results Based on Available Collocated Samplers (2022-2024) (cont.)

Pollutant	PQAO	Year	Measurement Method	Number Pairs of Collocated Samplers Reported	Percent Precision Completeness (%)	Upper Bound of CV (Precision)	C.F.R. Criteria for Precision Met?
PM _{2.5}	Nationwide**	2024	209	30	97	14.04	No
		2023	209	27	96	<u>12.54</u>	No
		2022	209	21	99	<u>14.15</u>	No
		2024	738***	2	100	24.89	No
		2023	238	30	99	<u>13.44</u>	No
		2022	238	28	100	<u>14.56</u>	No
		2024	545	5	100	6.83	Yes
		2023	545	5	100	7.35	Yes
		2022	545	5	100	7.00	Yes

- Source: AQS, AMP 256 Data Quality Indicator Report, run July 2025.
- NDA means no certified data available in AQS; **bold** text indicates CV greater than 10.1% in 2024; underlined text indicates CV greater than 10.1% in 2022 or 2023.
- Upper bound of CV (precision) is estimated by the upper confidence limit of the standard deviation of the percent differences of mass concentrations of the two collocated samplers collected on the same day; C.F.R. criteria for CV are provided in Appendix A of this report.
- A detailed list of measurement methods can be found in the List of Designated Reference and Equivalent Methods ([17](#)).
- *CARB's PQAO 2024 and 2023 data reflect a collocated continuous PM₁₀ sampler that was reported to AQS but was not required. C.F.R. only requires collocation of manual PM₁₀ samplers of the same method ([1](#)).
- **2024: Bay Area AQMD's PQAO data are not reflected in this report (for PQAO and nationwide), as certified data were not available in AQS (Source: AMP 256 Data Quality Indicator Report, run July 2025). Bay Area AQMD is currently implementing new documentation and validation processes. 2023: Bay Area AQMD's PQAO data are not reflected in this report (for PQAO and nationwide), as certified data were not available in AQS (Source: AMP 256 Data Quality Indicator Report, run July 2024).
- 2022: Bay Area AQMD reported on October 15, 2025, that data presented for 2022 have not undergone the required validation process as described in C.F.R. or the review necessary prior to reporting to AQS.
- ***Measurement method 238 data were reclassified as method 738 in AQS, per U.S. EPA's May 2024 PM_{2.5} Data Advisory ([18](#)).

Bias Results via Monthly Flow Rate Verifications

Bias results via the monthly FRVs for all PM samplers in 2024 are shown in Table 8. CARB's PQAO reported 100 percent for PM₁₀ Hi-Vol, more than 98 percent for PM₁₀ Low-Vol, and more than 99 percent for PM_{2.5} of the required FRVs performed. In summary, the bias criteria of ± 7.1 percent for PM₁₀ Hi-Vol, ± 4 percent for PM₁₀ Low-Vol, and ± 4.1 percent for PM_{2.5} were met in each PQAO for which data are available. Details regarding flow rate data not reported to AQS for CARB's PQAO PM samplers are provided in Appendices D-E of this report.

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Table 8. PM Samplers - Bias Results Based on FRVs (2022-2024)

Pollutant (Collection Method)	PQAO	Year	Number of Samplers	Number of Required FRVs	Percent Required FRVs Performed (%)	Average Percent Difference** (%)	Bias***	C.F.R. Criteria for Bias Met?
PM ₁₀ (Hi-Vol)	CARB	2024	7	28	100.0	0.23	3.63	Yes
		2023	8	29	100.0	2.45	3.93	Yes
		2022	14	41	100.0	1.55	3.29	Yes
	Bay Area AQMD*	2024	NDA	NDA	NDA	NDA	NDA	NDA
		2023	NDA	NDA	NDA	NDA	NDA	NDA
		2022	5	20	NDA	NDA	NDA	NDA
	South Coast AQMD	2024	9	36	100.0	0.41	4.02	Yes
		2023	9	27	100.0	0.49	4.17	Yes
		2022	19	61	100.0	0.13	3.39	Yes
	San Diego County APCD	2024	NDA	NDA	NDA	NDA	NDA	NDA
		2023	NDA	NDA	NDA	NDA	NDA	NDA
		2022	NDA	NDA	NDA	NDA	NDA	NDA
PM ₁₀ (Low-Vol)	CARB	2024	80	960	98.5	-0.09	1.06	Yes
		2023	81	955	99.1	-0.10	1.00	Yes
		2022	82	951	97.4	0.06	1.08	Yes
	Bay Area AQMD*	2024	NDA	NDA	NDA	NDA	NDA	NDA
		2023	NDA	NDA	NDA	NDA	NDA	NDA
		2022	1	12	NDA	NDA	NDA	NDA
	South Coast AQMD	2024	14	146	100.0	-0.82	1.30	Yes
		2023	18	154	100.0	-0.26	2.07	Yes
		2022	14	146	99.4	0.40	1.35	Yes
	San Diego County APCD	2024	10	120	100.0	0.40	1.20	Yes
		2023	9	81	100.0	0.07	1.41	Yes
		2022	9	71	95.6	0.33	1.35	Yes
PM _{2.5} (All)	CARB	2024	89	1,050	99.7	-0.01	±0.86	Yes
		2023	94	1,046	95.3	-0.15	±0.88	Yes
		2022	93	1,028	95.2	0.07	±1.00	Yes
	Bay Area AQMD*	2024	NDA	NDA	NDA	NDA	NDA	NDA
		2023	NDA	NDA	NDA	NDA	NDA	NDA
		2022	19	228	5.7	0.33	±0.55	Yes
	South Coast AQMD	2024	30	345	100	-0.25	±1.17	Yes
		2023	26	312	99.7	-0.29	±1.16	Yes
		2022	39	334	99.3	0.38	±1.28	Yes
	San Diego County APCD	2024	10	120	100.0	-0.12	±1.23	Yes
		2023	11	95	80.8	0.25	±1.34	Yes
		2022	17	118	66.3	0.25	±1.34	Yes

Table 8. PM Samplers - Bias Results Based on FRVs (2022-2024) (cont.)

- Source: AQS, AMP 256 Data Quality Indicator Report, run July 2025.
- NDA means no certified data available in AQS.
- U.S. EPA guidance criteria for PM₁₀ bias: $\pm 7.1\%$ (of standard) for Hi-Vol and $\pm 4\%$ (of standard) for Low-Vol; C.F.R. criteria for PM_{2.5} bias: $\pm 4.1\%$ (of standard).
- *2024: Bay Area AQMD's PQAQ data are not reflected in this report, as certified data were not available in AQS (Source: AMP 256 Data Quality Indicator Report, run July 2025). Bay Area AQMD is currently implementing new documentation and validation processes.
2023: Bay Area AQMD's PQAQ data are not reflected in this report, as certified data were not available in AQS (Source: AMP 256 Data Quality Indicator Report, run July 2024). Bay Area AQMD's PQAQ stores FRV data in its internal database and is developing a mechanism for reporting the data in AQS; data available for review upon request.
2022: Bay Area AQMD reported on October 15, 2025, that data presented for 2022 have not undergone the required validation process as described in C.F.R. or the review necessary prior to reporting to AQS.
- **Average percent difference is the arithmetic mean of the differences between the sampler's flow rate and the flow rate of the standard used during all FRVs performed.
- ***For PM₁₀ FRV, bias is an average of absolute bias values across samplers with no assigned sign (+, -, or $\pm$).

Bias Assessment via CARB's Flow Rate Audits

CARB's PQAQ and other PQAQs are required to conduct semi-annual flow rate audits on all PM samplers at each site, since an accurate measurement of PM is dependent upon the flow rate. Such audits should ideally be conducted five to seven months apart on each sampler in a given calendar year ([1](#)). In addition, as explained earlier, PQAQs are also required to submit FRVs (at least once every month) to AQS ([1](#)); in this case, bias estimates based on FRVs are further verified using the semi-annual flow rate audit data. All PM monitors, with a few exceptions, received the required semi-annual flow rate audits.

Table 9 summarizes the 2024 flow rate audit results for PM samplers. The number of samplers as well as those that met the required number of audits in 2024 are displayed. Two audits are required if a sampler operates more than seven months; one audit if less than seven months but more than three months; and zero if less than three months ([19](#)). Bias is estimated as an average percent difference between the sampler flow rates and the audit flow rates, which represents the arithmetic mean of the combined differences from the certified value of all the individual audit points for each sampler. Lower and upper confidence limits represent the range of the audit results across each PQAQ. A complete listing of CARB's PE audit acceptance criteria is provided in Appendix C of this report. Other PQAQs may utilize different audit criteria.

CARB conducts semi-annual flow rate audits for most samplers operating within CARB's PQAQ. In addition, certain monitoring organizations within CARB's PQAQ could conduct their own audits in 2024, per established Roles and Responsibilities Agreements ([20](#)). For example, Great Basin Unified APCD conducts one of the semi-annual flow rate audits for the sites operating within its jurisdiction. Other PQAQs are responsible for performing their own audits.

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Results of the audited PM samplers indicate that the samplers in the network were operating within CARB's and U.S. EPA's flow rate audit criteria. Flow rate audit results agree with bias estimates based on the FRVs within CARB's PQAO. Details on CARB's PQAO samplers not meeting these criteria are provided in Appendices D-E of this report.

Table 9. PM Samplers - Flow Rate Audits Results (2024)

Pollutant (Collection Method)	PQAO	Number of Samplers	Number of Samplers Meeting Required Number of Audits	Number of Flow Rate Audits Not Meeting CARB Criteria	Average Percent Difference*	Confidence Limit	
						Lower	Upper
PM ₁₀ (Hi-Vol)	CARB	7	7	0	-0.18	-1.64	1.28
	Bay Area AQMD***	NDA	NDA	NDA	NDA	NDA	NDA
	South Coast AQMD	9	9	0	1.63	0.02	3.24
	San Diego County APCD	NDA	NDA	NDA	NDA	NDA	NDA
PM ₁₀ (Low-Vol)**	CARB	80	80	0	0.33	0.16	0.50
	Bay Area AQMD***	NDA	NDA	NDA	NDA	NDA	NDA
	South Coast AQMD	14	14	0	1.35	1.04	1.66
	San Diego County APCD	10	10	0	0.58	0.07	1.09
PM _{2.5} (All)	CARB	89	89	0	0.27	0.09	0.44
	Bay Area AQMD***	NDA	NDA	NDA	NDA	NDA	NDA
	South Coast AQMD	30	30	0	1.79	1.43	2.14
	San Diego County APCD	10	10	0	-0.12	-0.79	0.55

- Source: AQS, AMP 256 Data Quality Indicator Report, run July 2025.
- NDA means no certified data available in AQS.
- Although ambient data collected at some SPM sites are not used for regulatory purposes, SPM sites are audited at the request of the monitoring organization, subject to availability of auditing resources, and results are included in this table.
- Sites could be audited multiple times in a quarter (by different entities or due to re-audits).
- CARB's flow rate audit criteria are provided in Appendix A of this report.
- *Bias is estimated as an average percent difference, which is the arithmetic mean of the differences between the sampler's flow rate and the flow rate of the standard used during the flow rate audits.
- **Count of Low-Vol samplers includes continuous BAM samplers.
- ***Bay Area AQMD's PQAO 2024 data are not reflected in this report, as certified data were not available in AQS (Source: AMP 256 Data Quality Indicator Report, run July 2025). Bay Area AQMD is currently implementing new documentation and validation processes.

Network Bias Results via PEP Audits

As noted earlier, PM_{2.5} samplers are subject to a PEP audit to assess “total bias” of the network. In general terms, a PEP audit is a type of audit in which the quantitative data generated in a measurement system are obtained independently and compared with routinely obtained data to evaluate the proficiency of the analyst or laboratory. The goal of a PEP audit is to evaluate total measurement system bias, which includes measurement uncertainties from both field and laboratory activities.

PEP audits are conducted annually within each PQAO and each method designation (for every designated FRM and FEM sampler within a PQAO) must be evaluated. Furthermore, each FRM and FEM sampler is subject to a PEP audit at least once every six years. For PQAOs with less than five monitoring sites, five valid PEP audits are required; for PQAOs with more than five monitoring sites, eight valid PEP audits are required. A PEP audit is valid when both the sampler and PEP audit concentrations are above 3 µg/m³.

Results from 2024 PEP audits for all PQAOs are presented in Table 10, with results from the previous two years presented to assess trends. Results from 2024 indicate that the PM_{2.5} network for CARB’s PQAO has low total bias, consistent with results determined through FRV and flow rate audits. U.S. EPA has lowered the threshold from 3 µg/m³ to 2 µg/m³ in its *Reconsideration of the National Ambient Air Quality Standards for Particulate Matter* [\(8\)](#) in March 2024; which helped increase the number of valid samples and improved the bias estimate based on PEP audits in CARB’s PQAO.

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Table 10. PM Samplers - Total Bias Results via PEP Audits (2022-2024)

Pollutant	PQAO	Year	Number of Samplers	Number of Audits Required	Number of Audits Collected	Percent Complete (%)	Bias
PM _{2.5}	CARB	2024	72	8	8	100	-0.42
		2023	72	8	4	50	-2.56
		2022	71	8	6	75	5.39
	Bay Area AQMD*	2024	NDA	NDA	NDA	NDA	NDA
		2023	NDA	NDA	NDA	NDA	NDA
		2022	15	8	5	63	-17.73
	South Coast AQMD	2024	16	8	8	100	-10.95
		2023	15	8	7	88	-0.91
		2022	20	8	9	100	-3.79
	San Diego County APCD	2024	9	8	10	100	11.94
		2023	9	8	2	25	6.94
		2022	8	8	6	75	-8.17

- Source: AQS, AMP 256 Data Quality Indicator Report, run July 2025.
- NDA means no certified data available in AQS.
- Number of samplers refers to monitors designated as "primary" in AQS.
- PEP audit criteria are provided in Appendix A of this report.
- *2024: Bay Area AQMD's PQAO data are not reflected in this report, as certified data were not available in AQS (Source: AMP 256 Data Quality Indicator Report, run July 2025). Bay Area AQMD is currently implementing new documentation and validation processes.
- 2023: Bay Area AQMD's PQAO data are not reflected in this report, as certified data were not available in AQS (Source: AMP 256 Data Quality Indicator Report, run July 2024).
- 2022: Bay Area AQMD reported on October 15, 2025, that data presented for 2022 have not undergone the required validation process as described in C.F.R. or the review necessary prior to reporting to AQS.

C. Summary of Results for Monitoring Organizations within CARB's PQAO

Table 11 summarizes the 2024 data quality results for gaseous pollutants and PM across different geographic areas¹⁶ within CARB's PQAO. To make an assessment, the 30 geographic areas were divided into four categories according to monitoring activities, as shown below. Notable observations from the assessment of these four categories for CARB's PQAO in 2024 include:

Gaseous pollutant monitoring only

- Two geographic areas:
 - Amador County and Tuolumne County met all MQOs.

PM monitoring only without collocation

- Two geographic areas:
 - Eastern Kern and Northern Sonoma met all MQOs.

Gaseous pollutant and PM monitoring without collocation

- Sixteen geographic areas:
 - Antelope Valley, Butte County, Calaveras County, Glenn County, Lake County, Mendocino County, Placer County, San Luis Obispo, Santa Barbara County, Siskiyou County, Tehama County, and Yolo-Solano met all MQOs.
 - Mariposa County met all MQOs for gaseous pollutants only.
 - Colusa County and El Dorado County met all MQOs for PM only.
 - One did not meet all MQOs for gaseous pollutants and PM.

Gaseous pollutant and PM monitoring with collocation

- Ten geographic areas:
 - Mojave Desert and North Coast met all MQOs.
 - Feather River, Monterey Bay, and Ventura County met all MQOs for gaseous pollutants only.
 - Five did not meet all MQOs for gaseous pollutants and PM.

¹⁶ In this report, a geographic area refers to a region covered by a monitoring organization. Sites may be operated by the monitoring organization, CARB, or both. See Appendix D of this report for a complete list of geographic areas and associated monitoring organizations.

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In Table 11, a “Y” indicates that all monitors within a given geographic area have met the MQOs while an “N” indicates otherwise. In some instances, one instrument or sampler may be responsible for several “N” marks due to instrument/sampler failure (more details are provided in Appendix E of this report). Note that MQOs were developed to be evaluated at the PQAO level but can be used for informational purposes at the monitoring organization level. The ongoing goal is to identify potential issues behind sites and/or monitoring organizations and remediate in a timely manner so as not to affect CARB’s PQAO as a whole.

As indicated earlier in this report, a systemic issue exists with PM precision in California and nationwide. Table 12 shows that most collocated samplers reported upper bound CV values exceeding the criterion of 10.1 percent and is consistent with 2023 data. Only one geographic area, Sacramento Metropolitan, met the criterion for achieving CV values of less than 10.1 percent for PM₁₀, while four geographic areas, Mojave Desert, North Coast, Sacramento Metropolitan, and San Joaquin Valley, met the criterion for PM_{2.5}. U.S. EPA adopted new methods for calculating CV in its *Reconsideration of the National Ambient Air Quality Standards for Particulate Matter* (8) in March 2024. However, these revisions are not reflected in this report, as AQS has not yet been updated to support the revised calculations.

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Table 11. Gaseous Instruments and PM Samplers - Composite Table of Ambient Data and Data Quality Results for Geographic Areas within CARB's PQAO (2024)

Geographic Area	Gaseous Instruments						PM Samplers					
	Ambient Data Capture Rate	1-pt QC Checks Reported	Precision Criteria Met	Bias Criteria Met	Instruments All Audited	Audited Instruments Met Criteria	Ambient Data Capture Rate	Precision Data Collocated Sites	Collocated Sites Met Criteria	FRV	Samplers All Audited	Audited Samplers Met Criteria
Amador County	Y	Y	Y	Y	Y	Y	NA	NA	NA	NA	NA	NA
Antelope Valley	Y	Y	Y	Y	Y	Y	Y	NA	NA	Y	Y	Y
Butte County	Y	Y	Y	Y	Y	Y	Y	NA	NA	Y	Y	Y
Calaveras County	Y	Y	Y	Y	Y	Y	Y	NA	NA	Y	Y	Y
Colusa County	N†	Y	Y	Y	Y	N†	Y	NA	NA	Y	Y	Y
Eastern Kern	NA	NA	NA	NA	NA	NA	Y	NA	NA	Y	Y	Y
El Dorado County	N†	Y	Y	Y	Y	Y	Y	NA	NA	Y	Y	Y
Feather River	Y	Y	Y	Y	Y	Y	Y	Y	N†	Y	Y	Y
Glenn County	Y	Y	Y	Y	Y	Y	Y	NA	NA	Y	Y	Y
Great Basin	N	N	Y	Y	Y	Y	N	Y	N	N	Y	Y
Imperial County	N	N	Y	Y	Y	Y	Y	Y	N†	Y	Y	Y
Lake County	Y	Y	Y	Y	Y	Y	Y	NA	NA	Y	Y	Y
Mariposa County	Y	Y	Y	Y	Y	Y	Y	NA	NA	N†	Y	Y
Mendocino County	Y	Y	Y	Y	Y	Y	Y	NA	NA	Y	Y	Y
Mojave Desert	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Monterey Bay	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
North Coast	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Northern Sierra	N	Y	Y	Y	Y	Y	N	NA	NA	Y	Y	Y
Northern Sonoma	NA	NA	NA	NA	NA	NA	Y	NA	NA	Y	Y	Y
Placer County	Y	Y	Y	Y	Y	Y	Y	NA	NA	Y	Y	Y
Sacramento Metropolitan	N	N	Y	Y	Y	Y	Y	Y	N††	Y	Y	Y
San Joaquin Valley	N†	N†	Y	Y	N	N†	Y	Y	N†	Y	Y	Y
San Luis Obispo	Y	Y	Y	Y	Y	Y	Y	NA	NA	Y	Y	Y
Santa Barbara County	Y	Y	Y	Y	Y	Y	Y	NA	NA	Y	Y	Y
Shasta County	N	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y
Siskiyou County	Y	Y	Y	Y	Y	Y	Y	NA	NA	Y	Y	Y
Tehama County	Y	Y	Y	Y	Y	Y	Y	NA	NA	Y	Y	Y
Tuolumne County	Y	Y	Y	Y	Y	Y	NA	NA	NA	NA	NA	NA
Ventura County	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
Yolo-Solano	Y	Y	Y	Y	Y	Y	Y	NA	NA	Y	Y	Y

- Geographic area = a region covered by a monitoring organization. Sites may be operated by the monitoring organization, CARB, or both. See Appendix D of this report for a complete list of geographic areas and associated monitoring organizations.
- Y = met criteria; N = not all sites met criteria, impacted site(s) operated by the monitoring organization; N† = not all sites met criteria, impacted site(s) operated by CARB; N†† = not all sites met criteria, impacted site(s) operated by both the monitoring organization and CARB; NA = not applicable for that geographic area.

Table 12. PM Samplers - Precision Results for Geographic Areas within CARB's PQAQ (2024)

Pollutant	Geographic Area	Measurement Method (Primary/Secondary)	Monitoring By	Percent Precision Completeness (%)	Upper Bound of CV (Precision)
PM ₁₀	Great Basin	All	MO MO	100 100	16.12* 13.81
	Sacramento Metropolitan	All	MO	100	9.65
PM _{2.5}	Feather River	170/170	CARB	100	16.99
	Great Basin	181/145	MO	100	17.13
	Imperial County	170/143	CARB	97	15.57
	Mojave Desert	170/170	MO	100	9.85
	Monterey Bay	170/143	MO	100	18.51
	North Coast	143/143	MO	97	2.43
	Sacramento Metropolitan	145/145	MO	93	5.52
		170/143	CARB	100	17.28
		170/170	MO	93	13.70
	San Joaquin Valley	170/145	CARB	100	10.91
		145/145	CARB	90	8.99
	Shasta County	209/143	MO	87	13.57
	Ventura County	170/170	MO	100	10.41

- Source: AQS, AMP 256 Data Quality Indicator Report, run July 2025.
- Upper bound of CV (precision) is estimated by the upper confidence limit of the standard deviation of the percent differences of mass concentrations of the two collocated samplers collected on the same day; C.F.R. criteria for CV are provided in Appendix A of this report.
- Details on samplers not meeting criteria are provided in Appendices D-E of this report.
- **Bold** text indicates CV greater than 10.1% in 2024.
- A detailed list of measurement methods can be found in the List of Designated Reference and Equivalent Methods ([17](#)).
- *Data reflect a collocated continuous PM₁₀ sampler that was reported to AQS but was not required. C.F.R. only requires collocation of manual PM₁₀ samplers of the same method ([1](#)).

IV. Conclusions and Recommendations

This report provides ambient air quality data producers and users with a centralized review of the quality of data collected at monitoring sites within CARB's PQAO with respect to MQOs. In addition, comparisons to other PQAOs in California and the nationwide average are shown where appropriate. Below are some highlights for 2024.

A. Gaseous Pollutants

The gaseous pollutants assessed in this report are CO, NO₂, O₃, and SO₂. Conclusions and recommendations pertaining to gaseous instruments and associated MQOs are highlighted below.

Conclusions

- Ambient data capture rate criteria of at least 75 percent were met by 92 percent of the gaseous instruments operating within CARB's PQAO in 2024.
- In 2024, 95 percent of the gaseous instruments operating within CARB's PQAO reported at least 75 percent of the required 1-pt QC checks. Additionally, more than 99 percent met the critical criteria¹⁷ for individual 1-pt QC checks for percent, absolute difference, and prescribed range, set by U.S. EPA (2) (6).
- CARB's PQAO met the C.F.R. criteria for precision and bias based on 1-pt QC checks (1).
- Data from CARB's PE audits indicate that 98 percent of all instruments met the audit acceptance criteria for CARB's PQAO. This confirms the bias estimates based on 1-pt QC checks, which showed that the gaseous network for CARB's PQAO generally exhibits a low bias, and is consistent with 2023 data.

Recommendations

- Overall, the achievement of MQOs associated with the gaseous instruments declined compared to 2023 for CARB's PQAO. For example, several instances were identified in which instruments did not meet the MQO for ambient data capture rate or the submittal of required 1-pt QC checks due to various instrument issues, which resulted in a 5 percent decline. Monitoring organizations should evaluate their instrument replacement plans, continue to investigate why these objectives were not met for each instrument in their respective jurisdictions and develop corrective actions, if appropriate, to meet MQOs in subsequent years.

¹⁷ U.S. EPA describes "critical" criteria as criteria deemed to maintaining the integrity of a sample or group of samples (2).

B. Particulate Matter

The PM assessed in this report are PM₁₀ and PM_{2.5}. Conclusions and recommendations pertaining to PM samplers and associated MQOs are highlighted below.

Conclusions

- Ambient data capture rate criteria of at least 75 percent were met by 99 percent of the PM samplers operating within CARB's PQAO in 2024.
- CARB's PQAO continued to meet the minimum 15 percent collocation requirement in the network of primary PM samplers, as indicated in CARB's Annual Network Plan ([7](#)).
- CARB's PQAO met precision completeness criteria of at least 75 percent for collocated PM samplers. The U.S. EPA guidance precision criteria of 10.1 percent CV upper bound for CARB's PQAO was not met for all PM₁₀ and for three of the five individual methods for PM_{2.5}.
- CARB's PQAO reported 100 percent for PM₁₀ Hi-Vol, more than 98 percent for PM₁₀ Low-Vol, and more than 99 percent for PM_{2.5} of the required FRVs performed. The results at the PQAO level indicate that the PM network exhibited low bias in 2024.
- CARB's PE audit data indicate that CARB's PQAO met audit criteria for flow rate audits. This is consistent with bias information from the routine FRV data, and is consistent with 2023 data.
- Total PM_{2.5} bias for CARB's PQAO, via PEP audits administered by U.S. EPA and based on limited mass samples, shows low bias, consistent with results determined by FRVs and CARB's PE audits for flow rate.

Recommendations

- In terms of precision, CV values among collocated PM_{2.5} samplers within CARB's PQAO remain high for three of the five individual methods for PM_{2.5} in 2024. CARB explored potential causes behind low PM_{2.5} precision among some collocated PM_{2.5} samplers; however, no definitive source of the issue was identified. U.S. EPA is aware of the systemic issue of PM imprecision (in California and nationwide). The agency adopted new statistics for calculating CV in its *Reconsideration of the National Ambient Air Quality Standards for Particulate Matter* ([8](#)) in March 2024. However, AQS has not yet been updated to reflect the revised calculations. CARB should further evaluate the potential causes of elevated CV values, including low PM precision, collocation of non-identical methods, and geographic diversity within CARB's PQAO.
- There were instances of PM₁₀ and/or PM_{2.5} samplers not meeting the MQOs (e.g., ambient data capture rate, FRVs, etc.). Monitoring organizations should investigate why these objectives were not met for each sampler in their

respective jurisdictions and develop corrective actions, if appropriate, to meet them in subsequent years.

The 2024 ambient data in AQS for CARB's PQAO have been certified and are considered suitable for comparison to federal ambient air quality standards. Although C.F.R. criteria for precision and bias are generally applied and evaluated at the PQAO level, assessments at the monitoring organization or site level may differ and can be important as well. Therefore, data producers are strongly encouraged to review the site-level information and assess whether their MQOs are met. When certain C.F.R. criteria are not met, it does not necessarily mean that the corresponding air quality data cannot be used, but rather, the data may be used with the knowledge of the quality behind it.

CARB has in place extensive Standard Operating Procedures and data review protocols through Quality Assurance Project Plans (QAPP) ([21](#)) ([22](#)) and the Quality Management Plan (QMP) ([23](#)) as well as detailed processes to document deviations from criteria, including AQDAs and CANs. Deviations from MQOs do not invalidate the data for regulatory decision making. A weight of evidence evaluation based on data quality measurements, in combination with other data information, reports, and similar documentation, can be used to demonstrate compliance with requirements in Appendix A of 40 C.F.R. Part 58 ([1](#)).

The statistics presented in this report are intended as assessment tools for the data producers to identify areas where program improvements can be made to meet all MQOs set by U.S. EPA or the data producers themselves.

A comprehensive list of all references used in this report is provided in Appendix F.

V. Appendices

Appendix A. U.S. EPA's Measurement Quality Objectives

Table A-1. Ambient Air Monitoring Measurement Quality Objectives*

Requirement and Pollutant	Coverage (Annual)	Minimum Frequency	MQOs
1-pt QC Check: CO, NO ₂ , O ₃ , SO ₂	Each instrument	Once every 14 days	CO: 90% confidence level (CL) CV < 10.1% for precision 95% CL < $\pm 10.1\%$ for bias ($< \pm 10.1\%$ percent difference and 0.5-5.0 ppm for an individual 1-pt QC check) NO₂: 90% CL CV < 15.1% for precision 95% CL < $\pm 15.1\%$ for bias ($< \pm 15.1\%$ (percent difference) or $< \pm 1.5$ ppb difference, whichever is greater, and 0.005-0.08 ppm for an individual 1-pt QC check) O₃: 90% CL CV < 7.1% for precision 95% CL < $\pm 7.1\%$ for bias ($< \pm 7.1\%$ (percent difference) or $< \pm 1.5$ ppb difference, whichever is greater, and 0.005-0.08 ppm for an individual 1-pt QC check) SO₂: 90% CL CV < 10.1% for precision 95% CL < $\pm 10.1\%$ for bias ($< \pm 10.1\%$ (percent difference) or $< \pm 1.5$ ppb difference, whichever is greater, and 0.005-0.08 ppm for an individual 1-pt QC check)
CARB's PE Audits: CO, NO ₂ , O ₃ , SO ₂	Each instrument	Once per year	CO, NO₂, SO₂: $< \pm 15.1\%$ for each audit concentration O₃: $< \pm 10.1\%$ for each audit concentration
National Performance Audit Program: CO, NO ₂ , O ₃ , SO ₂	20% of sites per year	Once per year	CO, NO₂, SO₂: $< \pm 15.1\%$ for each audit concentration O₃: $< \pm 10.1\%$ for each audit concentration

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Table A-1. Ambient Air Monitoring Measurement Quality Objectives* (cont.)

Requirement and Pollutant	Coverage (Annual)	Minimum Frequency	MQOs
FRV: PM ₁₀ , PM _{2.5}	Each sampler	Once every month and at least 14 days apart	PM ₁₀ : < ±7.1% of standard PM _{2.5} : < ±4.1% of standard
Semi-Annual Flow Rate Audit: PM ₁₀ Continuous, PM _{2.5}	Each sampler	Once every 6 months	PM ₁₀ : < ±10.1% of standard PM _{2.5} : < ±4.1% of standard
Collocated Sampling: PM _{2.5}	15%	Every 12 days	CV < 10.1% of samples ≥ 3.0 µg/m ³
PM Performance Evaluation Program: PM ₁₀ Continuous, PM _{2.5}	1. PM ₁₀ Continuous: All samplers in 6 years 2. PM _{2.5} : 5 valid audits for PQAOs, with ≤ 5 sites 3. PM _{2.5} : 8 valid audits for PQAOs, with > 5 sites	Over all 4 quarters	< ±10.1% of samples > 3.0 µg/m ³
Collocated Sampling: PM ₁₀ , PM _{2.5}	15%	Every 12 days	CV < 10.1% of PM _{2.5} samples > 3.0 µg/m ³ and of PM ₁₀ samples > 15.0 µg/m ³
FRV: PM ₁₀ (Low-Vol)	Each sampler	Once every month and at least 14 days apart	±4% of standard
FRV: PM ₁₀ Hi-Vol	Each sampler	Once a quarter	< ±7.1% of standard
Semi-Annual Flow Rate Audit: PM ₁₀ Low-Vol	Each sampler, all locations	Once every 6 months	< ±4.1% of standard
Semi-Annual Flow Rate Audit: PM ₁₀ Hi-Vol	Each sampler, all locations	Once every 6 months	< ±7.1% of standard

- *The details in this table were informed by Appendix A of 40 C.F.R. Part 58 (1) and/or U.S. EPA guidance (2).

Appendix B. Tools for Assessing Precision and Bias

Table B-1. Tools for Assessing Precision and Bias

Pollutant	Precision		Bias		CARB's PE Audits
	1-pt QC Checks	Collocated Measurements	1-pt QC Checks	FRVs	
Gaseous					
CO, NO ₂ , O ₃ , SO ₂	✓	--	✓	--	annually
Continuous PM					
PM _{2.5}	--	✓	--	monthly	semi-annually
PM ₁₀ ,	--	--	--	monthly	semi-annually
Manual PM					
PM _{2.5}	--	✓	--	monthly	semi-annually
PM ₁₀ Hi-Vol	--	✓	--	quarterly	semi-annually
PM ₁₀ Low-Vol	--	✓	--	monthly	semi-annually

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Appendix C. CARB's Performance Evaluation Audit Acceptance Criteria

Table C-1. Gaseous Instruments and PM Samplers - CARB's PE Audit Acceptance Criteria

Instrument/Sampler	Control Limit	Warning
CO, NO ₂ , and SO ₂	±15%*	±10%
O ₃	±10%*	±7%
PM ₁₀ (Dichotomous, Continuous); PM ₁₀ (Filter-Based Low-Vol; Lead Low-Vol)	±10%	±7%
PM ₁₀ (Filter-Based Hi-Vol)	±7% of transfer standard	±5%
PM ₁₀ , PM _{2.5} (Filter-based Low-Vol, PM coarse); PM ₁₀ (Filter-Based Low-Vol, Lead Low-Vol)	±4% of transfer standard	none
PM _{2.5} (Filter-Based, Continuous)	±4% of transfer standard	none
Total Suspended Particulates (Lead Hi-Vol)	±7% of transfer standard	±5%
Xontech 920/924 Toxic and Carbonyl Sampler	±10%	±7%

- *Audit levels 1 and 2 are subject to the following CARB's PE audit acceptance criteria based on Appendix A of 40 C.F.R. Part 58 (1) and/or U.S. EPA guidance (2):
 - For CO: ±0.03 ppm difference or ±15% difference, whichever is greater.
 - For NO₂, O₃, and SO₂: ±1.5 ppb difference or ±15% difference, whichever is greater.
- CARB's PE audit acceptance criteria are operational, and exceedances (especially at lower levels) do not automatically invalidate the data.

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Appendix D. Data Quality Tables for Geographic Areas within CARB's PQAO

This appendix further breaks down the results for CARB's PQAO from tables within this report into geographic areas within CARB's PQAO. Monitoring sites within each geographic area may be operated by a monitoring organization (MO), CARB, or both, and this distinction is noted in each table. While MQOs were developed for assessment of precision and bias at the PQAO level, information at the monitoring organization level may be used to identify underlying issues, which in turn may be helpful for improving the overall performance of CARB's PQAO. For this report, a geographic area refers to a region covered by a monitoring organization; see Table D-1 for a complete list of geographic areas and associated monitoring organizations.

Table D-1. Geographic Areas and Associated Monitoring Organizations

Geographic Area	Monitoring Organization	Monitoring By
Amador County	Amador County APCD	CARB
Antelope Valley	Antelope Valley AQMD	MO
Butte County	Butte County AQMD	CARB
Calaveras County	Calaveras County APCD	CARB
Colusa County	Colusa County APCD	CARB
Eastern Kern	Eastern Kern APCD	MO; CARB
El Dorado County	El Dorado County AQMD	CARB
Feather River	Feather River AQMD	CARB
Glenn County	Glenn County APCD	CARB
Great Basin	Great Basin Unified APCD	MO
Imperial County	Imperial County APCD	MO; CARB
Lake County	Lake County APCD	MO
Mariposa County	Mariposa County APCD	CARB
Mendocino County	Mendocino County AQMD	MO
Mojave Desert	Mojave Desert AQMD	MO; CARB
Monterey Bay	Monterey Bay ARD	MO
North Coast	North Coast Unified AQMD	MO
Northern Sierra	Northern Sierra AQMD	MO
Northern Sonoma	Northern Sonoma County APCD	MO
Placer County	Placer County APCD	MO; CARB
Sacramento Metropolitan	Sacramento Metropolitan AQMD	MO; CARB
San Joaquin Valley	San Joaquin Valley APCD	MO; CARB
San Luis Obispo	San Luis Obispo County APCD	MO; CARB
Santa Barbara County	Santa Barbara County APCD	MO
Shasta County	Shasta County APCD	MO
Siskiyou County	Siskiyou County APCD	MO
Tehama County	Tehama County APCD	MO; CARB
Tuolumne County	Tuolumne County APCD	CARB
Ventura County	Ventura County APCD	MO
Yolo-Solano	Yolo-Solano AQMD	MO; CARB

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Table D-2. Gaseous Instruments - Ambient Data Capture Rate Results for Geographic Areas within CARB's PQAO (2024)

Geographic Area	Monitoring By	Number of CO Instruments	Number of Instruments Reporting ≥ 75% Ambient Data Capture Rate	Percent of Instruments Reporting ≥ 75% Ambient Data Capture Rate (%)
Butte County	CARB	1	1	100
Great Basin	MO	1	1	100
Monterey Bay	MO	1	1	100
Sacramento Metropolitan	MO	2	1	50
San Joaquin Valley	MO; CARB	6	5	83
Santa Barbara County	MO	1	1	100
Geographic Area	Monitoring By	Number of NO ₂ Instruments	Number of Instruments Reporting ≥ 75% Ambient Data Capture Rate	Percent of Instruments Reporting ≥ 75% Ambient Data Capture Rate (%)
Antelope Valley	MO	1	1	100
Butte County	CARB	1	1	100
Feather River	CARB	1	1	100
Imperial County	MO; CARB	2	2	100
Mojave Desert	MO	3	3	100
Monterey Bay	MO	1	1	100
North Coast	MO	1	1	100
Placer County	CARB	1	1	100
Sacramento Metropolitan	MO; CARB	5	4	80
San Joaquin Valley	MO; CARB	17	16	94
San Luis Obispo	MO	2	2	100
Santa Barbara County	MO	1	1	100
Ventura County	MO	2	2	100
Yolo-Solano	CARB	1	1	100

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Table D-2. Gaseous Instruments - Ambient Data Capture Rate Results for Geographic Areas within CARB's PQAO (2024) (cont.)

Geographic Area	Monitoring By	Number of O ₃ Instruments	Number of Instruments Reporting ≥ 75% Ambient Data Capture Rate	Percent of Instruments Reporting ≥ 75% Ambient Data Capture Rate (%)
Amador County	CARB	1	1	100
Antelope Valley	MO	1	1	100
Butte County	CARB	2	2	100
Calaveras County	CARB	1	1	100
Colusa County	CARB	1	0	0
Eastern Kern	CARB	1	1	100
El Dorado County	CARB	3	2	67
Feather River	CARB	2	2	100
Glenn County	CARB	1	1	100
Great Basin	MO	1	1	100
Imperial County	MO; CARB	4	2	50
Lake County	MO	1	1	100
Mariposa County	CARB	1	1	100
Mendocino County	MO	1	1	100
Mojave Desert	MO; CARB	5	5	100
Monterey Bay	MO	5	5	100
North Coast	MO	1	1	100
Northern Sierra	MO	1	0	0
Placer County	MO; CARB	5	5	100
Sacramento Metropolitan	MO; CARB	5	4	80
San Joaquin Valley	MO; CARB	23	23	100
San Luis Obispo	MO; CARB	6	6	100
Santa Barbara County	MO	8	8	100
Shasta County	MO	2	1	50
Siskiyou County	MO	1	1	100
Tehama County	MO; CARB	2	2	100
Tuolumne County	CARB	1	1	100
Ventura County	MO	5	5	100
Yolo-Solano	MO; CARB	3	3	100

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Table D-2. Gaseous Instruments - Ambient Data Capture Rate Results for Geographic Areas within CARB's PQAO (2024) (cont.)

Geographic Area	Monitoring By	Number of SO ₂ Instruments	Number of Instruments Reporting ≥ 75% Ambient Data Capture Rate	Percent of Instruments Reporting ≥ 75% Ambient Data Capture Rate (%)
Great Basin	MO	1	0	0
Imperial County	CARB	1	1	100
North Coast	MO	1	1	100
Sacramento Metropolitan	MO	1	1	100
San Joaquin Valley	CARB	1	1	100
San Luis Obispo	MO	1	1	100
Santa Barbara County	MO	1	1	100

Table D-3. Gaseous Instruments - Precision Results and Bias for Geographic Areas within CARB's PQAO (2024)

Geographic Area	Monitoring By	Number of CO Instruments	Number of Instruments with ≥ 75% of Required 1-pt QC Checks	Upper Bound of CV (Precision)	Bias*
Butte County	CARB	1	1	3.36	2.58
Great Basin	MO	1	1	6.64	5.62
Monterey Bay	MO	1	1	3.29	2.53
Sacramento Metropolitan	MO	2	1	2.59	4.84
San Joaquin Valley	MO; CARB	6	5	3.35	4.37
Santa Barbara County	MO	1	1	3.45	3.65
Geographic Area	Monitoring By	Number of NO ₂ Instruments	Number of Instruments with ≥ 75% of Required 1-pt QC Checks	Upper Bound of CV (Precision)	Bias*
Antelope Valley	MO	1	1	0.95	1.61
Butte County	CARB	1	1	2.08	4.32
Feather River	CARB	1	1	5.04	4.33
Imperial County	MO; CARB	2	2	4.58	4.18
Mojave Desert	MO	3	3	2.40	2.16
Monterey Bay	MO	1	1	4.51	3.54

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Table D-3. Gaseous Instruments - Precision Results and Bias for Geographic Areas within CARB's PQAO (2024) (cont.)

Geographic Area	Monitoring By	Number of NO ₂ Instruments	Number of Instruments with ≥ 75% of Required 1-pt QC Checks	Upper Bound of CV (Precision)	Bias*
North Coast	MO	1	1	4.41	3.80
Placer County	CARB	1	1	7.37	6.88
Sacramento Metropolitan	MO; CARB	5	5	4.07	5.33
San Joaquin Valley	MO; CARB	17	16	4.08	4.81
San Luis Obispo	MO	2	2	3.30	4.82
Santa Barbara County	MO	1	1	2.78	2.30
Ventura County	MO	2	2	1.55	2.32
Yolo-Solano	CARB	1	1	3.06	5.61
Geographic Area	Monitoring By	Number of O ₃ Instruments	Number of Instruments with ≥ 75% of Required 1-pt QC Checks	Upper Bound of CV (Precision)	Bias*
Amador County	CARB	1	1	1.29	1.56
Antelope Valley	MO	1	1	1.83	1.54
Butte County	CARB	2	2	2.09	2.62
Calaveras County	CARB	1	1	1.15	2.17
Colusa County	CARB	1	1	1.31	1.85
Eastern Kern	CARB	1	1	1.49	1.41
El Dorado County	CARB	3	3	1.60	2.54
Feather River	CARB	2	2	2.03	3.71
Glenn County	CARB	1	1	1.12	2.29
Great Basin	MO	1	0	1.95	1.60
Imperial County	MO; CARB	4	2	3.04	2.69
Lake County	MO	1	1	1.88	1.84
Mariposa County	CARB	1	1	2.12	3.58
Mendocino County	MO	1	1	1.28	1.68
Mojave Desert	MO; CARB	5	5	1.73	1.41
Monterey Bay	MO	5	5	2.14	2.98
North Coast	MO	1	1	1.69	2.76
Northern Sierra	MO	1	1	3.51	3.30
Placer County	MO; CARB	5	5	2.59	2.48
Sacramento Metropolitan	MO; CARB	5	5	2.44	2.35
San Joaquin Valley	MO; CARB	23	23	1.99	2.02

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Table D-3. Gaseous Instruments - Precision Results and Bias for Geographic Areas within CARB's PQAO (2024) (cont.)

Geographic Area	Monitoring By	Number of O ₃ Instruments	Number of Instruments with ≥ 75% of Required 1-pt QC Checks	Upper Bound of CV (Precision)	Bias*
San Luis Obispo	MO; CARB	6	6	1.38	1.47
Santa Barbara County	MO	8	8	2.42	2.17
Shasta County	MO	2	2	3.20	2.21
Siskiyou County	MO	1	1	2.58	1.90
Tehama County	MO; CARB	2	2	2.00	2.22
Tuolumne County	CARB	1	1	0.71	1.22
Ventura County	MO	5	5	1.12	1.05
Yolo-Solano	MO; CARB	3	3	2.76	3.50
Geographic Area	Monitoring By	Number of SO ₂ Instruments	Number of Instruments with ≥ 75% of Required 1-pt QC Checks	Upper Bound of CV (Precision)	Bias*
Great Basin	MO	1	0	1.50	1.29
Imperial County	CARB	1	1	0.87	0.62
North Coast	MO	1	1	8.84	7.96
Sacramento Metropolitan	MO	1	1	4.14	5.01
San Joaquin Valley	CARB	1	1	4.05	7.89
San Luis Obispo	MO	1	1	1.58	1.28
Santa Barbara County	MO	1	1	1.41	1.37

- Source: AQS, AMP 256 Data Quality Indicator Report, run July 2025.
- Details on CARB's PQAO instruments not meeting these criteria are provided in Appendix E of this report.
- Upper bound of CV (precision) is estimated by the upper confidence limit of the standard deviation of differences measured by 1-pt QC checks. Bias is estimated as the upper bound on the mean absolute value of the percent differences measured by 1-pt QC checks. C.F.R. criteria for precision and bias are provided in Appendix A of this report. The AMP 600 report flags instruments that do not have at least 75% of the required 1-pt QC checks.
- *For each geographic area, bias is an average of absolute bias values across individual instruments within each area, with no assigned sign (+, -, or ±).

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Table D-4. Gaseous Instruments - 1-pt QC Checks Individual Assessment for Geographic Areas within CARB's PQAO (2024)

Geographic Area	Monitoring By	Number of Instruments	Number of CO 1-pt QC Checks Performed	Number of CO 1-pt QC Checks Meeting Critical Criteria	Percent of CO 1-pt QC Checks Meeting Critical Criteria (%)
Butte County	CARB	1	250	249	99.6
Great Basin	MO	1	63	58	92.1
Monterey Bay	MO	1	51	51	100.0
Sacramento Metropolitan	MO	2	296	296	100.0
San Joaquin Valley	MO; CARB	6	642	641	99.8
Santa Barbara County	MO	1	352	352	100.0
Geographic Area	Monitoring By	Number of Instruments	Number of NO ₂ 1-pt QC Checks Performed	Number of NO ₂ 1-pt QC Checks Meeting Critical Criteria	Percent of NO ₂ 1-pt QC Checks Meeting Critical Criteria (%)
Antelope Valley	MO	1	334	334	100.0
Butte County	CARB	1	255	255	100.0
Feather River	CARB	1	198	198	100.0
Imperial County	MO; CARB	2	277	277	100.0
Mojave Desert	MO	3	145	145	100.0
Monterey Bay	MO	1	50	50	100.0
North Coast	MO	1	120	120	100.0
Placer County	CARB	1	255	255	100.0
Sacramento Metropolitan	MO; CARB	5	952	952	100.0
San Joaquin Valley	MO; CARB	17	4,838	4838	100.0
San Luis Obispo	MO	2	531	526	99.1
Santa Barbara County	MO	1	345	345	100.0
Ventura County	MO	2	349	349	100.0
Yolo-Solano	CARB	1	257	257	100.0

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Table D-4. Gaseous Instruments - 1-pt QC Checks Individual Assessment for Geographic Areas within CARB's PQAO (2024) (cont.)

Geographic Area	Monitoring By	Number of Instruments	Number of O ₃ 1-pt QC Checks Performed	Number of O ₃ 1-pt QC Checks Meeting Critical Criteria	Percent of O ₃ 1-pt QC Checks Meeting Critical Criteria (%)
Amador County	CARB	1	338	338	100.0
Antelope Valley	MO	1	357	357	100.0
Butte County	CARB	2	613	613	100.0
Calaveras County	CARB	1	354	354	100.0
Colusa County	CARB	1	349	349	100.0
Eastern Kern	CARB	1	267	267	100.0
El Dorado County	CARB	3	685	680	99.3
Feather River	CARB	2	403	394	97.8
Glenn County	CARB	1	341	341	100.0
Great Basin	MO	1	47	47	100.0
Imperial County	MO; CARB	4	314	313	99.7
Lake County	MO	1	51	51	100.0
Mariposa County	CARB	1	99	99	100.0
Mendocino County	MO	1	50	50	100.0
Mojave Desert	MO; CARB	5	476	476	100.0
Monterey Bay	MO	5	258	256	99.2
North Coast	MO	1	114	114	100.0
Northern Sierra	MO	1	52	51	98.1
Placer County	MO; CARB	5	352	351	99.7
Sacramento Metropolitan	MO; CARB	5	968	966	99.8
San Joaquin Valley	MO; CARB	23	6,891	6972	99.9
San Luis Obispo	MO	6	1,892	1891	99.9
Santa Barbara County	MO	8	2,846	2819	99.1
Shasta County	MO	2	91	89	97.8
Siskiyou County	MO	1	27	27	100.0
Tehama County	MO; CARB	2	255	255	100.0
Tuolumne County	CARB	1	359	359	100.0
Ventura County	MO	5	883	883	100.0
Yolo-Solano	MO; CARB	3	316	316	100.0

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Table D-4. Gaseous Instruments - 1-pt QC Checks Individual Assessment for Geographic Areas within CARB's PQAO (2024) (cont.)

Geographic Area	Monitoring By	Number of Instruments	Number of SO ₂ 1-pt QC Checks Performed	Number of SO ₂ 1-pt QC Checks Meeting Critical Criteria	Percent of SO ₂ 1-pt QC Checks Meeting Critical Criteria (%)
Great Basin	MO	1	48	48	100.0
Imperial County	CARB	1	257	257	100.0
North Coast	MO	1	118	90	76.3
Sacramento Metropolitan	MO	1	103	103	100.0
San Joaquin Valley	CARB	1	126	124	98.4
San Luis Obispo	MO	1	359	359	100.0
Santa Barbara County	MO	1	352	352	100.0

- Source: AQS, AMP 251 QA Raw Assessment Report, run July 2025.
- Criteria for individual 1-pt QC checks are provided in Appendix A of this report. Details on CARB's PQAO instruments not meeting these criteria are provided in Appendix E of this report.

Table D-5. Gaseous Instruments - 1-pt QC Checks Individual Assessment on Prescribed Range for Geographic Areas within CARB's PQAO (2024)

Geographic Area	Monitoring By	Number of Instruments	Number of CO 1-pt QC Checks Performed	Number of CO 1-pt QC Checks Meeting Critical Criteria	Percent of CO 1-pt QC Checks Meeting Critical Criteria (%)
Butte County	CARB	1	250	250	100.0
Great Basin	MO	1	63	62	98.4
Monterey Bay	MO	1	51	51	100.0
Sacramento Metropolitan	MO	2	296	293	99.0
San Joaquin Valley	MO; CARB	6	642	641	99.8
Santa Barbara County	MO	1	352	332	94.3

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Table D-5. Gaseous Instruments - 1-pt QC Checks Individual Assessment on Prescribed Range for Geographic Areas within CARB's PQAO (2024) (cont.)

Geographic Area	Monitoring By	Number of Instruments	Number of NO ₂ 1-pt QC Checks Performed	Number of NO ₂ 1-pt QC Checks Meeting Critical Criteria	Percent of NO ₂ 1-pt QC Checks Meeting Critical Criteria (%)
Antelope Valley	MO	1	334	334	100.0
Butte County	CARB	1	255	255	100.0
Feather River	CARB	1	198	198	100.0
Imperial County	MO; CARB	2	277	277	100.0
Mojave Desert	MO	3	145	145	100.0
Monterey Bay	MO	1	50	50	100.0
North Coast	MO	1	120	120	100.0
Placer County	CARB	1	255	255	100.0
Sacramento Metropolitan	MO; CARB	5	952	923	97.0
San Joaquin Valley	MO; CARB	17	4,838	4,838	100.0
San Luis Obispo	MO	2	531	515	97.0
Santa Barbara County	MO	1	345	287	83.2
Ventura County	MO	2	349	349	100.0
Yolo-Solano	CARB	1	257	257	100.0
Geographic Area	Monitoring By	Number of Instruments	Number of O ₃ 1-pt QC Checks Performed	Number of O ₃ 1-pt QC Checks Meeting Critical Criteria	Percent of O ₃ 1-pt QC Checks Meeting Critical Criteria (%)
Amador County	CARB	1	338	338	100.0
Antelope Valley	MO	1	357	357	100.0
Butte County	CARB	2	613	613	100.0
Calaveras County	CARB	1	354	354	100.0
Colusa County	CARB	1	349	349	100.0
Eastern Kern	CARB	1	267	267	100.0
El Dorado County	CARB	3	685	685	100.0
Feather River	CARB	2	403	403	100.0
Glenn County	CARB	1	341	341	100.0
Great Basin	MO	1	47	46	97.9
Imperial County	MO; CARB	4	314	314	100.0
Lake County	MO	1	51	51	100.0
Mariposa County	CARB	1	99	99	100.0
Mendocino County	MO	1	50	50	100.0
Mojave Desert	MO; CARB	5	476	476	100.0
Monterey Bay	MO	5	258	258	100.0

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Table D-5. Gaseous Instruments - 1-pt QC Checks Individual Assessment on Prescribed Range for Geographic Areas within CARB's PQAO (2024) (cont.)

Geographic Area	Monitoring By	Number of Instruments	Number of O ₃ 1-pt QC Checks Performed	Number of O ₃ 1-pt QC Checks Meeting Critical Criteria	Percent of O ₃ 1-pt QC Checks Meeting Critical Criteria (%)
North Coast	MO	1	114	114	100.0
Northern Sierra	MO	1	52	52	100.0
Placer County	MO; CARB	5	352	352	100.0
Sacramento Metropolitan	MO; CARB	5	968	938	96.9
San Joaquin Valley	MO; CARB	23	6,981	6,981	100.0
San Luis Obispo	MO	6	1,892	1,879	99.3
Santa Barbara County	MO	8	2,846	2,782	97.8
Shasta County	MO	2	91	91	100.0
Siskiyou County	MO	1	27	27	100.0
Tehama County	MO; CARB	2	255	255	100.0
Tuolumne County	CARB	1	359	359	100.0
Ventura County	MO	5	883	883	100.0
Yolo-Solano	MO; CARB	3	316	316	100.0
Geographic Area	Monitoring By	Number of Instruments	Number of SO ₂ 1-pt QC Checks Performed	Number of SO ₂ 1-pt QC Checks Meeting Critical Criteria	Percent of SO ₂ 1-pt QC Checks Meeting Critical Criteria (%)
Great Basin	MO	1	48	42	87.5
Imperial County	CARB	1	257	257	100.0
North Coast	MO	1	118	118	100.0
Sacramento Metropolitan	MO	1	103	99	96.1
San Joaquin Valley	CARB	1	126	126	100.0
San Luis Obispo	MO	1	359	359	100.0
Santa Barbara County	MO	1	352	342	97.2

- Source: AQS, AMP 251 QA Raw Assessment Report, run July 2025.
- Details on CARB's PQAO instruments not meeting these criteria are provided in Appendix E of this report.

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Table D-6. Gaseous Instruments - Results for CARB's PE Audits for Geographic Areas within CARB's PQAO (2024)

Geographic Area	Monitoring By	Number of CO Instruments	Number of CO Instruments Audited	Average Percent Difference* (%)
Butte County	CARB	1	1	-4.21
Great Basin	MO	1	1	-3.11
Monterey Bay	MO	1	1	-3.81
Sacramento Metropolitan	MO	2	2	11.18
San Joaquin Valley	MO; CARB	6	6	1.04**
Santa Barbara County	MO	1	1	3.73
Geographic Area	Monitoring By	Number of NO ₂ Instruments	Number of NO ₂ Instruments Audited	Average Percent Difference* (%)
Antelope Valley	MO	1	1	-2.66
Butte County	CARB	1	1	1.98
Feather River	CARB	1	1	-1.04
Imperial County	MO; CARB	2	2	-1.57
Mojave Desert	MO	3	3	3.56
Monterey Bay	MO	1	1	2.02
North Coast	MO	1	1	0.28
Placer County	CARB	1	1	12.47
Sacramento Metropolitan	MO; CARB	5	5	-2.22
San Joaquin Valley	MO; CARB	17	15	1.92
San Luis Obispo	MO	2	2	-2.54
Santa Barbara County	MO	1	1	0.21
Ventura County	MO	2	2	-4.41
Yolo-Solano	CARB	1	1	3.62
Geographic Area	Monitoring By	Number of O ₃ Instruments	Number of O ₃ Instruments Audited	Average Percent Difference* (%)
Amador County	CARB	1	1	0.40
Antelope Valley	MO	1	1	-0.21
Butte County	CARB	2	2	0.63
Calaveras County	CARB	1	1	-6.58
Colusa County	CARB	1	1	-15.83
Eastern Kern	CARB	1	1	-1.35
El Dorado County	CARB	3	3	8.38
Feather River	CARB	2	2	3.18
Glenn County	CARB	1	1	-9.95
Great Basin	MO	1	1	-0.78
Imperial County	MO; CARB	4	4	-1.45

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Table D-6. Gaseous Instruments - Results for CARB's PE Audits for Geographic Areas within CARB's PQAO (2024) (cont.)

Geographic Area	Monitoring By	Number of O ₃ Instruments	Number of O ₃ Instruments Audited	Average Percent Difference* (%)
Lake County	MO	1	1	-12.84
Mariposa County	CARB	1	1	-0.10
Mendocino County	MO	1	1	2.13
Mojave Desert	MO; CARB	5	5	0.12
Monterey Bay	MO	5	5	-7.15
North Coast	MO	1	1	-2.27
Northern Sierra	MO	1	1	8.33
Placer County	MO; CARB	5	5	5.91
Sacramento Metropolitan	MO; CARB	5	5	0.66
San Joaquin Valley	MO; CARB	23	23	-3.89
San Luis Obispo	MO; CARB	6	6	-1.97
Santa Barbara County	MO	8	8	-2.65
Shasta County	MO	2	2	7.31
Siskiyou County	MO	1	1	6.82
Tehama County	MO; CARB	2	2	8.78
Tuolumne County	CARB	1	1	-0.70
Ventura County	MO	5	5	-1.47
Yolo-Solano	MO; CARB	3	3	-1.10
Geographic Area	Monitoring By	Number of SO ₂ Instruments	Number of SO ₂ Instruments Audited	Average Percent Difference* (%)
Great Basin	MO	1	1	1.64
Imperial County	CARB	1	1	2.24
North Coast	MO	1	1	5.06
Sacramento Metropolitan	MO	1	1	-12.43
San Joaquin Valley	CARB	1	1	3.97**
San Luis Obispo	MO	1	1	-4.53
Santa Barbara County	MO	1	1	3.85

- Source: AQS, AMP 256 Data Quality Indicator Report, run July 2025.
- NDA means no certified data available in AQS.
- Details on CARB's PQAO instruments not meeting these criteria are provided in Appendix E of this report.
- CARB's PE audit acceptance criteria are provided in Appendix A of this report and additional absolute differences in U.S. EPA audit levels 1 and 2 are provided in Appendix C of this report. Since the two lowest audit points for trace CO and trace SO₂ are U.S. EPA audit levels 1 and 2, and the lowest audit point for O₃ is U.S. EPA audit level 2, they were not subject to the AQDA process.
- *Average percent difference is the arithmetic mean of the combined differences from the known value of all the individual audit points over the range considered in the audits.
- **These values were due to trace values and were not subject to the AQDA process.

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Table D-7. PM Samplers - Ambient Data Capture Rate Results for Geographic Areas within CARB's PQAO (2024)

Geographic Area	Monitoring By	Number of PM ₁₀ Samplers	Number of PM ₁₀ Samplers Reporting ≥ 75% Ambient Data Capture Rate	Percent of PM ₁₀ Samplers Reporting ≥ 75% Ambient Data Capture Rate (%)
Antelope Valley	MO	1	1	100
Butte County	CARB	1	1	100
Calaveras County	CARB	1	1	100
Colusa County	CARB	1	1	100
Eastern Kern	MO; CARB	3	3	100
El Dorado County	CARB	1	1	100
Feather River	CARB	1	1	100
Glenn County	CARB	1	1	100
Great Basin	MO	18	17	94
Imperial County	MO; CARB	5	5	100
Lake County	MO	1	1	100
Mariposa County	CARB	1	1	100
Mendocino County	MO	1	1	100
Mojave Desert	MO	5	5	100
Monterey Bay	MO	3	3	100
North Coast	MO	1	1	100
Northern Sonoma	MO	3	3	100
Placer County	CARB	1	1	100
Sacramento Metropolitan	MO; CARB	4	4	100
San Joaquin Valley	MO; CARB	16	16	100
San Luis Obispo	MO	7	7	100
Santa Barbara County	MO	4	4	100
Shasta County	MO	1	1	100
Tehama County	MO	1	1	100
Ventura County	MO	2	2	100
Yolo-Solano	MO	3	3	100

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Table D-7. PM Samplers - Ambient Data Capture Rate Results for Geographic Areas within CARB's PQAO (2024) (cont.)

Geographic Area	Monitoring By	Number of PM _{2.5} Samplers	Number of PM _{2.5} Samplers Reporting ≥ 75% Ambient Data Capture Rate	Percent of PM _{2.5} Samplers Reporting ≥ 75% Ambient Data Capture Rate (%)
Antelope Valley	MO	1	1	100
Butte County	CARB	1	1	100
Calaveras County	CARB	1	1	100
Colusa County	CARB	1	1	100
Eastern Kern	MO; CARB	2	2	100
Feather River	CARB	2	2	100
Great Basin	MO	6	6	100
Imperial County	MO; CARB	4	4	100
Lake County	MO	1	1	100
Mendocino County	MO	2	2	100
Mojave Desert	MO	2	2	100
Monterey Bay	MO	7	7	100
North Coast	MO	2	2	100
Northern Sierra	MO	4	3	75
Placer County	MO; CARB	2	2	100
Sacramento Metropolitan	MO; CARB	9	9	100
San Joaquin Valley	MO; CARB	20	20	100
San Luis Obispo	MO	4	4	100
Santa Barbara County	MO	6	6	100
Shasta County	MO	2	2	100
Siskiyou County	MO	1	1	100
Tehama County	MO	1	1	100
Ventura County	MO	6	6	100
Yolo-Solano	MO	2	2	100

- Source: AQS, AMP 430 Data Completeness Report, run July 2025.
- Details on CARB's PQAO samplers not reporting at least 75% ambient data are provided in Appendix E of this report.

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Table D-8. PM Samplers - Bias Results for FRVs for Geographic Areas within CARB's PQAQ (2024)

Geographic Area	Monitoring By	PM ₁₀ Collection Method*	Number of PM ₁₀ Samplers	Number of PM ₁₀ FRVs Required	Percent Required PM ₁₀ FRVs Performed (%)	Average Percent Difference** (%)	Bias***
Sacramento Metropolitan	MO	Hi-Vol	3	12	100.0	1.59	2.22
Shasta County	MO	Hi-Vol	1	4	100.0	2.91	4.54
Yolo-Solano	MO	Hi-Vol	3	12	100.0	-2.03	4.74
Antelope Valley	MO	Low-Vol	1	12	100.0	0.27	0.64
Butte County	CARB	Low-Vol	1	12	100.0	0.50	1.26
Calaveras County	CARB	Low-Vol	1	12	100.0	-0.57	0.90
Colusa County	CARB	Low-Vol	1	12	100.0	0.09	1.29
Eastern Kern	MO; CARB	Low-Vol	3	24	100.0	-0.47	0.69
El Dorado County	CARB	Low-Vol	1	12	100.0	-0.13	0.84
Feather River	CARB	Low-Vol	1	12	100.0	-0.69	0.97
Glenn County	CARB	Low-Vol	1	12	100.0	-1.56	4.22
Great Basin	MO	Low-Vol	18	216	94.4	-0.02	1.36
Imperial County	MO	Low-Vol	5	60	100.0	0.07	0.66
Lake County	MO	Low-Vol	1	12	100.0	0.05	0.49
Mariposa County	CARB	Low-Vol	1	12	83.3	0.06	0.88
Mendocino County	MO	Low-Vol	1	12	100.0	-0.33	0.57
Mojave Desert	MO	Low-Vol	5	72	100.0	-0.67	1.41
Monterey Bay	MO	Low-Vol	3	36	100.0	-0.29	0.78
North Coast	MO	Low-Vol	1	12	100.0	-0.91	1.37
Northern Sonoma	MO	Low-Vol	3	36	100.0	0.22	1.22
Placer County	CARB	Low-Vol	1	12	100.0	-0.76	0.97
Sacramento Metropolitan	MO; CARB	Low-Vol	1	12	100.0	-0.47	0.91
San Joaquin Valley	MO; CARB	Low-Vol	16	192	100.0	0.30	0.94
San Luis Obispo	MO	Low-Vol	7	84	100.0	-0.15	0.56
Santa Barbara County	MO	Low-Vol	4	48	100.0	-0.06	0.72
Tehama County	MO	Low-Vol	1	12	100.0	-0.59	1.59
Ventura County	MO	Low-Vol	2	24	100.0	-0.28	0.66

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Table D-8. PM Samplers - Bias Results for FRVs for Geographic Areas within CARB's PQAQ (2024) (cont.)

Geographic Area	Monitoring By	PM _{2.5} Collection Method*	Number of PM _{2.5} Samplers	Number of PM _{2.5} FRVs Required	Percent Required PM _{2.5} FRVs Performed (%)	Average Percent Difference** (%)	Bias***
Antelope Valley	MO	All	1	12	100.0	0.26	0.64
Butte County	CARB	All	1	12	100.0	-0.13	0.85
Calaveras County	CARB	All	1	12	100.0	-0.61	0.93
Colusa County	CARB	All	1	12	100.0	0.20	1.63
Eastern Kern	MO; CARB	All	2	12	100.0	-0.19	0.53
Feather River	CARB	All	2	24	100.0	-0.74	1.19
Great Basin	MO	All	6	72	100.0	0.16	1.10
Imperial County	MO; CARB	All	4	48	100.0	0.42	0.71
Lake County	MO	All	1	12	100.0	-0.23	1.17
Mendocino County	MO	All	2	24	100.0	-0.40	0.80
Mojave Desert	MO	All	2	36	100.0	-0.39	0.94
Monterey Bay	MO	All	7	84	100.0	0.03	0.76
North Coast	MO	All	2	24	100.0	0.23	0.96
Northern Sierra	MO	All	4	42	100.0	-0.00	0.99
Placer County	MO	All	2	24	100.0	0.32	0.70
Sacramento Metropolitan	MO; CARB	All	9	108	100.0	-0.06	0.87
San Joaquin Valley	MO; CARB	All	20	240	100.0	-0.03	0.78
San Luis Obispo	MO	All	4	48	100.0	0.23	0.71
Santa Barbara County	MO	All	6	66	100.0	0.11	0.78
Shasta County	MO	All	2	24	87.5	-1.04	1.41
Siskiyou County	MO	All	1	12	100.0	0.48	0.67
Tehama County	MO	All	1	12	100.0	0.09	0.68
Ventura County	MO	All	6	72	100.0	-0.13	0.57
Yolo-Solano	MO	All	2	18	100.0	0.27	1.64

- *A detailed list of measurement methods can be found in the List of Designated Reference and Equivalent Methods ([17](#)).
- **Average percent difference is the arithmetic mean of the differences between the sampler's flow rate and the flow rate of the standard used during all FRVs performed.
- ***Bias is an average of absolute bias values across samplers with no sign assigned (+, -, or +) due to the absence of sign data by geographic area reported to AQS.

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Table D-9. PM Samplers - Results for Flow Rate Audits for Geographic Areas within CARB's PQAO (2024)

Geographic Area	Monitoring By	Number of PM ₁₀ Samplers	Number of PM ₁₀ Samplers Audited*	Number of PM ₁₀ Flow Rate Audits Not Meeting CARB Criteria*	Average Percent Difference** (%)
Antelope Valley	MO	1	1	0	0.18
Butte County	CARB	1	1	0	0.88
Calaveras County	CARB	1	1	0	0.97
Colusa County	CARB	1	1	0	0.39
Eastern Kern	MO; CARB	3	3	0	0.07
El Dorado County	CARB	1	1	0	1.13
Feather River	CARB	1	1	0	1.18
Glenn County	CARB	1	1	0	0.70
Great Basin	MO	18	18	0	0.13
Imperial County	MO	5	5	0	0.62
Lake County	MO	1	1	0	0.75
Mariposa County	CARB	1	1	0	2.05
Mendocino County	MO	1	1	0	2.05
Mojave Desert	MO	5	5	0	0.71
Monterey Bay	MO	3	3	0	0.24
North Coast	MO	1	1	0	-0.91
Northern Sonoma	MO	3	3	0	0.02
Placer County	MO; CARB	1	1	0	0.30
Sacramento Metropolitan	MO; CARB	4	4	0	0.71
San Joaquin Valley	MO; CARB	16	16	0	0.40
San Luis Obispo	MO	7	7	0	-0.29
Santa Barbara County	MO	4	4	0	0.08
Shasta County	MO	1	1	0	2.07
Tehama County	MO	1	1	0	0.05
Ventura County	MO	2	2	0	-0.13
Yolo-Solano	MO	3	3	0	-2.01
Geographic Area	Monitoring By	Number of PM _{2.5} Samplers	Number of PM _{2.5} Samplers Audited*	Number of PM _{2.5} Flow Rate Audits Not Meeting CARB Criteria*	Average Percent Difference** (%)
Antelope Valley	MO	1	1	0	-0.15
Butte County	CARB	1	1	0	-0.21
Calaveras County	CARB	1	1	0	-0.06
Colusa County	CARB	1	1	0	1.09
Eastern Kern	MO; CARB	2	2	0	0.06
Feather River	CARB	2	2	0	0.52
Great Basin	MO	6	6	0	-0.06
Imperial County	MO	4	4	0	1.41
Lake County	MO	1	1	0	0.21

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Table D-9. PM Samplers - Results for Flow Rate Audits for Geographic Areas within CARB's PQAO (2024) (cont.)

Geographic Area	Monitoring By	Number of PM _{2.5} Samplers	Number of PM _{2.5} Samplers Audited*	Number of PM _{2.5} Flow Rate Audits Not Meeting CARB Criteria*	Average Percent Difference** (%)
Mendocino County	MO	2	2	0	1.63
Mojave Desert	MO	2	2	0	0.55
Monterey Bay	MO	7	7	0	0.14
North Coast	MO	2	2	0	1.17
Northern Sierra	MO	4	4	0	-0.55
Placer County	MO; CARB	2	2	0	1.45
Sacramento Metropolitan	MO; CARB	9	9	0	0.26
San Joaquin Valley	MO; CARB	20	20	0	-0.09
San Luis Obispo	MO	4	4	0	-0.12
Santa Barbara County	MO	6	6	0	0.40
Shasta County	MO	2	2	0	0.37
Siskiyou County	MO	1	1	0	0.61
Tehama County	MO	1	1	0	0.95
Ventura County	MO	6	6	0	-0.11
Yolo-Solano	MO	2	2	0	1.94

- Source: AQS, AMP 256 Data Quality Indicator Report, run July 2025.
- CARB's flow rate audit acceptance criteria are provided in Appendix A of this report. Only audits conducted by CARB were subject to the AQDA process. Details on CARB's PQAO samplers not meeting these criteria are provided in Appendix E of this report. Only flow failures are included in this table.
- *Details on CARB's PQAO samplers not being audited or not meeting CARB's PE audit acceptance criteria are provided in Appendix E of this report.
- **Average percent difference is the arithmetic mean of the differences between the sampler's flow rate and the flow rate of the standard used during the flow rate audits.

Appendix E. CARB's PQAQ Data Quality Anomalies

This appendix includes a listing of gaseous instruments and PM samplers which did not meet a particular MQO. Instances where an MQO was not met would be considered a data anomaly. The data anomalies provided in this appendix are for informational purposes only, as most MQOs are assessed at the PQAQ level.

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**Table E-1. Gaseous Instruments - Ambient Data Completeness < 75%
Reported for Geographic Areas within CARB's PQAO (2024)**

Site ID	Site Name	Geographic Area	Monitoring By	Pollutant Parameter-Parameter Occurrence Code (POC)	(% Data Reported) Comment
06-067-0006	Sacramento-Del Paso Manor	Sacramento Metropolitan	MO	CO 42101-1	(68%) Data null coded (BA) maintenance/routine repairs from January - mid-April.
06-077-1003	Stockton-University Park	San Joaquin Valley	CARB	CO 42101-3	(6%) Data null coded (AS) poor quality assurance results from late January - late February; (AN) machine malfunction from late February - May. The site experienced a cooling system failure, which contributed to issues with the instrument. A waiver to discontinue CO monitoring was approved by U.S. EPA on December 8, 2025. Instrument is non-operational.
06-067-0011	Elk Grove-Bruceville Road	Sacramento Metropolitan	MO	NO ₂ 42602-1	(70%) Data null coded (BA) maintenance/routine repairs from early January - late January and late April - mid-June.
06-077-1003	Stockton-University Park	San Joaquin Valley	CARB	NO ₂ 42602-1	(57%) Data null coded (AN) machine malfunction from mid-March - mid-April, early - mid-May, and late August - early November. The site experienced a cooling system failure, which contributed to issues with the instrument.
06-011-1002	Colusa-Sunrise Blvd	Colusa County	CARB	O ₃ 44201-1	(64%) Data null coded (AS) poor quality assurance results from January - late April. Sample line interferences were identified with the instrument.
06-017-0012	Echo Summit	El Dorado County	CARB	O ₃ 44201-1	(73%) Data null coded (BK) site computer/data logger down from April - early May; (AE) shelter temperature outside limits multiple days in June, August, and September. Seasonal instrument operational from April - October.

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**Table E-1. Gaseous Instruments - Ambient Data Completeness < 75%
Reported for Geographic Areas within CARB's PQAO (2024) (cont.)**

Site ID	Site Name	Geographic Area	Monitoring By	Pollutant Parameter-POC	(% Data Reported) Comment
06-025-1003	El Centro-9th Street	Imperial County	MO	O ₃ 44201-1	(61%) Data null coded (AN) machine malfunction from mid-September - December. A lamp stability failure was identified with the instrument.
06-025-4004	Niland-English Road	Imperial County	MO	O ₃ 44201-1	(44%) Data null coded (AN) machine malfunction from January - late March, multiple days in July, and late August - September; (AS) poor quality assurance results multiple days in July, August, and October. The site experienced a power failure, which contributed to issues with the instrument.
06-057-0005	Grass Valley-Litton Building	Northern Sierra	MO	O ₃ 44201-1	(39%) Data null coded (AS) poor quality assurance results from January - early August. AQDA #8510 issued.
06-067-5003	Sloughhouse	Sacramento Metropolitan	MO	O ₃ 44201-1	(62%) Data null coded (AS) poor quality assurance results from January - late April.
06-089-0009	Shasta Lake-13971 Lake Blvd	Shasta County	MO	O ₃ 44201-1	(73%) Data null coded (AS) poor quality assurance results from late September - October.
06-027-0002	White Mountain	Great Basin	MO	SO ₂ 42401-1	(68%) Data null coded (AN) machine malfunction throughout most of January and from mid-October - December. Pump and internal mirror issues were identified with the instrument.

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**Table E-2. Gaseous Instruments - Precision/Bias 1-pt QC Checks < 75%
Reported for Geographic Areas within CARB's PQAO (2024)**

Site ID	Site Name	Geographic Area	Monitoring By	Pollutant Parameter-POC	(% 1-pt QC Checks Reported) Comment
06-067-0006	Sacramento-Del Paso Manor	Sacramento Metropolitan	MO	CO 42101-1	(73%) Data null coded (BA) maintenance/routine repairs from January - mid-April.
06-077-1003	Stockton-University Park	San Joaquin Valley	CARB	CO 42101-3	(8%) Data null coded (AS) poor quality assurance results from late January - late February; (AN) machine malfunction from late February - May. No 1-pt QC checks performed from February - May. The site experienced a cooling system failure, which contributed to issues with the instrument. A waiver to discontinue CO monitoring is pending U.S. EPA approval. Instrument is non-operational.
06-077-1003	Stockton-University Park	San Joaquin Valley	CARB	NO ₂ 42602-1	(69%) Data null coded (AN) machine malfunction from mid-March - mid-April, early - mid-May, and late August - early November. No 1-pt QC checks performed from September - October. The site experienced a cooling system failure, which contributed to issues with the instrument.
06-027-0002	White Mountain	Great Basin	MO	O ₃ 44201-1	(69%) No 1-pt QC checks performed from January - March. Manual calibrations were performed due to a non-operational primary calibration unit. Frequency did not meet U.S. EPA requirements.
06-025-1003	El Centro-9th Street	Imperial County	MO	O ₃ 44201-1	(73%) Data null coded (AN) machine malfunction from mid-September - December. No 1-pt QC checks performed from October - December. A lamp stability failure was identified with the instrument.

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**Table E-2. Gaseous Instruments - Precision/Bias 1-pt QC Checks < 75%
Reported for Geographic Areas within CARB's PQAO (2024) (cont.)**

Site ID	Site Name	Geographic Area	Monitoring By	Pollutant Parameter-POC	(% 1-pt QC Checks Reported) Comment
06-025-4004	Niland-English Road	Imperial County	MO	O ₃ 44201-1	(62%) No 1-pt QC checks performed from January - mid-March. Data null coded (AN) machine malfunction from January - late March, multiple days in July, and late August - September; (AS) poor quality assurance results multiple days in July, August, and October. The site experienced a power failure, which contributed to issues with the instrument.
06-027-0002	White Mountain	Great Basin	MO	SO ₂ 42401-1	(69%) Data null coded (AN) machine malfunction throughout most of January and from mid-October - December. No 1-pt QC checks performed from November - December. Pump and internal mirror issues were identified with the instrument.

Table E-3. Gaseous Instruments - CARB's PE Audits Not Conducted for Geographic Areas within CARB's PQAO (2024)

Site ID	Site Name	Geographic Area	Monitoring By	Pollutant Parameter-POC	Comment
06-029-2019	Bakersfield-Westwind	San Joaquin Valley	MO	NO ₂ 42602-1	Audit conducted. CARB preliminary direct-read NO ₂ methodology was used to conduct test audits. Audit results not reported to AQS.
06-019-2016	Fresno-Foundry Park	San Joaquin Valley	MO	NO ₂ 42602-1	Audit conducted. CARB preliminary direct-read NO ₂ methodology was used to conduct test audits. Audit results not reported to AQS.

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Table E-4. Gaseous Instruments - Audits Criteria Not Met for Geographic Areas within CARB's PQAO (2024)

Site ID	Site Name	Geographic Area	Monitoring By	Pollutant Parameter-POC	Comment
06-077-1003	Stockton-University Park	San Joaquin Valley	CARB	CO 42101-3	Instrument exceeded CARB and U.S. EPA audit criteria. AQDA #8504 issued. A waiver to discontinue CO monitoring is pending U.S. EPA approval. Instrument is non-operational.
06-011-1002	Colusa-Sunrise Blvd	Colusa County	CARB	O ₃ 44201-1	Instrument exceeded CARB and U.S. EPA audit criteria. AQDA #8508 issued.

Table E-5. PM Samplers - Ambient Data Completeness < 75% Reported for Geographic Areas within CARB's PQAO (2024)

Site ID	Site Name	Geographic Area	Monitoring By	Pollutant Parameter-POC	(% Reported) Comment
06-051-0011	Mono Lake-North Shore	Great Basin	MO	PM ₁₀ 81102-3	(3%) Data null coded (AV) power failure from January - mid-December. The site experienced a solar system failure.
06-057-1001	Truckee-Fire Station	Northern Sierra	MO	PM _{2.5} 88101-3	(74%) Sampler operated as a non-FEM from January - early July. Data null coded (AN) machine malfunction from late July - late August. Sampler operated as FEM from late August - December.

Table E-6. PM Samplers - Collocated Data Completeness < 75% Reported for Geographic Areas within CARB's PQAO (2024)

Site ID	Site Name	Geographic Area	Monitoring By	Pollutant Parameter-POC	Comment
All PM samplers met collocated data completeness criteria of $\geq 75\%$, as required. There are no anomalies to include in this table.					

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Table E-7. PM Samplers - Precision Criteria (CV Limit of 10.1%) Not Met for Geographic Areas within CARB's PQAO (2024)

Site ID	Site Name	Geographic Area	Monitoring By	Pollutant Parameter-POC	Comment*
06-027-1003	Keeler-Cerro Gordo Road	Great Basin	MO	PM ₁₀ 81102-6	CV = 13.81
06-027-0002	White Mountain	Great Basin	MO	PM ₁₀ 81102-1	CV = 16.12**
06-101-0003	Yuba City-Almond Street	Feather River	CARB	PM _{2.5} 88101-3	CV = 16.99
06-027-0002	White Mountain	Great Basin	MO	PM _{2.5} 88101-1	CV = 20.31
06-027-1003	Keeler-Cerro Gordo Road	Great Basin	MO	PM _{2.5} 88101-3	CV = 17.13
06-025-0005	Calexico-Ethel Street	Imperial County	CARB	PM _{2.5} 88101-3	CV = 15.57
06-053-1003	Salinas-#3	Monterey Bay	MO	PM _{2.5} 88101-3	CV = 18.51
06-067-0012	Folsom-Natoma Street	Sacramento Metropolitan	MO	PM _{2.5} 88101-3	CV = 17.28
06-067-0010	Sacramento-T Street	Sacramento Metropolitan	CARB	PM _{2.5} 88101-3	CV = 13.70
06-019-0011	Fresno-Garland	San Joaquin Valley	CARB	PM _{2.5} 88101-3	CV = 10.91
06-089-0004	Redding-Health Dept.	Shasta County	MO	PM _{2.5} 88101-3	CV = 13.57
06-111-2002	Simi Valley-Cochran Street	Ventura County	MO	PM _{2.5} 88101-3	CV = 10.41

- *U.S. EPA is aware of the systemic issue of PM imprecision (in California and nationwide). The agency adopted new statistics for calculating CV in its *Reconsideration of the National Ambient Air Quality Standards for Particulate Matter* ([8](#)) in March 2024. However, these revisions are not reflected in this report, as AQS has not yet been updated to support the revised calculations.
- **Data reflect a collocated continuous PM₁₀ sampler that was reported to AQS but was not required. C.F.R. only requires collocation of manual PM₁₀ samplers of the same method ([1](#)).

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Table E-8. PM Samplers - FRVs for Geographic Areas within CARB's PQAO (2024)

Site ID	Site Name	Geographic Area	Monitoring By	Pollutant Parameter- POC	(% Required FRVs Performed) Comment
06-027-1003	Keeler-Cerro Gordo Road	Great Basin	MO	PM ₁₀ 81102-6	(83%) No FRVs performed in May and November.
06-051-0001	Mammoth Lakes	Great Basin	MO	PM ₁₀ 81102-5	(92%) No FRVs performed in December. Operational issues were identified with the sampler in mid-December.
06-051-0011	Mono Lake-North Shore	Great Basin	MO	PM ₁₀ 81102-3	(25%) Data null coded (AV) power failure from January - mid-December. The site experienced a solar system failure.
06-043-1001	Yosemite-Visitor Center	Mariposa County	CARB	PM ₁₀ 81102-3	(83%) No FRVs performed from November - December. Health and safety concerns were identified. The site was not safe for use from late October - December.
06-089-0004	Redding-Health Dept.	Shasta County	MO	PM _{2.5} 88101-3	(75%) No FRVs reported in AQS from January - March. FRVs performed from January - March are not reflected in this report, as certified data were not available in AQS.

Table E-9. PM Samplers - Flow Rate Audits Not Conducted for Geographic Areas within CARB's PQAO (2024)

Site ID	Site Name	Geographic Area	Monitoring By	Pollutant Parameter- POC	Comment
All PM samplers met flow rate audit criteria, as required. There are no anomalies to include in this table.					

Table E-10. PM Samplers - CARB's PE Audit Acceptance Criteria Not Met for Geographic Areas within CARB's PQAO (2024)

Site ID	Site Name	Geographic Area	Monitoring By	Pollutant Parameter- POC	Comment
All PM samplers met CARB's PE audit acceptance criteria, as required. There are no anomalies to include in this table.					

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Table E-11. Gaseous Instruments and PM Samplers - Manual Adjustments* to Information Outputs from AQS for Geographic Areas within CARB's PQAO (2024)

Site ID	Site Name	Geographic Area	Monitoring By	Pollutant Parameter- POC	Comment
06-045-0011	Ukiah-Municipal Airport	Mendocino County	MO	O ₃ 44201-1	No audit conducted. Instrument operational for less than three months (early October). U.S. EPA guidance (19) states no audit is required if a sampler operates less than three months.
06-083-1021	Carpinteria-Gobernador Road	Santa Barbara County	MO	O ₃ 44201-1	Instrument exceeded CARB and U.S. EPA audit criteria. Four audits were conducted on the instrument (one by CARB and three from a third party contracted by the monitoring organization). CARB's audit program meets federal requirements and the one audit conducted by CARB met CARB and U.S. EPA audit criteria for SLAMS. This report only includes audit results from CARB's PE audits. Therefore, audit results from the third party contractor's audits were excluded from this analysis.
06-051-0011	Mono Lake-North Shore	Great Basin	MO	PM ₁₀ 81102-3	No audit conducted. Sampler non-operational at the time of the audit. The site experienced an off-grid power source failure from January - mid-December.
06-083-3001	Santa Ynez-Airport Road	Santa Barbara County	MO	PM _{2.5} 88101-1	No audit conducted. Sampler designated SPM from January - late October. SPM sites are only audited at the request of the monitoring organization/availability of auditor. CARB's PE audits were conducted in April and October. Audit results not reported (noted as Not For Record) because the sampler was not active in AQS. Sampler designated SLAMS from late October - December. U.S. EPA guidance (19) states no audit is required if a sampler operates less than three months.

- *Based on information available and as summarized in this table, data are manually adjusted when information outputs from AQS are not considered to be anomalies.

Table E-12. Gaseous Pollutants and PM - Summary of AQDAs and CANs Issued and Closed for Geographic Areas within CARB's PQAO (2024)

Pollutant	AQDAs Issued	AQDAs Closed*	CANs Issued	CANs Closed*
CO	1	0	5	4
NO ₂	1	1	9	7
O ₃	4	4	14	10
SO ₂	0	0	2	1
PM ₁₀	0	0	7	4
PM _{2.5}	0	0	18	12

- *The number of AQDAs and CANs closed in 2024 may include closures for AQDAs and CANs issued in previous years.

Appendix F. References

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