



U.S. ENVIRONMENTAL PROTECTION AGENCY

OFFICE OF INSPECTOR GENERAL

Improving air quality

Differences in Processing Practices Could Decrease the Reliability of Ozone Data Used for Assessing Air Quality to Protect Public Health

Report No. 18-P-0105

February 28, 2018



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Abbreviations

AQS	Air Quality System
CFR	Code of Federal Regulations
DEQ	Department of Environmental Quality
DHEC	Department of Health and Environmental Control
DNR	Department of Natural Resources
EPA	U.S. Environmental Protection Agency
NAAQS	National Ambient Air Quality Standards
OAQPS	Office of Air Quality Planning and Standards
OIG	Office of Inspector General
ppb	parts per billion
QA	Quality Assurance
QA Handbook	The EPA's <i>Quality Assurance Handbook for Air Pollution Measurement Systems</i>
QAPP	Quality Assurance Project Plan
QC	Quality Control
TSA	Technical Systems Audit

Cover photos: Air monitor audit being conducted under the National Performance Audit Program. (EPA, *Quality Assurance Handbook for Air Pollution Measurement Systems. Volume II: Ambient Air Quality Monitoring Program*, EPA-454/B-17-001, January 2017)

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At a Glance

Why We Did This Review

We conducted this review to determine whether selected air monitoring data in the U.S. Environmental Protection Agency's (EPA's) Air Quality System (AQS) meet criteria established by the EPA. Specifically, we determined whether ozone data revisions and data exclusions or gaps comply with EPA criteria.

The EPA uses AQS data to determine whether an area's air quality meets National Ambient Air Quality Standards (NAAQS) and to make regulatory decisions regarding acceptable levels of ozone, which is an air pollutant at ground level. State, local and tribal air monitoring agencies should use the EPA's recommended quality assurance (QA) criteria to develop their QA project plans (QAPPs) and report the highest quality of data to AQS.

In February 2017, we issued a [management alert](#) to notify the EPA about time-sensitive findings regarding the data processing practices of two air monitoring agencies. This current report details our comprehensive findings.

This report addresses the following:

- *Improving air quality.*

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Differences in Processing Practices Could Decrease the Reliability of Ozone Data Used for Assessing Air Quality to Protect Public Health

What We Found

Three of the six air monitoring agencies we reviewed did not consistently use the EPA's recommended QA practices, which are designed to produce data of an acceptable level of quality for the EPA to use in making regulatory decisions about air quality. For example, three monitoring agencies did not use the recommended quality control checks to validate data. Further, we found that these three monitoring agencies adjusted ozone data from 2012 to 2014 using processes that were inconsistent with EPA guidance. We also noted that, in the process of validating ozone data, some agencies used different shelter temperature range criteria.

There is a risk that the state, local and tribal agencies that monitor ambient air quality are not always implementing the EPA's recommended QA practices for validating ozone data. This risk could reduce the quality of the data that the EPA uses to determine whether the air is healthy to breathe.

For example, three monitoring agencies did not use the recommended quality control checks to validate data. Further, we found that these three monitoring agencies adjusted ozone data from 2012 to 2014 using processes that were inconsistent with EPA guidance. We also noted that, in the process of validating ozone data, some agencies used different shelter temperature range criteria.

The EPA's oversight controls did not always identify when validation and adjustment practices were inconsistent with the EPA's QA Handbook. For example, technical systems audits conducted by the EPA did not always identify or resolve inconsistencies between the monitoring agencies' data processing practices and the EPA's guidance. Improving the EPA's oversight controls can reduce the risk that monitoring data are not processed consistently and in accordance with accepted QA practices. Variation in data processing practices can lead to data quality uncertainty, decrease data reliability, and reduce the comparability of data across monitoring agencies. Since the EPA uses ozone monitoring data to determine whether air quality is healthy (i.e., in compliance with NAAQS), the data must be of known quality and be reliable and defensible.

Recommendations and Planned Agency Corrective Actions

We issued five recommendations to the Assistant Administrator for Air and Radiation: (1) assess the risk of data adjustments impacting the ozone data used in the EPA's NAAQS determinations, (2) issue guidance clarifying the shelter temperature criteria that should be used, (3) strengthen the EPA's oversight of monitoring agencies' data processing practices by completing the QAPP review-and-approval process to confirm that monitoring agencies are including appropriate QA criteria in their QAPPs, (4) use technical systems audits to verify that monitoring agencies are implementing the EPA's recommended QA criteria, and (5) develop a process to confirm that the data reported to the AQS meet the EPA's recommended validation criteria for certain quality control checks. The EPA completed corrective action for Recommendation 4, and the agency's planned corrective actions meet the intent of the remaining recommendations.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

THE INSPECTOR GENERAL

February 28, 2018

MEMORANDUM

SUBJECT: Differences in Processing Practices Could Decrease the Reliability of Ozone Data Used for Assessing Air Quality to Protect Public Health
Report No. 18-P-0105

FROM: Arthur A. Elkins Jr.

A handwritten signature in black ink, appearing to read "Arthur A. Elkins Jr.", is written over the printed name.

TO: William Wehrum, Assistant Administrator
Office of Air and Radiation

This is a final report on the subject review conducted by the Office of Inspector General (OIG) of the U.S. Environmental Protection Agency (EPA). The project number for this review was OPE-FY16-0009. This report contains findings that describe the problems the OIG has identified and corrective actions the OIG recommends.

The agency agreed with all recommendations and provided planned corrective actions and completion dates that meet the intent of these recommendations. Therefore, the agency is not required to provide a written response to this final report. Please update the EPA's Management Audit Tracking System as you complete the planned corrective actions for the recommendations. Please notify my staff if there is a significant change in the agreed-to corrective actions. Should you choose to provide a response to this final report, we will post your response on the OIG's public website, along with our memorandum commenting on your response. You should provide your response as an Adobe PDF file that complies with the accessibility requirements of Section 508 of the Rehabilitation Act of 1973, as amended.

We will post this report to our website at www.epa.gov/oig.

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Chapter 1

Introduction

Purpose

The Office of Inspector General (OIG) for the U.S. Environmental Protection Agency (EPA) conducted this review to determine whether selected air monitoring data in the EPA's Air Quality System (AQS) meet criteria established by the EPA. Specifically, we asked the following questions:

- Do data revisions comply with EPA criteria?
- Do data exclusions or gaps comply with EPA criteria?

Background

Ambient air is a term used to refer to the surrounding, outdoor air. Charged with protecting human health and the environment, the EPA establishes standards that limit pollution, such as ozone, in the ambient air. To determine compliance with these standards, air monitoring agencies (i.e., state, tribal and local governments that operate ambient air monitoring networks) collect data regarding air quality using air monitoring networks. These networks are composed of individual monitors and monitoring stations housed in shelters that have been installed at various sites throughout an area. The EPA uses the data from air monitoring networks to inform its regulatory decisions about ambient air quality standards.

National Ambient Air Quality Standards

The EPA uses data from state, local and tribal air monitoring networks to determine whether an area's air quality meets the National Ambient Air Quality Standards (NAAQS). The EPA sets these air quality standards at a level to protect public health, including sensitive populations such as the elderly, children and asthmatics, from the effects of air pollution. Table 1 identifies health effects associated with ground-level ozone, a major pollutant in ambient air.

Table 1: Health effects of ozone

Short-term health effects	Long-term health effects
<ul style="list-style-type: none">• Shortness of breath and pain when taking a deep breath.• Coughing and sore or scratchy throat.• Inflamed and damaged airways.• Increased frequency of asthma attacks.• Increased susceptibility to lung infection.	<ul style="list-style-type: none">• Aggravation of asthma, and is likely to be one of many causes of asthma development.• May be linked to permanent lung damage, such as abnormal lung development in children.• May increase the risk of death from respiratory causes.

Source: OIG analysis of EPA websites describing the health effects of ozone.

In October 2015, the EPA set the ozone ambient air quality standard at 70 parts per billion (ppb). To meet Clean Air Act requirements, the EPA was required to make its initial designation determinations as to whether the areas in the United States meet the 2015 ozone NAAQS by October 1, 2017. The EPA started this determination process in 2016. This designation process had not been completed as of February 26, 2018.

An EPA determination that an area's air quality does not meet NAAQS (which is called a "nonattainment designation") can have significant consequences for that area and state. If a responsible state or local agency is found to be in nonattainment, it must develop an implementation plan that identifies enforceable measures for reducing emissions of the specific criteria pollutant that is in nonattainment to improve air quality in that area. These measures can include more stringent permits and emission controls for industry and other sources within the nonattainment area.

Air Monitoring Databases

The EPA maintains ambient air monitoring data in two databases: AirNow and AQS. Air monitoring agencies report raw or real-time data to AirNow every hour. These data are used to report an area's air quality index, which informs the public of current air quality conditions. Then, monitoring agencies generally have 3 months to review and validate the monitoring data collected before submitting the data to the AQS. In addition, monitoring agencies must certify once every year that the ambient air monitoring data are accurate and entered into the AQS, as required by 40 CFR § 58.15.

The EPA uses the air monitoring data from the AQS to compute yearly design values for each monitor.¹ The EPA uses these design values to make its designation determinations and to classify nonattainment areas based on the monitor with the highest design value in an area.

<p style="text-align: center;">AirNow</p> <ul style="list-style-type: none">➤ Collects hourly, real-time and forecasted air quality information to inform the public.➤ Communicates air quality to the public via the air quality index.➤ Includes data that are considered preliminary and that are not used for regulatory decisions. <p><i>For more information, visit About AirNow.</i></p>
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<p style="text-align: center;">AQS</p> <p>AQS data are used to perform the following tasks:</p> <ul style="list-style-type: none">➤ Assess air quality.➤ Assist in attainment and nonattainment designations.➤ Evaluate state implementation plans for nonattainment areas.➤ Perform modeling for permit review analysis and other air quality management functions.
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¹ The ozone design value is the annual fourth-highest daily maximum 8-hour average concentration for a monitor, averaged over 3 years.

EPA Data Processing Requirements and Guidance

Appendix A of 40 CFR Part 58 requires that each air monitoring agency establish a quality system that provides sufficient information to assess the quality of the monitoring data. This quality system must include performance requirements for data precision, bias and completeness. To help the monitoring agencies meet these requirements, the EPA has established quality assurance (QA) criteria through both regulation and guidance. These regulations and guidance outline how to produce comparable data within an acceptable level of data quality for the EPA to use in making regulatory decisions about air quality.

Validation Criteria

The EPA's 2013 *Quality Assurance Handbook for Air Pollution Measurement Systems* (QA Handbook)² is specifically referenced in appendices to 40 CFR Part 58 as guidance for air monitoring agencies to use when developing a quality system for an ambient air monitoring program. This guidance has been updated a number of times since its issuance, most recently in 2008, 2013 and 2017; however, the 2013 edition was the applicable guidance for our review since we reviewed data from 2012 to 2014 when that version was effective. The QA Handbook provides guidance for performing quality checks of air monitors and establishing measurement objectives to validate the data collected by air monitors. These objectives should be based upon requirements in the Code of Federal Regulations (CFR), the monitoring agency's QA project plan (QAPP) and standard operating procedures, and field and laboratory technical expertise.

The EPA outlines criteria that monitoring agencies should use to validate ozone monitoring data in Appendix D of its QA Handbook. These criteria are referred to as the "validation criteria." Some validation criteria outlined in the QA Handbook are required by the CFR, while others are recommended as best practices. The EPA organizes these validation criteria into three levels based on how significant the criteria are to overall data quality:

- **Critical Criteria:** Critical for maintaining integrity of the data. Observations (i.e., the data collected by a monitor) that do not meet each and every critical criterion should be invalidated, unless there are compelling reasons or justifications for not doing so. The QA Handbook establishes three "critical" quality control (QC) checks that maintain the integrity of the data collected by an ozone monitor: the zero check, the one-point QC check and the span check. Although the EPA considers all three of these criteria to be critical, only the one-point QC check is required by the CFR.

² EPA, *Quality Assurance Handbook for Air Pollution Measurement Systems. Volume II: Ambient Air Quality Monitoring Program*, EPA-454/B-13-003, May 2013.

- **Operational Criteria:** Important for maintaining and evaluating the quality of the data. Violation of an operational criterion may be cause to invalidate the data, but further investigation is warranted. The QA Handbook states that the validation decision should consider other QC information that may or may not indicate that the data are acceptable. An example of an operational criterion is the temperature of the shelter that houses the monitor. Monitors are approved for use within certain temperature ranges, and monitoring agencies review shelter temperature as part of the data validation process.
- **Systematic Criteria:** Important for the correct interpretation of the data, but do not usually impact the validity of the data. For example, annual precision, bias and data completion criteria are considered systematic criteria. If these criteria are not met, the observations are not invalidated, but the error rate associated with the attainment/nonattainment decision may be impacted.

To conduct the three critical QC checks, air monitoring agencies regularly test each air monitor with known, certified concentrations of ozone. The concentration of ozone used for each test depends on the critical QC check being performed (see green box). The air monitoring agency then compares the monitor’s response (i.e., the ozone concentration detected and recorded by the monitor) to the certified test concentration for each test performed.

EPA’s critical QC checks	
➤	The zero check measures the analyzer’s response to zero ozone (0 ppb ozone).
➤	The one-point check measures the analyzer’s response to the typical ozone concentration at the site (5–80 ppb).
➤	The span check measures the analyzer’s response to a concentration at the upper range of the analyzer’s measurement capability, traditionally at 80–90 percent of operating range, which can be 500 ppb or more.

For each QC check, the EPA allows a certain degree of difference between the monitor’s response and the certified concentration. This acceptable difference is referred to as the “acceptance criteria.” The EPA provides recommended acceptance criteria for each QC check in its QA Handbook. According to the QA Handbook, if acceptance criteria are exceeded, the data collected by that monitor from the time of the last acceptable check to the failed check should be invalidated unless there are compelling reasons and justifications for not doing so. When data are invalidated, they are not reported to the AQS by the monitoring agency. Instead, null codes that explain why the data are missing are to be reported to the AQS. Data that are invalidated are not used to calculate ambient air averages or design values.

Data Adjustments

The QA Handbook states that “based upon validation criteria, the data is either reported as initially measured or invalidated.” The handbook allows daily

adjustments to monitors based on automated zero checks³ but only under certain circumstances. Adjustments based on automated zero checks are not intended to correct data previously collected at the monitor, which would be considered post-processing of the data and is not allowed.

EPA Oversight

The EPA's Office of Air Quality Planning and Standards (OAQPS) and the EPA regions provide oversight of the ambient air monitoring systems:

- OAQPS provides oversight of the national ambient air quality monitoring network, including (1) managing the AQS database to verify that monitoring agencies are properly reporting monitoring data; (2) using data from the AQS to determine whether an area's air quality meets the NAAQS; (3) issuing and revising guidance documents regarding quality systems, including the QA Handbook, as needed; and (4) providing technical assistance to the EPA regional offices and the air pollution monitoring community.
- EPA regional offices directly oversee the implementation of the air monitoring networks located in their regions. This oversight includes reviewing and approving monitoring agencies' QA and QC procedures, the ambient air monitoring data, and the QA data that each monitoring agency submits annually to the EPA as part of its annual data certification package. Per 40 CFR § 58.15, monitoring agencies are required to submit their data certification packages by May 1 of each year. In addition, the regulations require the regions to conduct technical systems audits (TSAs) of state, local and tribal monitoring agencies at least once every 3 years to assess their compliance with regulations governing the collection, analysis, validation and reporting of ambient air quality data.

Responsible Office

The EPA office responsible for implementing the recommendations included in this report is OAQPS, within the Office of Air and Radiation.

Scope and Methodology

We performed our review from January 2016 through October 2017. We conducted this performance audit in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that

³ According to the QA Handbook, some air monitoring analyzers are capable of periodically conducting regularly scheduled zero- and span-check calibrations and can automatically adjust the monitor readings based on the results of those calibrations.

the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

We selected two states in Region 4 (Georgia and South Carolina), one state in Region 5 (Michigan) and one state in Region 9 (Arizona) for review. We initially selected Georgia and South Carolina for review due to the volume of differences we observed in hourly ozone values in AirNow and AQS.⁴ We then expanded our review to include Michigan and Arizona because we observed hourly ozone values from both of these states that were different in AirNow and AQS. In addition, these states were also included because they were located in different EPA regions and because some monitoring sites in these states measured ambient air ozone conditions that were close to the EPA's ambient air ozone standard.

To address our objective regarding data revisions, we reviewed a sample of hourly ozone data for each of the four states we selected to determine whether data were adjusted by the monitoring agency prior to reporting the data to AQS.

To address our objective regarding data gaps or exclusions, we reviewed 1,326 instances in three states (Georgia, Michigan and South Carolina) where hourly averages were not reported to the AQS and were replaced with invalidation codes (null codes). A relatively small number of data gaps were sampled in Georgia and South Carolina because we limited our review to data gaps that resulted in different 8-hour averages among the highest 8-hour average daily maximums at each site. However, we expanded our review of data gaps in Michigan to include any day where the AQS did not have an 8-hour average daily maximum. We focused the data gap sample in Michigan to data reported in 2014 because this was the only year of our data review that would potentially impact data the EPA will use to make the 2015 ozone NAAQS attainment designations.

We selected six monitoring agencies in our sample of four states for further review. We conducted site visits at three of these agencies: the Georgia Department of Natural Resources (DNR), the Michigan Department of Environmental Quality (DEQ) and the South Carolina Department of Health and Environmental Control (DHEC). During these site visits, we obtained raw monitoring data, QA and QC data, and supporting documentation to explain data differences and gaps. We did not conduct site visits for the three monitoring agencies we reviewed in Arizona: Arizona DEQ, Maricopa County and Pima County. However, for all six monitoring agencies, we interviewed staff regarding data processing policies and procedures, including any data adjustment practices and data validation criteria. We also reviewed each monitoring agency's QAPP, standard operating procedures and TSAs.

⁴ For more details about our AirNow and AQS analyses, see the "Scope and Methodology" section in EPA OIG Report No. [17-P-0106](#), *Management Alert: Certain State, Local and Tribal Data Processing Practices Could Impact Suitability of Data for 8-Hour Ozone Air Quality Determinations*, issued February 6, 2017.

We also interviewed staff from the EPA's OAQPS regarding air monitoring regulations, EPA guidance on data processing, and how data in the AQS is used for attainment designation decisions. We interviewed staff in EPA Regions 3, 4 and 5 to discuss their oversight of air monitoring agencies. In interviews with Regions 4 and 5, specifically, we discussed the use of AQS data, review and approval of QAPPs, TSA findings, and review of annual data certifications.

Prior Coverage

During preliminary research for this evaluation, we identified concerns with the data processing practices of two monitoring agencies, and we issued a management alert report to notify the EPA of a potential risk in using this ozone data to make its designation determinations regarding compliance with the 2015 NAAQS. Our management alert report, EPA OIG Report No. [17-P-0106](#), *Management Alert: Certain State, Local and Tribal Data Processing Practices Could Impact Suitability of Data for 8-Hour Ozone Air Quality Determinations*, was issued on February 6, 2017. The report did not have any recommendations for the agency; however, the EPA issued a response to the management alert report and proposed several corrective actions.

Chapter 2

Varying Ozone Data Processing Practices Pose Risk to Data Reliability

Certain air monitoring agencies employed ozone data processing practices that were not consistent with EPA-recommended practices or with each other:

- Three of the six monitoring agencies we reviewed did not consistently use the EPA’s recommended critical validation criteria before reporting ozone data to the AQS. Managers at two of these agencies told us that the criteria were not required or not needed to meet regulatory requirements.
- Three of the six monitoring agencies we reviewed revised or adjusted ozone data reported to the AQS from 2012 to 2014 using processes that were not consistent with the EPA’s QA Handbook. Managers at these agencies told us that they thought their practices improved data accuracy.
- Data gaps or invalidated data in the sample we reviewed were generally supported and in accordance with EPA guidance. However, monitoring agencies applied varying shelter temperature range criteria for data validation.

The EPA’s oversight controls did not always identify when validation and adjustment practices were inconsistent with the EPA’s QA Handbook (see Chapter 3 for more details). Variation in monitoring agencies’ data processing practices could result in data quality uncertainty and could decrease the reliability of the data used to make decisions regarding NAAQS compliance.

EPA’s Data Validation Requirements and Guidance

Pursuant to Appendix A of 40 CFR Part 58, the failure to conduct or pass a required QC check does not by itself invalidate data for regulatory decision-making. Instead, the EPA’s ambient air monitoring regulations require that the EPA and monitoring agencies to use a “weight of evidence” approach to determine the data’s suitability for regulatory decision-making, such as determining compliance with the NAAQS. The regulation states that using the data validation criteria approved in an air monitoring agency’s QAPP is the basis for this approach.

Appendix D of the EPA’s QA Handbook contains data validation templates for all criteria pollutants. These templates were initially developed in 1998 by a workgroup composed of personnel from air monitoring agencies, EPA regional offices and OAQPS. The EPA recommends invalidating observations that do not

meet the critical criteria provided in this appendix, stating that such observations are invalid unless proven otherwise.

Air monitoring agencies are required to follow EPA regulations. Air monitoring agencies are encouraged—but not required—to follow the guidance provided in the EPA’s QA Handbook. To distinguish regulatory requirements from guidance in the QA Handbook, the EPA defines and uses the following terms:

- *Shall* and *must* when the element is required by statute and regulation.
- *Should* when the element is recommended to help establish or improve the quality of data or a procedure. If this element is not followed, an alternate procedure that meets the intent of the guidance should be developed.⁵
- *May* when the element is optional.

According to the QA Handbook, observations that do not meet each and every critical criterion *should* be invalidated unless there are compelling reasons and justifications for not doing so.

EPA’s Recommended Critical Validation Criteria Not Used Consistently

Three of the six monitoring agencies we reviewed used less stringent criteria for validating ozone data than the criteria recommended by the EPA. Further, none of these three agencies had incorporated all of the EPA’s critical validation criteria (zero, span and one-point QC checks) into their EPA-approved QAPPs.

Of the three critical QC checks listed in the QA Handbook, only the one-point QC check is required by regulation (40 CFR Part 58, Appendix A) to assess data quality. Per Appendix A of 40 CFR Part 58, the one-point QC checks are used by the EPA to *annually* assess the data quality from each monitoring site and agency to determine whether the data meet the designated regulatory goals.⁶ According to an EPA QA staff person, the CFR does not mandate that air monitoring agencies use the one-point QC check to validate or invalidate *hourly* data points; however, the QA Handbook recommends using the one-point QC for this purpose.

According to staff and managers at some air monitoring agencies we spoke to, the air monitoring agencies are not compelled to implement this approach because it is included in guidance and not required by regulation.

Table 2 provides the results of our review of the six monitoring agencies’ implementation of the EPA’s critical data validation criteria.

⁵ The EPA’s direction to develop an alternative procedure when a recommended element is not followed was added as part of the EPA’s January 2017 revision to its QA Handbook.

⁶ The regulatory goals for ozone data can be found in 40 CFR Part 58, Appendix A, § 2.3.1.2.

Table 2: Application of critical criteria for ozone data at six monitoring agencies

Monitoring agency	Were critical criteria implemented in accordance with the applicable EPA QA Handbook guidance?			Did the approved QAPP establish critical criteria that were consistent with the applicable EPA QA Handbook guidance?
	Zero check	One-point check	Span check	
Arizona DEQ	Yes	Yes	Yes	Yes
Georgia DNR	No	No	No	No
Maricopa County	Yes	Yes	Yes	No ^a
Michigan DEQ	No	Yes	No	No
Pima County	Yes	Yes	Yes	No ^a
South Carolina DHEC	No	No	No	No

Source: OIG analyses of air monitoring agencies' implementation practices, QAPPs and the EPA's 2013 QA Handbook.

^a Although Maricopa and Pima Counties implemented the EPA's recommended critical criteria, their QAPPs did not contain zero-check criteria that were consistent with the validation criteria in the EPA's 2013 QA Handbook.

State monitoring staff and one state manager provided us with several reasons why they did not use the critical criteria checks recommended by the EPA's guidance. For example, a South Carolina DHEC manager said that DHEC's monitoring network could meet the EPA's regulatory QA requirements without adopting the EPA's recommended criteria. Georgia's DNR staff stated that they interpreted the following statement in the 2008 and 2013 versions of the EPA's QA Handbook as allowing them to use zero- and span-check acceptance criteria that were less stringent than those recommended by the EPA:

Cumulative drifts of up to 15 percent of full scale from the original or nominal zero and span values may not be unreasonable, subject to [certain limitations].

Georgia DNR staff also noted that some recommended critical criteria are not found in regulation.

In the 2017 update of the QA Handbook, the EPA removed the statement referenced by Georgia. In addition, subsequent to our review of South Carolina DHEC, the state's DHEC management told us that the monitoring agency started using the EPA's recommended one-point QC check acceptance criterion in January 2017 and had recertified ozone data from 2012 through 2016 using this acceptance criterion.

Ozone Data Adjusted in Manner Inconsistent With EPA’s QA Handbook

In our February 2017 management alert report, we informed the EPA that monitoring agencies in Georgia and South Carolina had adjusted ozone data reported to the AQS. These adjustments were based on the results of zero checks and were conducted in a manner that was inconsistent with the EPA’s QA Handbook. While completing this current report, we also found that Michigan DEQ adjusted ozone data based on the results of zero checks in a manner that was inconsistent with the EPA’s QA Handbook. Table 3 summarizes the results of our review and the impact of the zero-check data adjustments.

Table 3: Monitoring agency ozone data adjustment practices

Monitoring agency	Were zero-check adjustments consistent with QA Handbook?	Examples of the extent of adjustments to data reviewed by OIG
Arizona DEQ	Not applicable. The agency does not adjust data.	Not applicable
Georgia DNR ^a	No ^a	Hourly ozone values adjusted by as much as 5 ppb from raw values
Maricopa County	Not applicable. The agency does not adjust data.	Not applicable
Michigan DEQ	No	Hourly ozone values adjusted by as much as 8 ppb from raw values
Pima County	Not applicable. The agency does not adjust data.	Not applicable
South Carolina DHEC	No	Hourly ozone values adjusted by as much as 5 ppb from raw values

Source: OIG analysis.

^a Georgia DNR applied a zero-check adjustment process to data we reviewed that were reported to the AQS from 2012 through 2014. Georgia DNR stopped its zero-check adjustment practice in June 2015 and no longer adjusts data reported to the AQS.

Monitoring agency staff in Georgia, Michigan and South Carolina told us that they thought the zero-adjustment practice improved the accuracy of the data reported to the AQS. In addition, Michigan DEQ staff told us that they had been performing zero-adjustments for a long time and that Region 5 had never identified it as a problem.

Varying Shelter Temperature Criteria Used to Validate Ozone Data

Monitoring agencies applied varying shelter temperature criteria to validate ozone data. For example, one agency applied the same shelter temperature criteria to all

monitors, while other agencies used shelter temperature criteria that were specific to the monitors used at each monitoring station.

The QA Handbook states that it is important to maintain each shelter at temperatures that accommodate the most temperature-sensitive instrument in the shelter. The EPA's QA Handbook recommends the acceptance criterion for the hourly average shelter temperature range to be 20 to 30 degrees Celsius "or per the monitor manufacturer's specifications 'if designated to a wider temperature range'" (emphasis added).⁷ The general acceptance range of 20 to 30 degrees Celsius specified in the QA Handbook is based on the temperature range that the EPA uses to test monitors.⁸ However, once the EPA approves the use of a monitor, the EPA publishes a Notice of Designation in the Federal Register, which sets forth the requirements for how a monitor is operated. This designation may allow the monitor to operate within a wider temperature range than 20 to 30 degrees Celsius.

The monitoring agencies we reviewed used different criteria to assess the validity of the data collected based on the shelter temperatures. For example, the Michigan DEQ's 2012 and 2014 QAPPs specified a shelter temperature acceptance range of 18 to 32 degrees Celsius. When shelter temperatures were outside this range, Michigan DEQ invalidated all data collected during those periods. However, Michigan DEQ used monitors that are allowed, per the published Notice of Designation, to operate at a wider temperature range: 5 to 40 degrees Celsius. Based on our review of 69 hours of ozone data that were invalidated by Michigan DEQ, at no time were the hourly shelter temperatures outside the wider operating range approved by the EPA.

Conversely, the three monitoring agencies we reviewed in Arizona established a shelter temperature range of 20 to 30 degrees Celsius in their respective QAPPs, with two of the agencies' QAPPs stating that manufacturer specifications could be used if designated to a wider range. According to the personnel at these monitoring agencies, they validate ozone data using the manufacturer's designated operating range as an acceptance criterion instead of applying the 20 to 30 degrees Celsius range to all monitors.

In general, data invalidation due to shelter temperatures should be infrequent if monitoring shelters have adequate cooling and heating systems and are properly maintained. It is important for monitoring agencies to keep shelter temperatures within an acceptable operating range, especially on hot summer days, which are generally associated with high ozone values and can cause excessively high

⁷ The QA Handbook references the EPA's list of approved monitoring methods with instrument-specific temperature ranges, which can be found in the *List of Designated Reference and Equivalent Methods* document on the EPA's "[Air Monitoring Methods–Criteria Pollutants](#)" webpage.

⁸ Per 40 CFR Part 58, a criteria pollutant monitoring method used for making NAAQS decisions must be approved by the EPA as a "federal reference method" or "federal equivalent method." The QA Handbook states that federal reference method and federal equivalent method testing is required to be conducted in the 20 to 30 degrees Celsius range.

shelter temperatures. Invalidating data on these days increases the risk that potentially high and unsafe ozone levels are not recorded and used to assess air quality safety. Further, invalidating data collected when shelter temperatures are within the monitor's designated operating range adds to that risk. The EPA should clarify its guidance concerning how shelter temperature should be considered within the data validation process so that agencies consistently use the appropriate shelter temperature criteria for each specific monitor.

Different Data Processing Practices Could Decrease Data Reliability

The use of differing data processing practices increases the risk that data reported to the AQS are not comparable. According to the EPA's QA Handbook, comparability is a measure of the confidence with which one data set or method can be compared to another. The EPA states in its QA Handbook that the comparability of data sets is critical to evaluating their uncertainty and usefulness. When the comparability of data is affected by different data processing practices, it could decrease the reliability of the data for certain uses.

To illustrate the impact that different data processing practices could have on the data reported to the AQS, we created a set of hourly ozone data and then processed the data using the different practices that we identified during our review. Specifically, we applied the following three zero-check adjustment practices to 24 hours of hourly ozone data:

- Not adjusting for zero-check results within the EPA's recommended acceptance criteria. This is the practice recommended by the EPA's QA Handbook.
- Adjusting each hourly value by the same amount, based upon the zero-check result at the start of the day.
- Adjusting each hourly value by an incremental amount, based upon the difference between the zero check at the start of the day and the zero check at the end of the day. Each hour is adjusted incrementally based on the difference between two zero checks divided by the number of hours between the zero checks.

The data in Table 4 demonstrate how these different daily zero-adjustment practices could cause the monitoring agencies to report different values to the AQS, even though the raw monitoring and QC data were the same. Our example illustrates zero-check results where adjustment procedures caused the adjusted data to be lower than the raw values recorded by the monitor. However, under different circumstances, the inverse is also possible, and adjusted values could be higher than raw values.

Table 4: How different zero-check adjustment processes could affect reported ozone data

Hourly values recorded by the monitor		Hourly values (ppb) reported in the AQS if:		
Time	Hourly value (ppb)	Not adjusting for zero-check results	Adjusting by same amount based on previous zero-check result	Adjusting by incremental amount based on difference between two zero-check results
11 a.m.	66	66	65	64
12 p.m. (noon)	71	71	70	68
1 p.m.	76	76	75	73
2 p.m.	77	77	76	74
3 p.m.	80	80	79	77
4 p.m.	81	81	80	78
5 p.m.	79	79	78	76
6 p.m.	79	79	78	76
8-hour average	76	76	75	73

Source: OIG analysis.

As illustrated in Table 4, different data adjustment practices can decrease the reliability of the data reported to the AQS. For example, using a common set of raw data, these three practices produced three different 8-hour averages to be reported to the AQS: 76 ppb, 75 ppb and 73 ppb. In this example, the unadjusted data resulted in an 8-hour average of 76 ppb, which would have exceeded the EPA’s 2008 ozone NAAQS of 75 ppb. However, the 8-hour averages for the two adjusted sets of data in the example did not exceed this standard. The data quality adjustment process used may therefore directly affect the EPA’s determination regarding whether the air is healthy or unhealthy.

The application of different validation practices can also produce different 8-hour averages using the same set of raw monitoring data and QC check results. Based on the validation practices used, some agencies would accept the data, while others would reject and invalidate the data. Since the ozone standard is based on an 8-hour average, differing data processing practices could impact the EPA’s design value calculations, which are used to determine compliance with the ozone NAAQS.

Risk That Other Air Monitoring Agencies Apply Different Data Processing Practices and Have Outdated QAPPs

While our review focused on the data processing practices of six monitoring agencies, we found data indicating a risk that other monitoring agencies are not implementing the EPA-recommended data processing practices. Based on our analysis, about 26 percent of the AQS hourly ozone data differed from the corresponding real-time data reported in AirNow. There are a number of reasons

for such differences. For example, monitoring agencies could find certain data reported in real time to AirNow to be invalid and, therefore, would not report the data to the AQS. Further, monitoring agencies could apply different conventions for rounding or truncating raw data before reporting to either database. However, because we confirmed that at least some of these differences were due to data adjustment practices, there is a risk that other monitoring agencies could have made adjustments to the raw monitoring data before they were reported to the AQS. These adjustments can impact the EPA's ability to assess data quality and to determine whether the data are reliable for making designation decisions.

Air monitoring agencies develop QAPPs that should identify their QA and QC procedures and data validation criteria. The EPA's critical criteria for zero checks changed significantly in 2013 and then again in 2014. However, our analysis of data from the EPA's AQS website shows that 58 percent of monitoring agencies have ozone monitoring QAPPs that were approved before 2014. Thus, there is a risk that those QAPPs do not include the EPA's revised critical criteria.

EPA Has Taken Actions to Assess AQS Data Quality

During our review, OAQPS initiated several corrective actions to address the QA concerns outlined in our February 2017 management alert report and in this report:

- **Revising the QA Handbook.** OAQPS revised its QA Handbook in January 2017 to clarify its [guidance](#) on the zero-adjustment (Section 10.4) and data-validation processes (Section 17 and Appendix D). In addition, in May 2017, OAQPS posted a [technical note](#) to the EPA website alerting air monitoring agencies to the appropriate practice for conducting zero-check adjustments.
- **Reviewing data that failed one-point QC checks.** OAQPS sent a memorandum in April 2017 to EPA regions, directing them to begin reviewing and invalidating monitoring data when acceptance criteria for one-point QC checks were exceeded and when the air monitoring agency did not have compelling evidence to support the data's validity. OAQPS stated that it is providing monitoring agencies with the flexibility to determine data validity in cases where their QAPPs provided less stringent acceptance criteria than the EPA's recommended criteria.
- **Reviewing the impact of data adjustments on attainment decisions.** In November 2016, OAQPS began reviewing hourly ozone data from 2012 through 2015 in AirNow and the AQS to determine the risk of data adjustments impacting the data that could be used in the EPA's designation determinations for the 2015 ozone NAAQS. In July 2017, OAQPS provided an updated analysis, which included ozone monitoring data through 2016. However, the analysis did not address how zero-check

adjustment practices may impact design values or designation determinations for specific locations. An OAQPS manager told us that if OAQPS had concerns about the quality of data from a particular monitoring site, such an analysis would be considered on a case-by-case basis.

Conclusions

Variation in the data adjustment practices and data validation criteria used by monitoring agencies can lead to data quality uncertainty and decrease the reliability of data used to make decisions regarding NAAQS compliance. In addition, the comparability of monitoring data can be impacted if monitoring agencies implement quality systems with different data validation and processing practices. Thus, improved EPA oversight of monitoring agencies is needed to reduce the risk that monitoring agencies inconsistently apply data processing practices and report unreliable data to the AQS.

Consistent implementation of data processing and validation practices results in comparable data and provides better assurances that the data used to determine whether air quality meets the EPA's health-based standards are reliable and of sufficient quality. The EPA has initiated actions to correct the inconsistencies in how monitoring agencies process ozone data.

Recommendations

We recommend that the Assistant Administrator for Air and Radiation:

1. Assess the risk of any data adjustments impacting the ozone data used in the EPA's National Ambient Air Quality Standards designation determinations.
2. Issue guidance clarifying the shelter temperature criteria that should be used during data validation.

Agency Comments and OIG Evaluation

The agency concurred with the recommendations and provided acceptable planned corrective actions and completion dates. Recommendations 1 and 2 are resolved. In addition to a response to our recommendations, the agency provided technical comments on the draft report. Based on the agency response and technical comments received, we made revisions to the report where appropriate. Appendix A contains the agency's response to the draft report, the OIG's evaluation of the agency's response, the agency's technical comments, and the OIG's response to each technical comment.

Chapter 3

EPA Oversight Should Be Strengthened to Improve Ozone Data Quality

The EPA’s oversight of the air monitoring agencies’ quality systems should be strengthened to improve the agencies’ data processing practices. Specifically, we found the following issues:

- EPA regions did not verify that the monitoring agencies’ QAPPs were up to date and included the EPA’s recommended data processing practices.
- The EPA’s annual data certifications did not incorporate data for two of the three critical validation criteria recommended by the EPA.
- The EPA’s TSAs did not always identify or resolve the use of data processing practices that did not follow the EPA’s recommended practices.

The quality and reliability of monitoring data could be impacted if monitoring agencies implement quality systems with different data processing practices. The EPA’s oversight of monitoring agencies’ quality systems and practices is an important function to facilitate consistent application of data processing practices and to reduce the risk that monitoring data submitted to the EPA is unsuitable for use in attainment decisions.

EPA Oversight of Ambient Air Monitoring Programs

The EPA’s OAQPS and regional offices oversee ambient air monitoring programs. The responsibilities of OAQPS and EPA regional offices are listed in Table 5.

Table 5: Summary of OAQPS and regional oversight responsibilities

OAQPS responsibilities	Regional office responsibilities
<ul style="list-style-type: none"> • Develop a satisfactory quality system for the ambient air quality monitoring network. • Ensure that the methods and procedures used in making air pollution measurements are adequate to meet program objectives and that the resulting data are of appropriate quality. • Perform data quality assessments of monitoring agencies making air pollution measurements. 	<ul style="list-style-type: none"> • Distribute and explain technical and QA information to monitoring agencies. • Alert EPA headquarters to QA needs of monitoring agencies that are “national” in scope. • Confirm that monitoring agencies have approved QAPPs prior to routine monitoring. • Provide monitoring agency personnel with knowledge of QA regulations and with adequate technical expertise to address air monitoring and QA issues.

OAQPS responsibilities	Regional office responsibilities
<ul style="list-style-type: none"> • Ensure that guidance pertaining to the QA aspects of the ambient air monitoring program are written and revised as necessary. • Render technical assistance to the EPA regional offices and the air pollution monitoring community. 	<ul style="list-style-type: none"> • Evaluate the capabilities of monitoring agencies to measure air pollutants by implementing network reviews and TSAs. • Assess the quality of data submitted by monitoring agencies.

Source: OIG analysis of the EPA's QA Handbook.

Annual QAPP Reviews

Appendix A of 40 CFR Part 58 requires that monitoring agencies implement a quality system that provides sufficient information to assess the quality of the monitoring data. Each monitoring agency must describe its quality system in a quality management plan and a QAPP. A QAPP outlines the required procedures for providing monitoring data that are of adequate quality, meet statutory requirements and comply with applicable standard specifications.

According to EPA guidance, the EPA Project Manager (or authorized representative) should review QAPPs at least annually.⁹ When revisions are necessary, the QAPP must be revised and submitted to the EPA for review and approval. Revisions to a QAPP are necessary when a reviewing official determines that a substantive change (i.e., a change impacting the technical and quality objectives of the project) is needed. In addition, EPA staff told us that a change to national policy or guidance, such as a revision to the QA Handbook, may warrant revisions to QAPPs. In addition, the 2017 QA Handbook recommends that QAPPs be updated and resubmitted to the EPA at least once every 5 years.

In certain instances, EPA regions can grant monitoring agencies the authority to self-approve QAPPs. In these cases, EPA staff may not be involved in the review and approval of the QAPPs, which means they would not see any revised QAPPs until the next TSA. However, an OAQPS staff person expressed concern about the EPA's ability to properly oversee monitoring agencies without reviewing the QAPPs to verify that the agencies meet the regulatory requirements. The EPA revised 40 CFR Part 58, Appendix A, in March 2016 to require that self-approving monitoring agencies submit a copy of their QAPPs to the EPA to identify and correct any inaccuracies.

Annual Data Certification Reviews

Per 40 CFR Part 58, each monitoring agency is required to submit all ambient air quality data and associated QA data to the AQS quarterly in accordance with the

⁹ EPA, *EPA Requirements for Quality Assurance Project Plans (QA/R-5)*, EPA/240B-01/003, March 2001 (reissued May 2006).

AQS Data Coding Manual and the monitoring agency's QAPP. Additionally, the regulations require each monitoring agency to annually certify the following statements:

- Data collected at its monitoring sites meet the criteria in 40 CFR Part 58, Appendix A.
- Concentration data are accurate to the best of its knowledge.
- Concentration data and QA data are completely submitted to the AQS.

To meet these regulatory requirements, monitoring agencies must submit an annual data certification letter, an annual summary report of the air quality data collected for the year, and a summary of precision and accuracy data by May 1 of each year. EPA regional offices review and evaluate each monitoring agency's annual data certification package to confirm that the EPA has no reservations about data quality. The regions review the certification letters, the summary reports, the completeness of QA data submitted to the AQS, the resulting quality statistics, and the days with the highest reported concentrations.

In addition, the EPA has developed a Data Evaluation and Concurrence Report (AMP 600) that pulls data quality information already reported by the monitoring agencies to the AQS. This report summarizes various QC data in the AQS and flags whether the EPA has concurred that the data are of suitable quality.

TSAs

Appendix A of 40 CFR Part 58 requires the EPA regional offices to conduct a TSA at each monitoring agency at least once every 3 years and to report the TSA results to the AQS. A TSA is an on-site review and inspection of a monitoring organization's ambient air monitoring program to assess its compliance with established regulations governing the collection, analysis, validation and reporting of ambient air quality data. The QA Handbook states that TSAs are designed to address and report on an organization's field operations, laboratory operations, QA and QC processes, data management, and reporting.

As part of the quality portion of the audit, EPA regional staff are expected to review the monitoring agency's most recent QAPP to determine when it was approved; review data handling procedures, including verifying that QC checks are conducted properly and documented; and select a portion of the data for a data quality audit. The results of each TSA are reported to the monitoring agency, and agencies are required to take any necessary corrective action.

EPA Did Not Verify That QAPPs Were Revised in Timely Manner

Five of the six monitoring agencies we reviewed had QAPPs that had not been fully approved since 2014. For example, the EPA last approved ozone monitoring QAPPs for Georgia and South Carolina in 2007. The Michigan DEQ's QAPP was

approved in 2014, but it did not contain validation criteria that were consistent with the criteria recommended in the EPA's QA Handbook.

OAQPS informed us that Region 4 had conditionally approved the Georgia DNR's QAPP in December 2016. According to EPA staff, the Georgia DNR received a conditional approval because the monitoring agency was not willing to incorporate measurement quality objectives into its QAPP that were consistent with the EPA's QA Handbook.

The EPA can identify QAPPs that are outdated by reviewing data in the AQS database and by running an AQS management report (the AMP 600 report) that identifies the date of the last EPA-approved QAPP. However, the report does not generate a nonconcurrency flag until the QAPP is older than 10 years or unless the QAPP has never been approved. The EPA can also use TSAs to identify when QAPPs are outdated and request that monitoring agencies take corrective action.

Based on the QAPPs we reviewed, we also found that the EPA is not verifying whether QAPPs are updated with current QA requirements and guidance. This lapse could directly impact the data validation criteria used by monitoring agencies. If monitoring agencies are conducting CFR- and QA Handbook-compliant QA activities, as stated in their QAPPs, then the legal defensibility of the data is enhanced. As noted in Appendix A of 40 CFR Part 58, data validation criteria should be established in a monitoring agency's approved QAPP. Therefore, it is important that the EPA effectively use its available oversight mechanisms to verify that QAPPs reflect current regulatory requirements and EPA recommendations for QA and data validation.

Data Certification Reviews Could Be Used to Better Identify Inconsistent Data Processing Practices

The EPA requires monitoring agencies to report one-point QC check results in the AQS, but the EPA does not require monitoring agencies to report data for the other two critical QC checks: zero checks and span checks. The EPA uses the one-point QC check data in the AQS to conduct its annual certification reviews of the monitoring agencies. These reviews could be enhanced if all critical QC data were reported to the AQS.

A key tool that the EPA uses to review the annual certification packages is the AMP 600 report housed in the AQS. The AMP 600 report calculates data quality statistics for each monitor using the results from the one-point QC checks. This report generates either a green (acceptable), yellow (warning) or red (nonconcurrency) color code for each monitor based on the EPA identified ranges. A red flag for any monitor will elicit an AQS recommendation of nonconcurrency, indicating that issues regarding the quality of the data cannot be resolved. Three yellow warning flags for any one monitor will also result in a nonconcurrency flag. However, without data in the AQS for two critical criteria,

the EPA can only evaluate data quality based upon the results of the one-point QC check. The benefits of the AMP 600 report could be improved if it included the additional QC data from the zero and span checks.

The monitoring agencies we visited maintained the zero- and span-check results. In addition, as noted in Chapter 1, the EPA's QA Handbook clearly states that zero, span and one-point QC checks for ozone are all critical to maintaining the integrity of the ambient air data. However, monitoring agencies may not be willing to submit data associated with zero and span checks or to have the quality of their monitoring data assessed against these criteria because they are not required by regulation.

TSA's Did Not Identify Data Processing Practices That Were Inconsistent With EPA Guidance

The TSA's of the air monitoring agencies we reviewed did not always identify or resolve the use of critical criteria and data adjustment practices that did not follow the EPA's recommended practices. The EPA should use TSA's to identify and oversee these types of practices. During a TSA, EPA regions conduct an on-site review of quality systems in place at monitoring agencies. The EPA's TSA checklist, which is sent to agencies to complete prior to the TSA, includes questions that could help identify zero-adjustment practices and whether data validation criteria vary from the EPA's recommended practices. EPA regional staff must follow up on each of these questions during a TSA to fully understand how data are processed.

Specifically, we found the following issues:

- EPA Region 4 identified zero-adjustment practices at the Georgia DNR in both the 2011 and 2014 TSA's, but the region stated in both TSA's that the practices were allowed. However, the 2014 TSA should have noted that the practice did not follow the recommended practices outlined in the 2013 version of the EPA's QA Handbook.
- EPA Region 4 TSA's did not identify the South Carolina DHEC's zero-adjustment practices.
- EPA Region 5 did not identify the Michigan DEQ's zero-adjustment practices in the 2014 TSA. A Michigan DEQ manager told us that staff had been performing zero adjustments for a long time and that Region 5 had never identified it as a problem.
- EPA Region 4 noted in its 2015 TSA of the South Carolina DHEC that the state's ozone validation criteria did not conform to the QA Handbook. However, the issue was not resolved until January 2017. South Carolina DHEC management told us that it adopted the EPA's recommended

validation criteria for one-point QC checks after Region 4 issued a November 2016 memorandum proposing that all monitoring agencies in Region 4 include the EPA's recommended one-point QC check acceptance criteria in their QAPPs.

- Region 5's 2014 TSA of the Michigan DEQ did not identify that Michigan had invalidated ozone data for shelter temperature exceedances when the temperature was still within the monitoring method's approved operating range.

EPA Has Improved Oversight, but Further Steps Are Needed

In response to the OIG's February 2017 management alert report, the EPA initiated actions to improve oversight to help confirm that monitoring agencies' QAPPs are developed and revised in a timely manner and reflect the EPA's critical criteria contained in the most recent QA Handbook. Many of these actions were detailed in an OAQPS memorandum issued on July 11, 2017, to EPA Program Managers and staff. The EPA initiated the following action plans:

- OAQPS developed a list of all QAPPs reported to AQS and requested that EPA regions that have not approved QAPPs within a 5-year period work with the monitoring agencies to provide a schedule of when each QAPP will be revised and submitted to the EPA.
- OAQPS will revise the AQS AMP 600 report by 2019 to flag QAPPs that are over 5 years old. The current report flags QAPPs with approvals more than 10 years old or that have never approved.
- OAQPS and the EPA regions agreed to develop a QAPP review "checksheet" to provide a more consistent review of QAPPs.

In addition, OAQPS asked EPA regional air monitoring staff to review QAPPs to determine whether they contain the EPA's critical criteria. The EPA stated that only conditional approval of a QAPP will be provided if monitoring agencies do not revise their QAPPs to include the critical criteria. However, until the QAPP update-and-review process is completed, there is a risk that some QAPPs may not reflect the EPA's critical validation criteria.

As discussed in Chapter 2, the EPA is reviewing whether monitoring agencies adhered to the acceptance criteria for one-point QC checks for data already submitted to the AQS. In addition, OAQPS issued guidance on flagging data values in the AQS that exceed critical criteria. This practice will provide additional information and consistency regarding the assessment and validity of data collected in cases of failed one-point QC checks. However, the EPA is only able to identify exceedances of one-point QC criteria because the EPA does not require agencies to submit zero- and span-check data to the AQS.

We believe the EPA's TSA process should include steps to determine whether air monitoring agency QAPPs are kept up-to-date and contain the following elements:

- Critical criteria that meet EPA recommendations for data validation.
- A process for documenting any adjustments made to raw data before submittal to the AQS.

In response to our evaluation, the EPA developed and issued a national TSA guidance document in December 2017 to achieve more consistent implementation of the TSA process across all EPA regions. The guidance included steps to address the issues we identified above.

Conclusions

The EPA should more effectively use its available oversight tools to help verify that air monitoring agencies are implementing the EPA's recommended QA practices. The QAPPs are the primary way that monitoring agencies establish validation criteria and QA practices, and it is important for EPA regions to conduct careful reviews of these documents to determine whether they include the EPA's recommended practices or, if not, a valid explanation of why the QAPP practice differs. Other EPA oversight functions, such as TSAs and annual data certification reviews, should validate that the quality systems identified in the QAPPs reflect the most recent regulatory requirements and guidance and are being implemented appropriately. The EPA also should collect additional QC data in the AQS, such as zero- and span-check data, and develop more robust AQS reports to oversee monitoring agencies.

Recommendations

We recommend that the Assistant Administrator for Air and Radiation:

3. Complete the quality assurance project plan review-and-approval process to verify that air monitoring agencies' quality assurance project plans incorporate EPA regulations and guidance for conducting data validations and adjustments.
4. Periodically verify that air monitoring agencies are implementing the EPA's recommended criteria for data validation and adjustments through technical systems audits or other oversight mechanisms.
5. Develop a process to provide assurances that data reported to the Air Quality System database have met the approved zero- and span-check validation criteria.

Agency Comments and OIG Evaluation

The agency concurred with Recommendation 3 and provided an acceptable planned corrective action. Recommendation 3 is resolved. The agency agreed with Recommendation 4 and completed the corrective action on December 7, 2017.

The agency provided two corrective actions for Recommendation 5. However, these corrective actions, as described in the agency's written response to our draft report, did not fully meet the intent of our recommendation. As a result, we met with the agency to obtain clarification. At this meeting, agency staff explained that they were also taking an additional action to address this recommendation. Thus, our final report continues to recommend that the EPA develop a process to assure that the reported data for the zero- and span-check meet validation criteria, but we revised the recommendation to no longer specify the timing of this process. When implemented, we believe that the agency's proposed actions, as described in the written response and in our meeting, comprise a process to provide reasonable assurance that zero- and span- checks are properly used to validate data. Recommendation 5 is resolved.

In addition to a response to our recommendations, the agency provided technical comments on the draft report. Based on the agency response and technical comments received, we made revisions to the report where appropriate. Appendix A contains the agency's response to the draft report, the OIG's evaluation of the agency's response, the agency's technical comments, and the OIG's response to each technical comment.

Status of Recommendations and Potential Monetary Benefits

RECOMMENDATIONS

Rec. No.	Page No.	Subject	Status ¹	Action Official	Planned Completion Date	Potential Monetary Benefits (in \$000s)
1	16	Assess the risk of any data adjustments impacting the ozone data used in the EPA's National Ambient Air Quality Standards designation determinations.	R	Assistant Administrator for Air and Radiation	3/31/18	
2	16	Issue guidance clarifying the shelter temperature criteria that should be used during data validation.	R	Assistant Administrator for Air and Radiation	3/31/18	
3	23	Complete the quality assurance project plan review-and-approval process to verify that air monitoring agencies' quality assurance project plans incorporate EPA regulations and guidance for conducting data validations and adjustments.	R	Assistant Administrator for Air and Radiation	12/31/18	
4	23	Periodically verify that air monitoring agencies are implementing the EPA's recommended criteria for data validation and adjustments through technical systems audits or other oversight mechanisms.	C	Assistant Administrator for Air and Radiation	12/7/17	
5	23	Develop a process to provide assurances that data reported to the Air Quality System database have met the approved zero- and span-check validation criteria.	R	Assistant Administrator for Air and Radiation	9/30/18	

¹ C = Corrective action completed.
R = Recommendation resolved with corrective action pending.
U = Recommendation unresolved with resolution efforts in progress.

Agency Comments on Draft Report and OIG Evaluation



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

DEC 14 2017

OFFICE OF
AIR AND RADIATION

MEMORANDUM

SUBJECT: Response to Office of Inspector General Management Alert OPE-FY16-0009, "Differences in Air Monitoring Agencies' Data Processing Practices Could Decrease the Reliability of Ozone Data Used to Assess Air Quality"

FROM: William L. Wehrum 
Assistant Administrator

TO: Kevin Christensen, Assistant Inspector General for Audit and Evaluation
Office of Inspector General

Thank you for the opportunity to review and comment on the Office of Inspector General's (OIG's) Management Alert titled "*Differences in Air Monitoring Agencies' Data Processing Practices Could Decrease the Reliability of Ozone Data Used to Assess Air Quality.*" We appreciate the efforts and investigations the OIG has made to alert the Office of Air and Radiation (OAR) to potential data reporting issues with ozone data. We generally agree with the findings and recommendations identified in the report. However, to place these findings in context, we note that our analysis shows that the majority of the ozone data are not impacted by these issues and less than two percent of the data show differences which may represent a legitimate concern in terms of quality assurance (QA) practices.¹⁰ Furthermore, our analysis shows that these differences have a minimal impact on the 2014-2016 design values (DVs) which the EPA expects to use in designations for the 2015 ozone national ambient air quality standards (NAAQS), and thus will have little, if any, impact on initial area designations for that standard.

¹⁰ https://www.epa.gov/sites/production/files/2017-07/documents/_epaig_17-p-0106_agency_response_technical_addendum_july2017.pdf.

The EPA’s previous response to the OIG Management Alert on this project (dated February 10, 2017) provided background on the OIG process, the methodology used by OIG in their fact finding, our involvement in the findings, and our response to those findings.¹¹ OAR believes that the OIG’s findings in the earlier management alert and this draft report are substantially the same and, therefore, our response is similar. While we generally agree with these findings, there are a few places where information in the draft report is slightly unclear and deviates from our understanding of specific facts. Please refer to the attached list and suggested revisions intended to clarify and improve the draft report’s accuracy.

Below are OAR’s responses to the OIG’s specific recommendations (recommendations 1, 2, 3, 4, and 5).

Recommendation 1: Assess the risk of any data adjustments impacting the ozone data used in the EPA’s National Ambient Air Quality Standards designation determinations.

Response 1: The Office of Air and Radiation agrees with this recommendation. The Office of Air and Radiation conducted a review of the 2014-2016 data, which we intend to use for initial area designations for the 2015 ozone NAAQS. Specifically, we calculated 2014-2016 DVs based on the data from AirNow and compared those values to the 2014-2016 DVs in the Air Quality System (AQS). We found 12 monitors where the DV computed using AirNow exceeded the standard (> 70 parts per billion, ppb) and the AQS DV attained the standard (<= 70 ppb). Table 1 below provides a listing of these monitors. Eight of the 12 monitors differed by 1 ppb (i.e., AirNow DV = 71 ppb; AQS DV = 70 ppb). Since the data in AirNow are preliminary values and the validated data in AQS are truncated as specified by regulation, we conclude that the differences at those eight monitors are explainable based purely on data reporting conventions versus monitoring agency data adjustments and will not impact designations. Three of the remaining four monitors were located in counties with other violating monitors, and thus will have no impact upon designations. The final site was located in Shasta County, California, which does not contain any other violating monitors, nor is it in an existing nonattainment area. The Office of Air and Radiation is working with EPA Region 9 to investigate why the differences in the AQS and AirNow data occurred at this site.

Table 1

AQS Site ID	State Name	County Name	CBSA Name	AirNow Design Value (ppb)	AQS Design Value (ppb)	Potential Impact on O3 Designations
04-013-3002	Arizona	Maricopa	Phoenix-Mesa-Scottsdale, AZ	71	70	None – Rounding/ Truncation
04-013-4003	Arizona	Maricopa	Phoenix-Mesa-Scottsdale, AZ	71	70	None – Rounding/ Truncation

¹¹ https://www.epa.gov/sites/production/files/2017-02/documents/_epaog_17-p-0106_agency_response.pdf.

06-089-0009	California	Shasta	Redding, CA	71	68	EPA Investigating
21-111-0027	Kentucky	Jefferson	Louisville/Jefferson County, KY	72	69	None – Other Violating Monitors
32-003-1019	Nevada	Clark	Las Vegas-Henderson-Paradise, NV	73	70	None – Other Violating Monitors
34-007-1001	New Jersey	Camden	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	74	69	None – Other Violating Monitors
34-025-0005	New Jersey	Monmouth	New York-Jersey City, NY-NJ-PA	71	70	None – Rounding/ Truncation
42-005-0001	Pennsylvania	Armstrong	Pittsburgh, PA	71	70	None – Rounding/ Truncation
44-003-0002	Rhode Island	Kent	Providence-Warwick, RI-MA	71	70	None – Rounding/ Truncation
44-009-0007	Rhode Island	Washington	Providence-Warwick, RI-MA	71	70	None – Rounding/ Truncation
51-059-0030	Virginia	Fairfax	Washington-Arlington-Alexandria, DC-VA-MD-WV	71	60	None – Rounding/ Truncation
55-127-0005	Wisconsin	Walworth	Whitewater-Elkhorn, WI	71	70	None – Rounding/ Truncation

Planned Completion Date: FY18, Q2 for the one ozone monitoring site indicated above. Otherwise, OAR considers the assessment to be completed.

OIG Response #1: The agency concurred with the recommendation and provided acceptable planned corrective actions and completion dates. Recommendation 1 is resolved.

Recommendation 2: Issue guidance clarifying the shelter temperature criteria that should be used during data validation.

Response 2: The Office of Air and Radiation agrees with this recommendation. The Office of Air and Radiation will issue a technical memo that will be shared with the monitoring agencies and posted to the Ambient Monitoring Technology Information Center (AMTIC). The Office of Air and Radiation will subsequently revise the Quality Assurance Handbook to clarify the

current language on this topic. Since the Quality Assurance Handbook gets updated every five years and was last updated in 2017, OAR will develop and post a table of changes that will apply to monitoring guidance until the next full Quality Assurance Handbook revision.

Planned Completion Date: FY18, Q2 for Technical memo and Quality Assurance Handbook change table posted on AMTIC.

OIG Response #2: The agency concurred with the recommendation and provided acceptable planned corrective actions and completion dates. Recommendation 2 is resolved.

Recommendation 3: Complete the quality assurance project plan review-and-approval process to verify that air monitoring agencies' quality assurance project plans incorporate the EPA regulations and guidance for conducting data validations and adjustments.

Response 3: The Office of Air and Radiation agrees with this recommendation. The Office of Air and Radiation issued a memo on July 11, 2017, alerting the monitoring agencies of the importance of having Quality Assurance Project Plans (QAPPs) submitted and approved that conform to regulation and critical criteria. The Office of Air and Radiation expects this review process to be completed by the end of CY18. Additionally, OAR plans to revise the Data Certification and Concurrence Report (AMP600) to flag non-concurrence for any QAPP approval dates over 5 years. The Office of Air and Radiation has already revised AQS to provide better information on the QAPP data reported to AQS. The Office of Air and Radiation is committed to revising the Air Pollution Training Institute (APTI) course *Quality Assurance for Air Pollution Measurement Systems* that will address the issue of QAPP development and approval. Finally, the technical system audits that are conducted on monitoring agencies every 3 years will be used to identify QAPPs requiring revision. The EPA notes that the 2016 revision to 40 Code of Federal Regulations (CFR) part 58, Appendix A requires submission of QAPPs to the EPA for agencies that have been delegated self-approval of QAPPs in order to ensure conformance with the EPA regulation and important guidance such as the validation templates.

Planned Completion Dates: FY18, Q4 Revision of Data Certification and Concurrence Report; FY19, Q1 completion of APTI 470 Course; FY19, Q1 Completion of approval process for QAPPs to ensure meeting every five-year timeline.

OIG Response #3: The agency concurred with the recommendation and provided acceptable planned corrective actions and completion dates. Recommendation 3 is resolved.

Recommendation 4: Periodically verify that air monitoring agencies are implementing the EPA's recommended criteria for data validation and adjustments through technical system audits or other oversight mechanisms.

Response 4: The Office of Air and Radiation agrees with this recommendation. The Office of Air and Radiation has developed and anticipates issuing a technical systems audit guidance document with consensus from the EPA Regions to implement. This document will specify that auditors review validation criteria and the "process for documenting any adjustments made to

raw data before submittal to AQS.” The EPA Regions will use this guidance during technical systems audits that are conducted on the monitoring agencies every 3 years.

Planned Completion Date: FY18, Q2 for completion of Technical Systems Audit Guidance Document.

OIG Response #4: The agency concurred with the recommendation and provided acceptable planned corrective actions and completion dates. The agency released the revised TSA guidance in December 2017, which will be used by EPA regions to conduct TSAs. The corrective action for Recommendation 4 has been completed.

Recommendation 5: Develop a process to provide assurances that data reported to the Air Quality System database have met the approved zero- and span-check validation criteria prior to regional review and approval of the air monitoring agencies’ annual data certification packages.

Response 5: The Office of Air and Radiation believes that the most important of the three critical criteria quality control checks (zero, span, 1-point QC) is the 1-point QC (reported to AQS) since it involves the use of both the zero air source (used for the zero check) for ozone standard dilution, as well as the ozone standard that is used to generate and measure the span. The 1-point QC check concentration approximates the ambient air concentrations reported by the monitoring organization and best represents the precision and bias around the concentrations reported by the monitoring agency. The Office of Air and Radiation believes that it is sufficient for monitoring agencies to complete zero and span checks in accordance with their approved QAPPs that utilize the EPA validation template critical criteria, and make these data available for review during the EPA technical systems audits. Although the AQS reporting of zero and span checks is not a regulatory requirement, some monitoring organizations and the EPA Regions have requested zero and span transactions be developed in order to voluntarily submit these data to AQS. The Office of Air and Radiation has requested that zero and span QA transactions be added to AQS and we will provide technical guidance suggesting that monitoring agencies submit these data to AQS.

Planned Completion Date: FY18, Q4 for completion and deployment of zero span QA transaction in AQS for use by monitoring organizations consistent with technical guidance posted to AMTIC.

OIG Response #5: The agency provided two corrective actions for Recommendation 5: expanding AQS' capabilities to include zero- and span-check data and issuing a technical guidance document suggesting that monitoring agencies submit their zero- and span-check data. We met with the agency to obtain clarification on the corrective actions. Agency staff stated that TSA guidance directs regions to review QC check data during TSAs. Further, the EPA plans to provide TSA training by June 2018, which will emphasize to EPA staff that zero- and span-check results should be reviewed during TSAs. If fully implemented, we believe the process described in the agency's response and during our meeting is sufficient to provide reasonable assurance that zero- and span- checks are properly used to validate data. Thus, our final report continues to recommend that the EPA develop a process to assure that the reported data for the zero- and span-check meet validation criteria, but we no longer specify the timing of this process. We accept the EPA's corrective actions as meeting the intent of our recommendation. Recommendation 5 is resolved.

If you have any questions regarding this response, please contact Mike Jones, Office of Air Quality Planning and Standards, Office of Air and Radiation (OAQPS/OAR) Audit Liaison, at (919) 541-0528.

Attachment

TECHNICAL COMMENTS ATTACHMENT

OAR and Region 9 offered these comments for OIG review:

Page 4: “EPA’s Critical QC Checks” (text box)

In 2016, the ozone concentration for the 1-point QC check changed from 10 – 100 ppb to 5 – 80 ppb. It is recommended to include a footnote about this change in the 2016 regulation.

“The span check measures the analyzer’s response to a concentration at the upper range of the analyzer’s measurement capability (e.g., 500+ppb)”

Recommend revising statement to: *“The span check measures the analyzer’s response to a concentration at the upper range of the analyzer’s measurement capability (e.g., 70 to 90 percent of full scale)”*

OIG Technical Comment #1: The final report was revised to show the change in the one-point QC check range from 10–100 ppb to 5–80 ppb. We also revised the span-check language to clarify that it is 80–90 percent of full scale, which can be 500 ppb or more.

Page 4: Incomplete Statement

“... if the acceptance criteria are exceeded, the data collected by that monitor from the time of the last acceptable check to the failed check should be invalidated.” Should be corrected to include QA Handbook language **“...invalidated unless there are compelling reason and justification for not doing so”**

OIG Technical Comment #2: The suggested statement was added to the final report.

Page 10: Suggested Table Corrections (provided by Region 9)

Table 2: Application of critical criteria for ozone data at six monitoring agencies

Monitoring agency	Were critical criteria implemented in accordance with EPA’s QA Handbook?			Were the critical criteria adopted in the approved QAPP?
	Zero check	One-point check	Span check	
Arizona DEQ	Yes	Yes	Yes	Yes
Georgia DNR	No	No	No	No
Maricopa County	Yes	Yes	Yes	Yes
Michigan DEQ	No	Yes	No	No
Pima County	Yes	Yes	Yes	Yes
South Carolina DHEC	No	No	No	No

Source: OIG analyses of air monitoring agencies’ QAPPs and the EPA’s QA Handbook.

Since OAQPS finalized the Validation Templates, it has been the practice of Region 9 during our QAPP review process to require that air monitoring agencies either adopt these templates, or require our agencies to provide justification. All three Arizona agencies reviewed agreed to adopt the data validation templates. Region 9 expects agencies to incorporate updates to regulation and guidance into their procedures and provide updated QAPPs during regular review cycles. This is reinforced through notifications and TSAs.

Region 9 does not agree that Maricopa County and Pima County did not adopt the QA Handbook Appendix D Critical Criteria. The Region also believes that it was clear to each agency that their QAPP commitment was to use the most current QA Handbook criteria. Maricopa County did adopt ozone critical criteria in their QAPP approved in July 2011. Element 9 of this QAPP indicates that the validation SOP used by Maricopa (updated in 2014) must use the QA Handbook validation criteria. Pima County adopted the validation template in their QAPP approved in October of 2013 and their 2014 validation SOP refers the validator specifically to Appendix D for QA/QC criteria for validation.

Region 9 requests that critical criteria adoption be changed to “Yes” for both Maricopa and Pima County in Table 2. Alternatively, the column could be relabeled to state “Were the May 2013 critical criteria present in the approved QAPP.” All three Arizona agencies would be “Yes” in response to this question.

OIG Technical Comment #3: The OIG agrees that Maricopa County and Pima County were implementing critical criteria that were consistent with applicable guidance in the EPA’s QA Handbook. This is reflected in Table 2 of our report. However, we do not agree that the far right column of Table 2 should indicate “Yes” for either Maricopa County or Pima County. Maricopa County’s 2011 QAPP and Pima County’s 2013 QAPP (the most recent EPA-approved QAPPs for these agencies) both contain acceptance criteria for zero checks that were not consistent with the guidance in the EPA’s 2013 QA Handbook. In response to our discussion document for this report, Pima County stated, “As new revisions to validation templates become available, PDEQ adjusts operational procedures to adhere to the changes, but does not make correctional changes to the QAPP until the review and re-submission period, which is every 5 years.” We did, however, revise the headings in Table 2 to better distinguish which agencies were implementing the EPA’s critical criteria and which had updated critical criteria in their QAPPs.

Page 12: Suggested rephrasing

“However, once the EPA approves the use of a monitor, the EPA publishes regulation that may allow it to be operated at a wider temperature range than 20 to 30 degrees Celsius.”

Recommend revising statement to: *“However, once the EPA approves the use of a monitor, the EPA publishes a method approval notice in the Federal Register that may allow it to be operated at a wider temperature range than 20 to 30 degrees Celsius.”*

OIG Technical Comment #4: We revised the language as follows: *However, once the EPA approves the use of a monitor, the EPA publishes a Notice of Designation in the Federal Register, which sets forth the requirements for how a monitor is operated. This designation may allow the monitor to operate within a wider temperature range than 20–30 degrees Celsius.*

“Based on our review of 69 hours of ozone data that were invalidated by Michigan DEQ, at no time were the hourly shelter temperatures outside the operating range designated by EPA regulation.”

Recommend revising statement to: *“Based on our review of 69 hours of ozone data that were invalidated by Michigan DEQ, at no time were the hourly shelter temperatures outside the operating range designated by in the EPA method approval notice.”*

OIG Technical Comment #5: We revised the language as follows: *Based on our review of 69 hours of ozone data that were invalidated by Michigan DEQ, at no time were the hourly shelter temperatures outside the operating range approved by the EPA.*

Page 12: Suggested edits (Region 9)

“In our view, the EPA should clarify its guidance so that agencies consistently use the appropriate shelter temperature criteria for each specific monitor.”

Recommend revising statement to: *“In our view, the EPA should clarify its guidance concerning how shelter temperature should be considered within the data validation process that agencies consistently use the appropriate shelter temperature criteria for each specific monitor. In some cases, EPA may approve QAPPs that use criteria that are more stringent than EPA criteria if these criteria are applied consistently, do not intentionally or unintentionally bias the data set, and do not compromise completeness. If a sampling shelter climate control system is malfunctioning, data may not be representative and this could be an additional rationale for invalidation even if the instrument is within its operating temperature range. EPA’s guidance should clarify that a weight of evidence approach should be used when determining if invalidation is appropriate, and that these validation decisions should be supported by multiple lines of evidence, one of which could be instrument temperature requirements.”*

OIG Technical Comment #6: We included the first sentence in the final report. We did not include the other language in the final report because OAQPS and the regions need to discuss and agree on how to clarify the guidance.

Page 13-14 Table 4: One-sided example

OIG used a zero check example that showed the ozone monitor was reading 1 ppb high (4th column in Table 4) and therefore adjusted the monitor down by 1 ppb. OAR does not dispute what is presented in the Table but suggests that the information be clear that the zero check can also demonstrate that the monitor is reading 1 ppb low and that the monitor, in this case, would be adjusted up by 1 ppb. Therefore, in a case where an 8-hour average was 75 ppb, the monitor would be adjusted to read 76 ppb. OAR finds data from precision as well as zero data are

normally distributed around the acceptance limits so there is equal potential for positive and negative drift in ozone monitors.

If a monitoring organization has a reliable QC system and knows that its zero system is functioning properly, providing a zero adjustment that is well within the zero acceptance criteria does not necessarily decrease reliability of data reported to AQS if it can be proven that the monitor drifts slightly over a 24-hour period. EPA's concern, and why it suggests not performing a zero adjustment, is that one may not know which – the monitor or the zero check system – is malfunctioning and a continuous zero adjustment could be masking a technical issue that should be addressed and not continuously corrected.

OIG Technical Comment #7: We added the following language before Table 4: *Our example illustrates zero-check results where adjustment procedures caused the adjusted data to be lower than the raw values recorded by the monitor. However, under different circumstances, the inverse is also possible, and adjusted values could be higher than raw values.*

Page 14: Add clarification.

“Based on our analysis, about 26 percent of the AQS hourly ozone data differed from the corresponding real-time data reported in AirNow.”

While OAR does not dispute this finding, we believe that it is important to include the following clarification: *“The 26 percent finding includes data records where a measurement value was reported to AirNow but no value was reported to AQS, and data records where a measurement value was reported to AQS but no value was reported to AirNow. These specific situations accounted for more than half of differences noted above.”*

OIG Technical Comment #8: We added the following language from the 2017 OIG Management Alert report: *There are a number of reasons for such differences. For example, monitoring agencies could find certain data reported in real time to AirNow to be invalid and, therefore, would not report the data to the AQS. Further, monitoring agencies could apply different conventions for rounding or truncating raw data before reporting to either database.*

Page 23: Revise Improvement Section.

*“The EPA is also **developing** a national TSA document....”* Revise to: **“The EPA has developed and anticipates issuing...”**

OAR believes the TSA guidance document addresses the two bullets recommended by OIG.

- *Critical criteria that meet EPA recommendations for data validation.*
- *A process for documenting any adjustments made to raw data before submittal to the AQS.*

OIG Technical Comment #9: We revised the final report language to the following: *In response to our evaluation, the EPA developed and issued a national TSA guidance document in December 2017 to ensure that all EPA regions consistently implement the TSA process.*

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