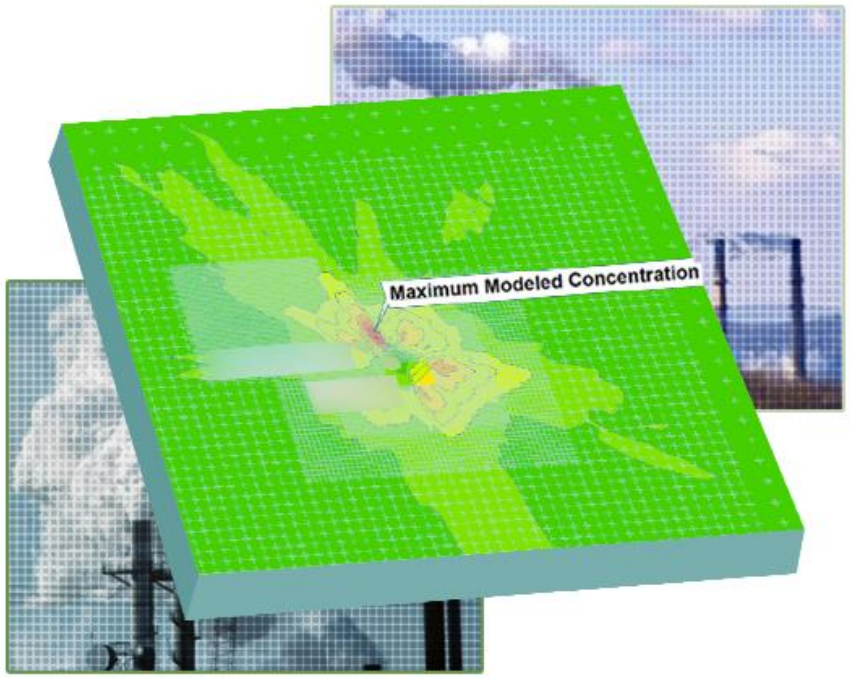
U.S. ENVIRONMENTAL PROTECTION AGENCY

OFFICE OF INSPECTOR GENERAL

Improving Air Quality

EPA Can Strengthen Its Process for Revising Air Quality Dispersion Models that Predict Impact of Pollutant Emissions

Report No. 18-P-0241 **September 5, 2018**



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Abbreviations

AERMOD	American Meteorological Society/EPA Regulatory Model
AQMG	Air Quality Modeling Group
CFR	Code of Federal Regulations
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
QAPP	Quality assurance project plan
SOPs	Standard operating procedures
SO_2	Sulfur dioxide

Cover Image: AERMOD modeling and pollutant emissions imagery. (EPA and OIG images)

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U.S. Environmental Protection Agency
Office of Inspector General

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At a Glance

EPA Can Strengthen Its Process for Revising Air Quality Dispersion Models that Predict Impact of Pollutant Emissions

Why We Did This Project

We conducted this audit to assess the effectiveness of the U.S. Environmental Protection Agency's (EPA's) process for reviewing and approving air quality dispersion models it recommends for use by state, local and tribal air pollution control agencies.

Air quality dispersion models predict the air quality impact of pollutants released into the atmosphere. The EPA's review and approval process for designating preferred models is outlined in Appendix W of 40 CFR Part 51. The goal of this process is to identify the best-performing model as the preferred model, and the appendix lists preferred models. Appendix W was originally promulgated in 1978 and most recently revised in 2017. The American Meteorological Society/EPA Regulatory Model (AERMOD) is the EPA preferred model for most regulatory uses listed in Appendix W. AERMOD predicts the air quality impact of pollutants from sources up to 50 kilometers downwind, and was first designated as a preferred model in the 2005 revision of Appendix W.

This report addresses the following:

- *Improving air quality.*

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What We Found

Although the agency has prepared guidance on the recommended procedures for reviewing the development and evaluation of new air quality dispersion models, similar guidance is not available for model revisions. The development of standard operating procedures (SOPs) and quality assurance project plans (QAPPs) or equivalent documents for model revisions could assure consistent application of quality assurance and quality control activities.

Air quality estimates derived from air quality dispersion models are used to make important decisions to protect public health, such as setting emissions limits.

From 2006 through 2016, the EPA issued 12 Model Change Bulletins revising AERMOD with enhancements, bug fixes and/or miscellaneous changes to improve the model. The 12th Model Change Bulletin was associated with the 2017 Appendix W revisions that included adding new regulatory uses to AERMOD. However, the quality assurance and control activities undertaken for these revisions were not as extensive as what EPA guidance recommends for new model development and evaluation. For example, the agency used peer-reviewed journal articles to satisfy peer-review requirements, while AERMOD received a panel peer review when it was developed. In one instance, the agency proposed a new regulatory option for AERMOD, which lacked peer-review literature and later needed additional evaluation. Development of SOPs, as well as QAPPs or equivalent documents, could assure that consistent and appropriate quality control and assurance activities are conducted when revising preferred models by helping assure that the predicted results are of sufficient quality. This is especially important because AERMOD is used by all 50 states, as well as tribes and territories, to predict air quality impacts for regulatory purposes under the Clean Air Act.

Recommendations and Planned Agency Corrective Actions

We made four recommendations to the Assistant Administrator for Air and Radiation. These recommendations involved developing SOPs to guide and document its process for reviewing and approving revisions to preferred air quality dispersion models, developing QAPPs or equivalent documents to describe results of systematic planning for air quality dispersion model revisions, updating the Office of Air Quality Planning and Standards' Quality Management Plan, and training staff. The agency agreed with our recommendations and provided acceptable corrective actions.

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

THE INSPECTOR GENERAL

September 5, 2018

MEMORANDUM

SUBJECT: EPA Can Strengthen Its Process for Revising Air Quality Dispersion Models that Predict Impact of Pollutant Emissions
Report No.18-P-0241

FROM: Arthur A. Elkins Jr.

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

This is a final report on the subject audit conducted by the Office of Inspector General (OIG) of the U.S. Environmental Protection Agency (EPA). The project number for this audit was OPE-FY17-0016. This report contains findings that describe the problems the OIG has identified and corrective actions the OIG recommends.

In accordance with EPA Manual 2750, your office provided acceptable corrective actions and milestone dates in response to OIG recommendations. All recommendations are resolved and no final response to this report is required. However, if you submit a response, it will posted on the OIG's website, along with our memorandum commenting on your response. Your response should be provided as an Adobe PDF file that complies with accessibility requirements of Section 508 of the Rehabilitation Act of 1973, as amended. The final response should not contain data that you do not want to be released to the public; if your response contains such data, you should identify the data for redaction or removal along with corresponding justification.

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

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Chapter 1
Introduction

Purpose

We conducted this audit to assess the effectiveness of the U.S. Environmental Protection Agency's (EPA's) process for reviewing and approving air quality dispersion models that it recommends for use by state, local and tribal air pollution control agencies.

Background

Air quality models are tools that predict the fate[1] of pollutants upon their release into the atmosphere. Air quality modeling uses include:

- Estimating the impact of emissions from new sources and from modifications to existing sources on the surrounding air quality.
- Predicting future pollutant concentrations from multiple sources after implementation of a new regulatory program.

Air quality dispersion modeling uses mathematical formulations to characterize the atmospheric processes that disperse a pollutant emitted by a source. Based on emissions and meteorological inputs, a dispersion model can be used to predict concentrations at selected downwind locations.

The Clean Air Act includes the following requirements related to air quality models:

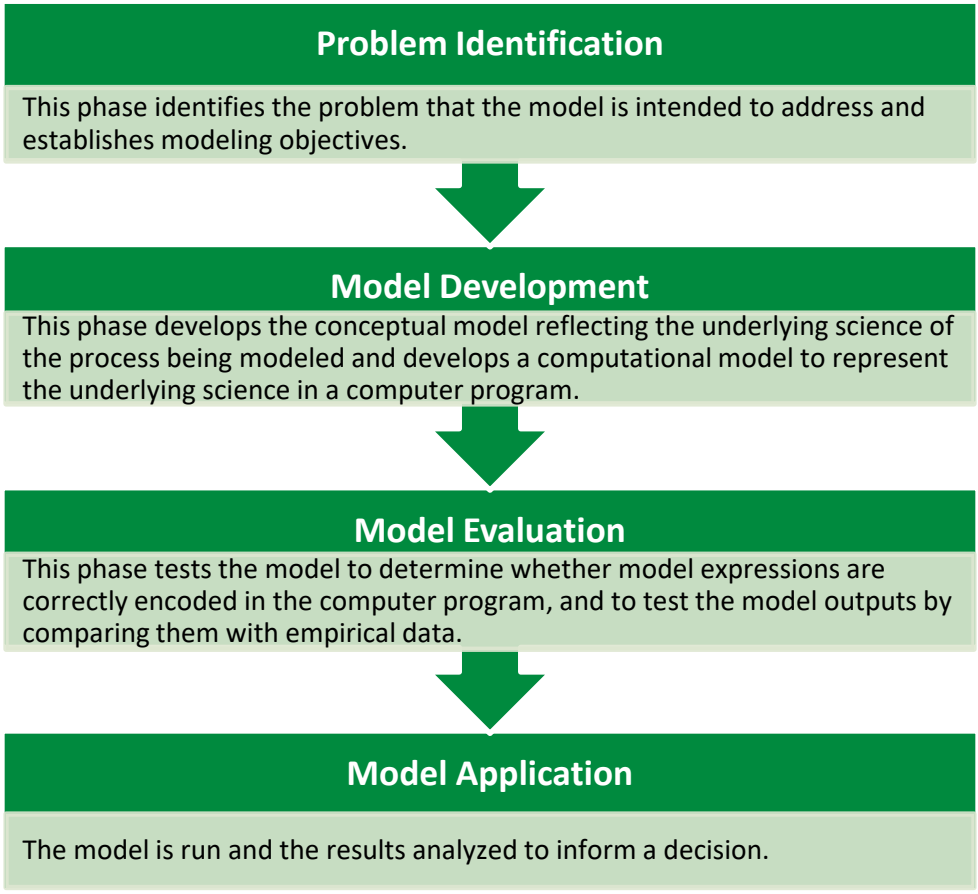
- Section 103 requires the EPA to conduct a program that includes the development of methods for modeling of air pollutants.
- Section 165(e)(3)(D) requires the EPA to adopt regulations specifying with reasonable particularity models to be used to comply with the act's Prevention of Significant Deterioration requirements. The EPA has met this requirement through publication of the *Guideline on Air Quality Models* as Appendix W to 40 CFR Part 51.
- Section 320 requires the EPA to conduct a conference on air quality modeling at least once every 3 years. The EPA has held 11 such conferences since 1977.

[1] Fate refers to the predicted future state of pollutants. The concentration of pollutants may become diluted downwind of the source, or undergo chemical and/or physical transformations after being released into the atmosphere.

Process of Modeling for Environmental Decision-Making

Modeling for environmental decision-making follows the four basic phases shown in Figure 1:

Figure 1: Environmental decision-making phases



Source: EPA Office of Inspector General (OIG) image developed from the EPA's Guidance on the Development, Evaluation, and Application of Environmental Models (CREM guidance), EPA/100/K-09/003 (2009).

Appendix W Provides Guidelines for Consistent Application of Models

To provide consistency in the application of air quality models for regulatory purposes in accordance with Section 165(e)(3)(D) of the Clean Air Act, the EPA publishes the *Guideline on Air Quality Models*, which is codified as Appendix W to 40 CFR Part 51, and is known simply as Appendix W.

Appendix W was originally promulgated in 1978 and was most recently revised in 2017. Appendix W is used by the EPA, states, tribes and industry to prepare and review permits for new or modified sources of air pollution. State and tribal air agencies also use Appendix W to revise their plans detailing strategies for reducing emissions and improving air quality known as State or Tribal

Implementation Plans. Appendix A of Appendix W includes a list of those models that the EPA has determined are "preferred" for the various regulatory uses.

Appendix W also defines the process that the EPA uses to determine the best performing model, which is then designated as the agency's preferred model for air quality modeling analyses. As noted in Appendix W, the EPA has developed some models suitable for regulatory application, while other models have been submitted by private developers for possible inclusion in Appendix W.

Appendix W further notes that refined models that are preferred and required by the EPA for particular applications are to go through the necessary peer scientific reviews and model performance evaluation exercises, including statistical measures of model performance in comparison with measured air quality data. When a single model is found to perform better than others, it is recommended for application as a preferred model and listed in Appendix W.

AERMOD a Preferred Model Listed in Appendix W

Appendix W lists three[2] preferred air quality models. Of those three, the American Meteorological Society/EPA Regulatory Model (AERMOD) is the one used for the majority of regulatory uses identified in Appendix W.

AERMOD is a steady-state Gaussian plume dispersion model[3] that predicts the transport and dispersion of pollutants up to 50 kilometers downwind of pollutant sources. AERMOD resulted from a joint effort by the American Meteorological Society and the EPA. The effort was initiated to build upon earlier model developments and provide a state-of-the-art dispersion model for regulatory applications.

AERMOD Modeling Uses

AERMOD is used to model the impact on air quality from sources that emit a variety of pollutants regulated by the EPA. These include common pollutants, such as carbon monoxide, lead, sulfur dioxide, nitrogen dioxide and primary particulate matter; and hazardous air pollutants, also known as air toxics.

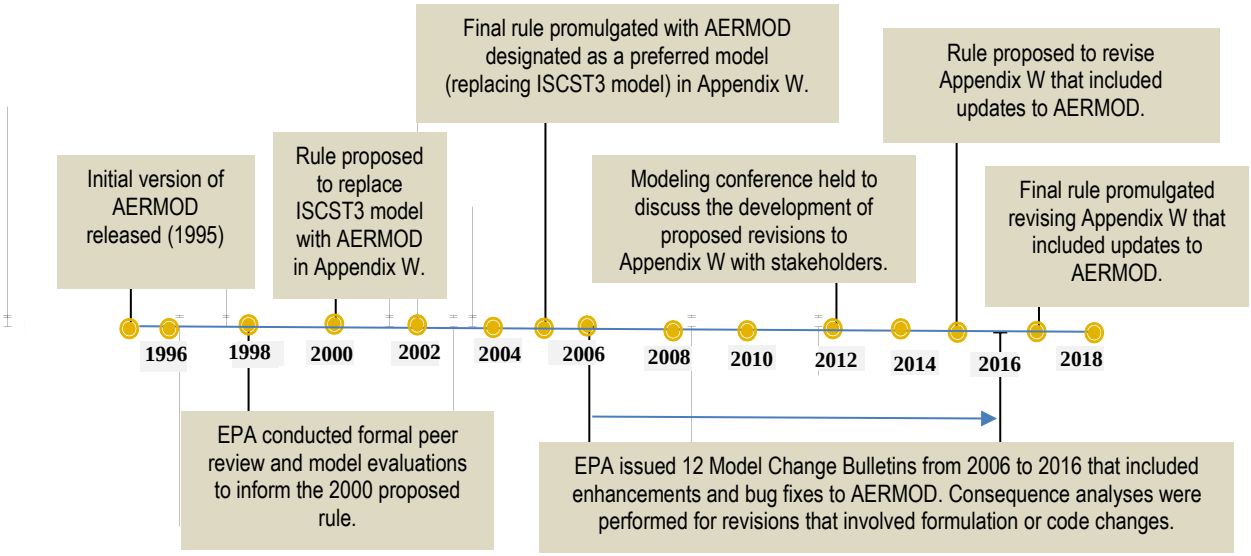
In 2005, the EPA designated AERMOD as a preferred model for determining air quality impacts of air pollutant emissions from stationary sources, such as point, volume and area sources.[4] Figure 2 provides a timeline of the events concerning AERMOD.

[2] The other two preferred air quality dispersion models are the Complex Terrain Dispersion Model Plus Algorithms for Unstable Situations and the Offshore and Coastal Dispersion Model.

[3] A Gaussian plume dispersion model assumes that the pollutant concentration distribution in the emission plume is a normal probability distribution.

[4] According to the Air Quality Modeling Group, stationary sources can be characterized in AERMOD as point, volume or area sources. Point sources are well-defined stacks, chimneys or pipe vents that are considered to have a single point of release. Area sources are typically low-level, non-buoyant releases considered to represent uniform fugitive emissions over a large area. Examples of area sources are storage piles and lagoons. Volume sources could be considered similar to area sources except that they have a vertical dimension at the time of the release due to buoyancy (temperature), turbulence or the nature of the release. Examples of volume sources are building roof monitors and drop points from loaders.

Figure 2: The Timeline for the AERMOD Model



Note: Modeling evaluations were conducted between 1994 and 2005 and between 2013 and 2017. Modeling conferences were held in 1995, 2000, 2005, 2008, 2012 and 2015. During the 2000 and 2015 modeling conferences, the EPA provided an opportunity for public comment on the proposed Appendix W revisions.

ISCST3: Industrial Source Complex - Short Term Model.

Source: OIG analysis of EPA documents pertaining to the development and revision of AERMOD.

AERMOD Uses

States and local air pollution control agencies rely heavily on AERMOD to make regulatory decisions on such matters as:

- New Source Review/Prevention of Significant Deterioration permit applications and State and Tribal Implementation Plans. AERMOD is used in all 50 states for conducting compliance demonstrations under the New Source Review permit program.

- Designating areas as in attainment or nonattainment of the 1-hour sulfur dioxide (SO_2) National Ambient Air Quality Standards (NAAQS). On August 21, 2015, the EPA issued the final Data Requirements Rule[5] for the 2010 1-Hour SO_2 Primary NAAQS to inform the designations process. This gave air pollution control agencies the flexibility to characterize air quality through monitoring or modeling of ambient SO_2 levels in areas with large sources of SO_2 emissions. According to the EPA, 41 states, two territories and one tribal nation are using AERMOD to model SO_2 sources in their jurisdiction to satisfy the requirements of the Data Requirement Rules.

[5] Data Requirements Rule for the 2018 1-Hour SO_2 Primary NAAQS Final Rule, 80 Fed. Reg. 51,052 (Aug. 21, 2015).

- Federally supported highway and transportation project activities. The 2017 revision to Appendix W replaced the CALINE3 model with AERMOD as the preferred model for mobile sources. There is a 3-year transition period that ends on January 17, 2020, for transportation conformity determinations. Any modeling analyses started before the end of this 3-year transition period with CALINE3 can be completed after the end of the transition period.

Highway traffic. AERMOD is the preferred model for estimating the impact of mobile source emissions on air quality. (U.S. Department of Transportation Federal Highway Administration photo)

Also, the 2017 revision to Appendix W replaced the Buoyant Line and Point Source model with AERMOD as the preferred model for buoyant, elevated line sources,[6] such as aluminum reduction plants.

Responsible Office

The EPA office primarily responsible for the review and approval of air quality dispersion models is the Air Quality Modeling Group in the Office of Air Quality Planning and Standards (OAQPS) within the EPA's Office of Air and Radiation.

Scope and Methodology

We conducted our performance audit from June 2017 through June 2018, in accordance with generally accepted government auditing standards. Those standards require that we obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our objective. We believe the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objective.

Our audit focused primarily on the review and approval process for AERMOD because AERMOD is used for the most regulatory purposes compared to the other two preferred models. Our audit included a review of the process used by the EPA to revise AERMOD in the Appendix W revisions in 2017. We also reviewed the EPA's 12 Model Change Bulletins, which included bug fixes, enhancements, and/or miscellaneous changes to AERMOD. We also reviewed the Appendix W revisions concerning AERMOD.

To address our objective, we identified and reviewed applicable statutes, regulations, policies and guidance. To help us determine what actions the EPA has taken to evaluate AERMOD as well as the adherence to the EPA's Quality System, we obtained and reviewed Appendix W; AERMOD evaluations;

[6] Examples of line sources are roadways and streets along which there are well-defined movements of motor vehicles, and lines of roof vents or stacks such as in aluminum refineries.

AERMOD consequence analysis reports; AERMOD Technical Support Documents; NAAQS Technical Assistance Documents; modeling guidance; modeling conference transcripts; clarification memorandums; EPA Quality System policy, procedures and guidance documents; and the regulatory docket associated with the 2017 Appendix W revisions. We compared these documents to the model development and revision processes described by the agency and found in the EPA's model development and evaluation guidance documents.

We interviewed EPA staff and managers in the OAQPS, Region 1, Region 4 (which covers North Carolina), Region 5 (which covers Indiana), and a Region 10 water quality modeler. In addition, we interviewed an EPA Office of Environmental Information manager and staff to learn more about the EPA's Quality System and how it relates to the development and revisions of air quality dispersion models. We interviewed a former EPA employee to gain an understanding of EPA actions to evaluate AERMOD. We also interviewed staff from the North Carolina Department of Environmental Quality, the Indiana Department of Environmental Management, and the Association of Air Pollution Control Agencies.

To assess internal controls, we reviewed EPA policies and guidance on the EPA's Quality System, including:

- Policy and Program Requirements for the Mandatory Agency-wide Quality System, EPA Order CIO 2105.0 (2000).
- EPA Quality Manual for Environmental Programs, CIO 2105-P-01-0 (2000).
- Guidance for Quality Assurance Project Plans for Modeling, EPA QA/G-5M (2002).
- Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4 (2006).
- Guidance for Preparing Standard Operating Procedures (SOPs), EPA QA/G-6 (2007).
- U.S. Environmental Protection Agency Quality Policy, EPA CIO Order 2106.0 (2008).
- Procedure for Quality Policy, CIO 2106-P-01.0 (2008).
- Guidance on the Development, Evaluation, and Application of Environmental Models (CREM guidance), EPA/100/K-09/003 (2009).
- The OAQPS Quality Management Plan (2015).

We compared these Quality System policy, procedure and guidance documents to the agency's activities described in interviews, as well as the documents produced during the AERMOD development and revision processes. We also analyzed these documents to determine the Quality System requirements that the agency had to follow during model development and revision processes.

We did not independently evaluate or assess the accuracy of AERMOD.

Chapter 2
Controls Should Be Strengthened to Improve Review and Approval Process for Preferred Models

Although the agency has prepared guidance on the recommended procedures for developing and evaluating new air quality dispersion models, similar guidance is not available to define the process for model revisions. The model evaluation activities conducted to assess the revisions to AERMOD were not always as extensive as what EPA guidance requires for new models. The EPA could strengthen the model revision process by developing:

- Standard operating procedures (SOPs) to assure consistency in the development, evaluation and approval of revisions to existing models.

- Model-specific quality assurance project plans (QAPPs) or equivalent documents defining the activities that should be conducted to assure the desired quality of results when developing or revising the preferred model.

Without SOPs and QAPPs, the agency lacks the assurance that all necessary technical activities have been completed to produce a preferred model that generates results of sufficient quality for its intended uses. This is especially important because AERMOD is used by all 50 states, as well as tribes and territories, to predict air quality impacts for regulatory purposes under the Clean Air Act.

Model Evaluation Determines the Quality of a Model

As described in the EPA's CREM guidance, model evaluation is the process for generating information over the project's life cycle that helps determine whether a model and its results are of sufficient quality to serve as the basis for a decision. Model quality is an attribute that is meaningful only within the context of a specific application. Information from a model evaluation helps to answer the following questions:

- How have sound science principles been addressed during model development?
- How is the model choice supported by the quantity and quality of available data?
- How well does the model approximate the real system of interest?
- How well does the model perform the specified task while meeting the objectives established under quality assurance project planning?

Model Evaluation Activities Varied for Model Revisions

As described in the EPA's CREM guidance, the recommended components of the model evaluation process include:

a. Credible, objective peer review.
b. QAPP and data quality assessment.
c. Qualitative and/or quantitative model corroboration.
d. Sensitivity and uncertainty analyses.

We noted that the process for evaluating AERMOD revisions was not as extensive as that recommended for new model development. For example, AERMOD received a panel peer review when it was developed. However, the EPA's Air Quality Modeling Group (AQMG) used peer-reviewed journal articles to support AERMOD revisions. In one instance, the EPA proposed a new regulatory option for AERMOD that had not been peer reviewed prior to its proposal. Specifically, the EPA proposed a change in Appendix W concerning a low-wind option in AERMOD to address issues with the model's tendency to over-predict during low wind conditions. In its response to public comments on the proposed rule, EPA acknowledged it lacked published, peer-reviewed literature with supporting model evaluations that fully addressed the concerns for the low-wind option literature and acknowledged public commenter concerns regarding the available model evaluations of this low wind option. As a result, the EPA did not include this proposed revision in the final 2017 version of Appendix W.

Power plant in Poca, West Virginia. (EPA photo)

AERMOD was corroborated with 14 field databases before the Appendix W revisions were finalized in 2017. Initial development of AERMOD in the 1990s included corroborating the model with 17 different field databases with varying conditions. Fourteen of these 17 field databases were used to corroborate the 2017 Appendix W revisions.

From 2006 to 2016, the EPA issued 12 Model Change Bulletins to revise AERMOD. Model Change Bulletin 12 was associated with the Appendix W revisions in 2017. Nine of the bulletins contained enhancements.[7] Enhancements add new functionality or change existing functionality in a way that makes AERMOD more efficient, usable and useful.

During the first 10 times AERMOD was undergoing revisions, AQMG conducted consequence analyses for all but three AERMOD revisions. According to AQMG, the three AERMOD versions that did not undergo consequence analysis did not

[7] These enhancements included options for estimating the conversion of nitrogen oxide emissions to ambient nitrogen dioxide concentrations, and allowing users to specify background ozone concentrations.

contain formulation updates or code changes that would affect modeled concentrations. Consequence analyses assess the change in predicted pollutant concentrations between the revised and current AERMOD versions.

Table 1 summarizes the revisions to AERMOD from 2006 to 2016.

Table 1: Changes made to AERMOD summarized in 12 Model Change Bulletins

Model Change Bulletin number	Date	Number of changes by type		
		Bug fixes[a]	Enhancements[b, d]	Miscellaneous[c]
1	12/07/2006	9	6	5
2	1/26/2007	9	0	3
3	10/19/2009	24	13	31
4	2/28/2011	7	12	6
5	4/13/2011	1	0	1
6	12/19/2011	5	0	0
7	2/29/2012	3	2	2
8	12/10/2012	6	2	2
9	12/16/2013	10	3	5
10	5/14/2014	21	5	8
11	6/30/2015	12	7	1
12	8/03/2016	10	6	1
Totals		**117**	**56**	**65**

Note a: A bug fix is a fix to a software bug, which is an error, flaw, failure or fault in a computer program or system that causes it to produce an incorrect or unexpected result, or to behave in unintended ways.
Note b: An enhancement adds new functionality or changes existing functionality in a way that makes the software application more efficient, usable and useful.
Note c: Miscellaneous changes are other changes that are neither bug fixes nor enhancements, such as including potential downwash effects for stack heights that equal or exceed the EPA formula height.
Note d: New options that represent scientific formulation changes have been added as Beta options as different versions of the model have been released over the years. Beta options were included in the "enhancements" section of Model Change Bulletins.

Source: OIG analysis of EPA's Model Change Bulletins for AERMOD.

The extent of quality control and assurance activities needed for a model revision project could reasonably vary based on the nature of the revision. However, due to a lack of documentation describing (1) the basic procedures for revisions and (2) the results of systematic planning describing the detailed model evaluation activities needed for a specific model's revisions, there is a lack of assurance that the appropriate steps were taken to assure the desired quality of the revision.

AQMG Lacks SOPs for Review and Approval Process for Revising Preferred Models

The AQMG lacks SOPs for the review and approval process for revising preferred models. In addition to AERMOD, the EPA oversees revisions to two other preferred air quality dispersion models: the Complex Terrain Dispersion Model Plus Algorithms for Unstable Situations and the Offshore and Coastal Dispersion Model. These models were developed in the 1980s and are used infrequently compared to AERMOD. According to the AQMG manager, it is likely that one of these models will be incorporated into AERMOD at a later date.

Since AERMOD has been frequently revised, the AQMG manager indicated that the agency would benefit from the development of SOPs to assure consistency in the process. These SOPs could lay out what procedures need to be completed when a model is revised, such as:

- Determining whether the revision requires a QAPP.
- Determining whether consequence analyses need to be completed.
- Determining what type of model evaluations are needed for revision.
- Determining when and what type of peer review is needed.
- Determining how code will be verified.

The *Guidance for Preparing Standard Operating Procedures (SOPs),* developed by the EPA's Office of Environmental Information, states that the development and use of SOPs are an integral part of a successful quality system, as they provide staff with the information to perform a job properly and facilitate consistency in the quality and integrity of a product or end-result. SOPs detail the regularly recurring work processes to be followed within an organization. SOPs document the way activities are to be performed to facilitate conformance to technical and quality system requirements, and to support data quality. Further, The OAQPS Quality Management Plan states that SOPs should ensure consistent conformity with organizational practices; serve as training aids; provide ready reference of proper procedures; reduce work effort; reduce data error occurrences; and improve data comparability, credibility and defensibility.

The EPA has started to develop SOPs for changing AERMOD's source code. In March 2017, the AQMG developed a draft AERMOD System Update Checklist to provide a process to complete before changing the AERMOD source code. While this checklist does provide SOPs for changing the model code when the model is revised, additional SOPs are needed to define the general process of developing and revising models.

AQMG Did Not Develop a QAPP When It Revised AERMOD

The AQMG did not develop a QAPP or similar planning documents describing the results of systematic planning to guide AERMOD revisions. These plans would include a description of the extent and type of model evaluation activities needed to determine the quality of the model revision based on the results of systematic planning. We also noted that a QAPP was not prepared to describe the systematic planning and model evaluation process when AERMOD was initially developed in the 1990s. Such a plan, with supplemental language added as necessary, could have served as a guide for future enhancements to the model.

The EPA's *Policy and Program Requirements for the Mandatory Agency-wide Quality System* establishes the minimum requirements for quality systems supporting EPA environmental programs that encompass the collection, evaluation and use of environmental data by or for the EPA, which would be applicable to the development and revision of environmental models. The agency's Quality System requirements include the use of a systematic planning approach to develop performance criteria for all work covered by the agencywide Quality System, and the development of approved QAPPs or equivalent documents for all applicable projects and tasks involving environmental data.

The OAQPS Quality Management Plan[8] requires the use of QAPPs for modeling. The OAQPS uses a graded approach to determine the appropriate level for its projects: Categories I to IV. Category I projects include monitoring, modeling and/or analyses involving Prevention of Significant Deterioration. AERMOD is used in modeling for Prevention of Significant Deterioration permit applications.

OAQPS personnel noted that they developed numerous documents in support of revisions to AERMOD, and that, in their view, these documents are equivalent to a QAPP and demonstrate evidence that their process complies with EPA requirements for systematic planning. These documents included the following:

- EPA's *Guideline on Air Quality Models.*
- AERMOD User's Guide.
- AERMOD Model Formulation and Evaluation Document.
- AERMOD Implementation Guide.
- Consequence analyses.
- Model Change Bulletins.
- Technical Support Documents.
- Option-specific evaluation documents.
- Evaluation databases.

[8] The EPA Quality Manual for Environmental Programs requires each EPA organization unit to document its quality system in a quality management plan.

The EPA's *Policy and Program Requirements for the Mandatory Agency-wide Quality System* allows the use of equivalent planning documents in lieu of a QAPP as long as the documents are defined in an office's quality management plan. However, The OAQPS Quality Management Plan does not state whether the above-listed documents are equivalent to a QAPP and does not define the systematic planning process used to revise AERMOD. Thus, it was not clear from the documentation we reviewed how the EPA's process for revising AERMOD complies with the systematic planning process required by the EPA's Quality System.

Development of SOPs and QAPPs Provides Better Assurance that Modeling Results Are of Sufficient Quality

The development of SOPs and QAPPs to guide model revisions can better assure that the model produces data sufficient for its intended use. Air quality dispersion models generate results that are used to make regulatory decisions. Therefore, it is important the models do not considerably over- or underestimate ambient air concentrations.

A potential impact of models that overestimate ambient air concentrations is:

- Establishment of facility emission limits that are more stringent than required. This in turn could increase facility construction costs to implement pollution controls that may not be needed.

Potential impacts of models that underestimate ambient air concentrations include:

- Establishment of facility emissions limits that are not stringent enough to sufficiently protect the public from exposure to harmful air pollutants.

- Inaccurate determinations that areas are complying with ambient air quality standards. This would result in the public being exposed to harmful air pollutants in concentrations above what the EPA considers safe, thus increasing public health risk.

The EPA received comments expressing concern as to whether AERMOD was sufficiently evaluated for some of its proposed uses during the 2015 comment period for the proposed rulemaking to revise Appendix W. For example, the American Association of State Highway and Transportation Officials recommended that the EPA consider the results from other peer-reviewed studies in the literature and perform additional model comparison studies for a range of conditions before replacing one model with another. The EPA responded in the preamble to the 2017 final rulemaking on revisions to Appendix W that it has reviewed the available literature and conducted its own analysis that demonstrates

AERMOD provides superior performance to that of CALINE3 for refined applications

Conclusion

SOPs are intended to minimize variation and promote quality through consistent implementation of a process or procedure within the organization. Due to the frequency of revisions and enhancements to existing air quality dispersion models, SOPs would help assure that the development, evaluation and approval of these revisions meet minimum requirements for this process. At the project level, QAPPs document the results of systematic planning for an environmental data project to assure the project produces results of sufficient quality for the intended use. For models, this planning, which should be included in a QAPP, should address the nature and extent of model evaluation activities needed to determine whether the model produces the desired quality of results.

Assuring the consistency and quality of air quality dispersion model revisions for AERMOD is important because the model is used by all 50 states, as well as tribes and territories, to predict air quality impacts for regulatory purposes under the Clean Air Act. AERMOD is also used to assess compliance with ambient air quality standards for SO_2 designation decisions and to evaluate the impact of emission control strategies for State and Tribal Implementation Plans.

Recommendations

We recommend that the Assistant Administrator for Air and Radiation:

1. Develop standard operating procedures for the review and approval process for revising preferred air quality dispersion models.

2. Develop a quality assurance project plan or equivalent documents describing the results of systematic planning before developing a new air quality dispersion model or undertaking any significant revisions in the future to existing preferred air quality dispersion models, which are codified in Appendix A to Appendix W of 40 CFR Part 51.

3. Revise the Office of Air Quality Planning and Standards' Quality Management Plan to state whether the agency is developing quality assurance project plans or equivalent documents to meet EPA Quality System requirements for developing or revising preferred air quality dispersion models.

4. Train the Air Quality Modeling Group staff concerning the standard operating procedures of preferred air quality dispersion model review and approval and EPA Quality System requirements.

Agency Comments and OIG Evaluation

The agency concurred with the recommendations and provided acceptable planned corrective actions and completion dates. All recommendations are resolved with correction actions pending. 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 revised the report where appropriate.

The agency's comments are in Appendix A.

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	13	Develop standard operating procedures for the review and approval process for revising preferred air quality dispersion models.	R	Assistant Administrator for Air and Radiation	9/30/18	
2	13	Develop a quality assurance project plan or equivalent documents describing the results of systematic planning before developing a new air quality dispersion model or undertaking any significant revisions in the future to existing preferred air quality dispersion models, which are codified in Appendix A to Appendix W of 40 CFR Part 51.	R	Assistant Administrator for Air and Radiation	3/31/20	
3	13	Revise the Office of Air Quality Planning and Standards' Quality Management Plan to state whether the agency is developing quality assurance project plans or equivalent documents to meet EPA Quality System requirements for developing or revising preferred air quality dispersion models.	R	Assistant Administrator for Air and Radiation	3/31/20	
4	13	Train the Air Quality Modeling Group staff concerning the standard operating procedures of preferred air quality dispersion model review and approval and EPA Quality System requirements.	R	Assistant Administrator for Air and Radiation	9/30/19	

[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

July 5, 2018

OFFICE OF
AIR AND RADIATION

MEMORANDUM

SUBJECT: Response to Office of Inspector General Draft Report, "EPA Can Strengthen Its Process for Revising Air Quality Dispersion Models That Predict Impact of Pollutant Emissions" – Project No. OPE-FY17-0016

FROM: William L. Wehrum 7-5-18
Assistant Administrator

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

INTRODUCTION

EPA's Office of Air and Radiation (OAR) welcomes the opportunity to review and comment on the Office of Inspector General's (OIG) draft report titled *EPA Can Strengthen Its Process for Revising Air Quality Dispersion Models That Predict Impact of Pollutant Emissions* (Draft Report). In general, we appreciate the observations and recommendations the OIG has provided in the Draft Report that underscore the need for more formal development and documentation of quality assurance (QA) measures and standard operating procedures (SOPs) for the review and approval of new or revision of existing preferred air quality dispersion models. We believe that such improvements will strengthen the agency's air quality modeling program.

As means of background, we wish to note that our air quality modeling program stems from the statutory requirements of Section 165 of the Clean Air Act (CAA), which states that "The Administrator… shall specify with reasonable particularity each air quality model or models to be used under specific sets of conditions for the purposes of this part…" To satisfy this congressional mandate, EPA established the *Guideline on Air Quality Models* (Appendix W to 40 CFR part 51, or *Guideline*) in 1978, which includes the review and approval approach that

EPA must take in determining preferred models for use in regulatory air quality programs under the CAA and a summary of EPA's promulgated preferred models. Section 320 of the CAA also requires EPA to conduct a conference on air quality models at least once every 3 years to ensure ongoing formal public engagement, review, and comment on the existing preferred air quality models and future air quality model development needs necessary for various regulatory applications and compliance demonstrations.

EPA's preferred dispersion air quality model for many applications is the American Meteorological Society/EPA Regulatory Model (AERMOD) Modeling System, which was promulgated in 2005 after extensive peer-review and formal public review and comment. EPA established the applicability and suitability of AERMOD through federal rulemaking under the Action Development Process (ADP) that included full documentation and clear demonstration that the modeling system met the criteria as specified for preferred and alternative models in the *Guideline*. Aside from usability enhancements that make AERMOD more efficient for regulatory applications and "bug fixes" that address identified computer coding errors, the only significant revision of AERMOD occurred in 2017 through the federal rulemaking process including public review and comment, and based upon peer-reviewed scientific research of those formulation changes.

The Air Quality Modeling Group (AQMG) in OAR's Office of Air Quality Planning and Standards (OAQPS) has been responsible for the *Guideline* since the late 1970s and its periodic revisions that include development and updates to preferred air quality models. Based on this long-standing role and responsibility, the AQMG manager has served as the OAR representative on EPA's Council for Regulatory Environmental Modeling (CREM) and assisted in the development of the 2002 *Guidance for Quality Assurance Project Plans for Modeling* and the 2009 *Guidance on Development, Evaluation, and Application of Environmental Models*. These guidance documents and others related to procedures for model development and updates have benefited from the AQMG's experience under the *Guideline* and the approaches in determining preferred air quality models. This background discussion is intended to highlight our statutory directive, current practice, and long-standing role in ensuring that EPA's air quality modeling program meets the needs under the CAA and adheres to appropriate and necessary QA measures and SOPs.

RESPONSES TO RECOMMENDATIONS

Consistent with our interest in continuously improving our air quality modeling program, OAR welcomes the observations and recommendations OIG has provided in the Draft Report. OAR's responses to OIG's specific recommendations follow.

OIG Recommendation 1:
Develop standard operating procedures for the review and approval process for revising preferred air quality dispersion models.

EPA Response 1:
Throughout the development history of AERMOD, EPA has followed a systematic approach to model development that seeks to ensure that model enhancements and updates are technically

and scientifically appropriate. This approach was acknowledged by the OIG report as they examined and reported on the panel peer review for the initial model promulgation, the peer reviewed journal articles, model evaluations based on field datasets, and the consequence analyses performed for each model update that resulted in changed concentrations. However, EPA acknowledges that these procedures were not codified in written SOPs or other documents, but were instead historically completed at the discretion of AQMG's Dispersion Modeling Team (DMT).

In response to this recommendation, EPA proposes the following three actions:

1. EPA will develop internal SOPs for logging bugs, enhancements, and planned formulation updates, handling code, evaluating model code changes, and acquiring approval for releasing updated code to the public.
2. As part of the SOPs, EPA will include a management review and approval process, which will include a management approval form. This approval form will be archived internally to document adherence to systematic planning for model development and update activities.
3. EPA will provide a general summary of the internal SOPs along with a broad explanation of our approach to model updates in an upcoming release of a report titled *AERMOD System Development and Update Plan*.

Planned Completion Date:

1. Complete. EPA completed formal documentation of a set of SOPs earlier this year. While these are continuously being evaluated for improvements, they were formally adhered to as part of EPA's release of AERMOD version 18081 on April 24, 2018.
2. Complete. Our current SOPs include management review and signoff of model code prior to release. This was included with the release of AERMOD version 18081 and the review and approval form has been archived internally.
3. In progress. Expected release date of September 30, 2018. A draft of the *AERMOD System Development and Update Plan* is currently under review by the AQMG Manager. We expect to update this plan annually to reflect changes in new model releases and new directions in model improvement efforts for future updates to the model.

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

OIG Recommendation 2:

Develop a quality assurance project plan or equivalent documents describing the results of systematic planning before developing a new air quality dispersion model or undertaking any significant revisions in the future to existing preferred air quality dispersion models, to include any revisions to preferred models in EPA's *Guideline on Air Quality Models*, which is codified as Appendix A to Appendix W of 40 CFR part 51.

EPA Response 2:

In response to this recommendation, EPA proposes the following action:

1. EPA will develop the *AERMOD System Development and Update Plan*. The plan serves several functions. In addition to generally describing the SOPs for model development, the plan will provide detailed descriptions of the model development and update process outlined in EPA's *Guideline* which relies upon EPA's ADP requirements for the federal rulemaking process. The ADP process provides a robust process and documentation that ensures quality of its regulatory actions such that the model development and update process meets EPA's Quality System requirements.
2. As noted in the OIG report, EPA provides extensive documentation on model performance, function, and application (*e.g.*, the AERMOD User's Guide, the AERMOD Formulation and Evaluation Document, and the AERMOD Implementation Guide). We believe these documents provide the documentation necessary to meet EPA's Quality System requirements. The connections between these documents and these requirements will be spelled out in updates to the OAQPS QMP (see response to recommendation 3).

Planned Completion Date:

1. In progress. Expected release date of September 30, 2018.
2. In progress. Please refer to planned completion of this task under recommendation 3.

OIG Response #2: The agency provided two corrective actions to address the recommendation. We met with the agency to clarify its corrective actions. During our meeting, AQMG managers committed to documenting the systematic planning process for developing air quality dispersion models and revising existing preferred air quality dispersion models in its revised Quality Management Plan as well as its *AERMOD System Development and Update Plan*. We accept the EPA's corrective actions as meeting the intent of our recommendation. Recommendation 2 is resolved.

OIG Recommendation 3:

Revise the OAQPS QMP to state whether the agency is developing quality assurance project plans or equivalent documents to meet EPA Quality System requirements for developing or revising preferred air quality dispersion models.

EPA Response 3:

In response to this recommendation, EPA proposes the following action:

1. The AQMG Manager will coordinate with the OAQPS QA Manager to modify the OAQPS QMP so that it clearly states how the process for developing and revising preferred air quality models is conducted and adheres to EPA Quality System requirements.

Planned Completion Date:

1. In progress. The OAQPS QMP was last issued in 2015 and is revised every 5 years. EPA will provide the requested update to the QMP with its currently scheduled release by March 31, 2020.

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

OIG Recommendation 4:
Train the Air Quality Modeling Group staff concerning the standard operating procedures of preferred air quality dispersion model review and approval and EPA Quality System requirements.

EPA Response 4:
OAR agrees with this recommendation and recognizes the importance of ensuring the AQMG staff (now and into the future) are fully aware of and adhere to the group's internal SOPs for model development and updates and are fully understanding of EPA's Quality System requirements and related guidance for model development and updates.
In response to this recommendation, EPA proposes the following action:

1. The AQMG Manager will work with staff in the DMT to define the annual review of SOPs by the team and coordinate with the OAQPS QA Manager to identify the appropriate training materials on the EPA Quality System requirements.

Planned Completion Date:

1. In progress. Definition of training materials will be defined by September 30, 2018, codified in the FY2019 Performance Appraisal and Recognition System (PARS) for each staff in the DMT, and completed by September 30, 2019.

OIG Response #4: We met with the agency to clarify the corrective action. During our meeting, the AQMG manager committed to AQMG staff receiving SOP training. This requirement will be included in AQMG staff's Fiscal Year 2019 Performance Appraisal and Recognition System agreements. The AQMG manager also committed to work with OAQPS' Central Operations and Resources Office to look for training courses on EPA's Quality System that are available and appropriate to also include as part of the staff's Fiscal Year 2019 Performance Appraisal and Recognition System agreements. The identified courses will be required training. We accept the EPA's corrective actions as meeting the intent of our recommendation. Recommendation 4 is resolved.

If you have any questions regarding this response, please contact Tyler Fox, Group Leader, AQMG, OAQPS, at (919) 541-5562, or at *fox.tyler@epa.gov*.

cc: Peter Tsirigotis
Richard Wayland
Betsy Shaw
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Appendix B

Distribution

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