On December 20, 2016, the U.S. Environmental Protection Agency (EPA) Administrator signed a final rule entitled, *Revisions to the Guideline on Air Quality Models: Enhancements to the AERMOD Dispersion Modeling System and Incorporation of Approaches to Address Ozone and Fine Particulate Matter,* which provides information concerning EPA-preferred models and other techniques, as well as guidance for their use in predicting ambient concentrations of air pollutants. EPA’s finalized changes enhance the formulation and application of the agency’s AERMOD dispersion model, prescribe modeling techniques for secondarily formed fine particle and ozone pollution for single sources, revise the approach for long-range transport (LRT) assessments, and make various editorial improvements. The rule, referred to hereafter as the 2017 *Guideline*, was published in the *Federal Register* on January 17, 2017, and became effective on May 22, 2017. Air dispersion modeling is an aspect of regulatory permitting exercises that can often become the critical path item; therefore, an understanding of changing modeling requirements is beneficial for modelers and non-modelers alike.
The *Guideline on Air Quality Models* was originally published in 1978 with the goal of maintaining national consistency in air quality analyses for regulatory activities. The 2017 *Guideline* replaces the previous version published in 2005. The 2005 version provided primary guidance to EPA regional offices, state/local environmental regulatory agencies, and air permit applicants for the dispersion modeling component of industrial air quality permitting, State Implementation Plan (SIP) development, and many other applications for the past 11 years. Changes in air quality standards, EPA policy, and available tools in the time since the 2005 version of the *Guideline* was published resulted in the need for the revisions recently finalized.

Most notably, EPA promulgated new 1-hr National Ambient Air Quality Standards (NAAQS) for nitrogen dioxide (NO\textsubscript{2}) and sulfur dioxide (SO\textsubscript{2}) in 2010 that were much more stringent than prior NAAQS for these pollutants. The increased level of stringency meant that some of the straightforward, yet conservative assumptions that had historically been made in regulatory modeling analyses could no longer be made and a more refined approach had to be developed instead.

Additionally, in January 2012, EPA granted a petition submitted on behalf of the Sierra Club that committed EPA to rulemaking to consider whether updates to the *Guideline* were warranted to incorporate new analytical techniques or models to address the formation of ozone and secondary particulate matter in regulatory analyses. EPA began the process of gathering input on revisions to be considered to the *Guideline* at the Tenth Conference on Air Quality Modeling held in March 2012. This process continued through the publication of a proposed rulemaking to revise the *Guideline* in July 2015, public hearing at the Eleventh Conference on Air Quality Modeling held in August 2015, and finally publication of the final rule in January 2017.

**Summary of the 2017 Guideline**

The 2017 *Guideline* is organized with sections providing model overviews, recommendations, and requirements, and sections addressing the use of meteorological data sets, actual versus allowable emissions data, model accuracy, and model options. The following are excerpts and summaries of finalized components of the revised *Guideline*.

**Preface**

The preface retains the discussion on the importance and need for the *Guideline*:

*Industry and control agencies have long expressed a need for consistency in the application of air quality models for regulatory purposes. In the* 1977 Clean Air Act (CAA), Congress mandated such consistency and encouraged the standardization of model applications. The *Guideline on Air Quality Models* (hereafter, *Guideline*) was first published in April 1978 to satisfy these requirements by specifying models and providing guidance for their use. The *Guideline* provides a common basis for estimating the air quality concentrations of criteria pollutants used in assessing control strategies and developing emissions limits.

EPA has been steadfast in its commitment to this mandate and brings to the modeling community this next generation of guidance which seeks to improve model performance, consider new options, and meet the needs of implementing the many forms of the NAAQS.

**Section 1 - Introduction**

This section describes the purpose and applicability of the *Guideline* and remains essentially the same as in the 2005 version of the *Guideline*, but reflecting the reorganized nature of the revised *Guideline*.

**Section 2 – Overview of Model Use**

This section was updated to clarify the modeling process flow and provide consistent definitions of commonly-used terms, such as screening technique, screening model, and refined model. Model performance evaluation is described within the context of accuracy and model uncertainties, as well as the suitability of a model for a particular application.

**Section 3 – Preferred and Alternative Air Quality Models**

This section contains the requirements or “rules of the game” for model use and approvals. Appendix A of the *Guideline* contains a list of “preferred” models, which can be used in dispersion modeling application without further justification. This section also provides the approval criteria for the use of “alternative” models, which are modeling tools developed for specific source types or by private companies. The last portion of Section 3 includes the most substantive change in this section—further codifying the role of the Modeling Clearinghouse in the model approval process, in regulatory interpretation, and in other case-specific modeling issues that may arise.

**Section 4 – Models for Carbon Monoxide, Lead, Sulfur Dioxide, Nitrogen Dioxide, and Primary Particulate Matter**

*Industrial Sources*

This section describes the screening and refined models approved for use to model inert criteria pollutants. The
approved refined model remains AERMOD. AERSCREEN is formally introduced and codified as the industrial source screening model for single sources. A revised “multi-tiered” approach for NO₂ is presented, as follows:

- Tier 1 still assumes that all emitted nitrogen oxides (NOₓ) converts to NO₂.
- Tier 2 (previously known as the Ambient Ratio Method [ARM]) is now replaced with ARM2 in AERMOD, which uses concentration-specific ambient ratios based on nationwide monitoring data, rather than the single, fixed value used previously.
- Tier 3 screening techniques, including OLM and PVMRM2 (PVMRM2 is a revised PVMRM formulation in AERMOD and simply replaces it), which provide a more detailed treatment of NOₓ to NO₂ atmospheric chemistry in the presence of ozone, are now regulatory default options in AERMOD. Therefore, applicants intending to use these techniques no longer require case-by-case approval from EPA, but rather only require minimal additional approval efforts beyond modeling protocol approval.

The section also confirms that AERMOD should be used for primary PM₂.₅ modeling, while secondary impacts are addressed in later sections.

**Mobile Sources, Buoyant Plumes, and Long-Range Transport**

CALINE3 and related models have been replaced by AERMOD as the preferred model for mobile source modeling but EPA recognizes that such modeling can be accomplished in a number of ways and thus, the CALINE models may still be used over the next three years. The Buoyant Line Plume (BLP) model is integrated into AERMOD (BLP is removed from Appendix A). CALPUFF has been removed as the preferred model for long-range transport (LRT) and as an alternative this section discusses use of CALPUFF or other Lagrangian models for LRT screening analysis. EPA now classifies CALPUFF as a “screening technique” and this section allows for the use of other Lagrangian or photochemical models to perform refined LRT analyses. EPA has also clarified that LRT assessments for inert pollutants are no longer required and that Prevention of Significant Deterioration (PSD) increment LRT assessments are only needed in limited situations, as long as there is a near-field assessment conducted for those pollutants as part of the permitting process.

**Section 5 - Ozone and Secondary Particulate Matter**

This section is a revised and expanded subject in the *Guideline* and provides discussion of new techniques to address individual facility impacts on atmospheric ozone and secondary particulate formation. Its inclusion was driven by EPA’s commitment to update the *Guideline* when it granted the Sierra Club’s petition discussed previously. EPA’s suggested approach to address secondary formation involves two tiers. The two-tiered approach consists of a semi-quantitative first-tier process based on historical photochemical modeling data, monitoring data, and other documented information, with one option for implementation of this approach laid out in EPA’s *Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and PM₂.₅ under the PSD Permitting Program.*³ The second tier consists of full photochemical modeling analyses. Anna Henolson and Justin Fickas provide additional details regarding EPA suggested methods for addressing secondary formation in a separate article in this issue.

**Section 6 – Modeling for Air Quality Related Values and Other Governmental Programs**

This section in the *Guideline* addresses visibility modeling and
analysis to determine the impacts on Air Quality Related Values (AQRV). AQRVs can include nitrate and sulfate deposition on surfaces, as well as visibility degradation at Class I areas (i.e., national parks, wildlife refuges, monuments, etc.) in the form of plume blight and extinction coefficients. Section 6 specifically defers to the most current Federal Land Managers (FLM) guidance (FLAG 2010), including the use of CALPUFF, for AQRV analysis, but also goes on to provide guidance on visibility and deposition modeling that emphasizes the use of photochemical models.

Section 7 – General Modeling Considerations
This section is designed to capture specific modeling details that are not otherwise included in the remainder of the document. Much of the basic information in the section was included in the previous version of the Guideline and includes topics, such as dispersion coefficients, complex winds, gravitational settling and deposition, and plume rise formulations.

Section 8 - Model Input Data
This section includes and expands on the previous discussion on use of source input data for the models including the consideration of actual and allowable emissions, regional inventory requirements, and source parameterization. The section also includes an overview of use of background concentrations, tying in all current guidance to reflect both the old NAAQS forms of the deterministic standards, as well as the new probabilistic forms of the new 1-hr SO2 and NO2 standards. The discussion on inventory sources and background concentrations reflect EPA’s intent to discontinue outdated and generally overly conservative approaches that applicants have relied upon in the past. In particular, EPA discusses use of emission rates that better represent actual operating scenarios for nearby sources in permit application NAAQS modeling analyses rather than the traditional method of using potential to emit for all sources in a NAAQS assessment. Finally, EPA has added a discussion of the Mesoscale Model Interface (MMIF) program to the meteorological input requirements section. MMIF processes prognostic weather data (e.g., Mesoscale Model Version 5 [MMS] or Weather Research and Forecasting [WRF] models), into formats compatible with AERMET and AERMOD, allowing for the use of those forecast model outputs in situations where representative National Weather Service (NWS) or onsite data are unavailable.

Section 9 - Regulatory Application of Models
This section remains focused on recommendations on the modeling requirements, development of modeling protocols, use of measured (monitored) air quality data, and emissions limits and their relationship to modeled concentrations. The section also discusses the concept of design concentrations, NAAQS based limits, and PSD increment-based limits.

Appendix A – Summaries of Preferred Air Quality Models
This section provides information on key features of preferred models for regulatory modeling applications. It also contains information on data inputs and outputs, key details on atmospheric physics treatments, and model availability. The 2017 preferred models, which can be used without a formal demonstration of applicability provided Guideline procedures are followed, are AERMOD, CTDMPLUS, and OCD.

Status of Major Proposed Revisions to AERMOD Formulation
In the preamble to the revisions to the Guideline, EPA requested comments on several proposed revisions to AERMOD. Several of these updates, such as incorporation of a buoyant line plume source type and refinements to NOX chemistry screening techniques, were discussed above in Section 4 of the Guideline. The other major proposed revision to AERMOD involves the treatment of turbulence under low wind speed conditions, which are often the conditions under which maximum modeled concentrations occur in regulatory applications. In the 2015 proposed rulemaking, EPA provided justification to make the previous “beta” options ADJ_U* and LOWWIND3 regulatory default options, but only finalized the regulatory default status of ADJ_U* in the January 2017 final rulemaking. A revised version of AERMOD (16216r) and the AERMET (16216) meteorological data pre-processor, incorporating these revised algorithms, was released by EPA in close proximity with the release of the revised Guideline for use by the modeling community.

Summary
This significant revision to EPA’s primary modeling guidance document is intended to formalize current guidance and provide insight and instruction on leading-edge modeling intricacies. Environmental professionals with a focus on air quality assessment will find the publication along with the related technical guidance documents required reading. The publication of this final regulation is by no means the final chapter in the continually evolving world of regulatory air dispersion modeling. EPA is expected to continue to address currently known and future issues impacting dispersion modeling assessments through guidance and additional future rulemaking.

The following three articles in this issue of EM offer further insight into the revised Guideline and current air quality
modeling practices. In the first article, Anna Henolson and Justin Fickas summarize this latest regulation revision and associated guidance documents for assessing secondarily formed pollutants. In the second article, Robert Paine and Jeff Connors consider the differences in the treatment of low wind speed conditions between the proposed and final versions of the Guideline and the implications of these differences for air quality modelers. In the third article, Brian Eder et al. present an overview of EPA’s updated CMAQ_{NRT} Protocol.

Tony Schroeder and Jonathan Hill are both managing consultants, and George Schewe is a principal consultant, all with Trinity Consultants. Tony Schroeder is also a member of EH&S Editorial Advisory Committee. E-mail: tschroeder@trinityconsultants.com.

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