Air Dispersion Modeling Update
Changes to Guideline on Air Quality Models
SO_2 Data Requirements Rule

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I. OVERVIEW

The purpose of this paper is to provide an overview of recent major developments in the field of air dispersion modeling. In particular, this paper will address proposed changes[1] to the Guideline on Air Quality Models[2] (GAQM), along with the latest developments in the Sulfur Dioxide (SO_2) Data Requirements Rule[3] (DRR). The changes proposed to the GAQM are its first modifications in more than ten years, and represent some significant changes in the way some modeling analyses are conducted. The DRR requires States to provide information to the U.S. Environmental Protection Agency (EPA) to assist EPA in determining which areas do and do not attain the 2010 SO_2 National Ambient Air Quality Standard (NAAQS). As a result, States are reaching out to many industrial sources asking them to conduct dispersion modeling of their SO_2 emissions to assist in providing this information to EPA. This paper addresses each of these two recent developments in the air dispersion modeling field.

II. CHANGES TO GUIDELINE ON AIR QUALITY MODELS

On July 29, 2015 EPA proposed revisions the Guideline on Air Quality Models, or GAQM (40 CFR 51 Appendix W), for the first time in more than ten years. These proposed changes included, among other things, significant revisions to AERMOD (the most commonly-applied dispersion model), new procedures for creating meteorological datasets for air dispersion modeling, clarification on modeling procedures for particulate matter smaller than 2.5 microns ($PM_{2.5}$), and the demotion of CALPUFF such that it is no longer an approved long-range transport model.

Following an overview of the GAQM, the proposed changes are described below.

A. Introduction to GAQM

EPA first published the GAQM in April 1978 for the purpose of providing consistency amongst air quality analyses. The GAQM was incorporated by reference in the Prevention of Significant Deterioration (PSD) regulations in June of 1978, and has been updated several times, most recently in 2005.

Shortly after proposing the revisions to GAQM last July, on August 12, 2015, EPA held the 11th Conference on Air Quality Modeling to discuss these proposed changes[4]. EPA's

[1] Federal Register, Vol. 80, No. 145, pp. 45340 - 45387
[2] 40 CFR 51 Appendix W
[3] Federal Register, Vol. 80, No. 162, pp. 51052 - 51088
[4] Proceedings from this Conference, including slides, transcripts, and audio recordings, are available at http://www3.epa.gov/ttn/scram/11thmodconf.htm

revisions were not met without resistance from the modeling community. Coupled with what many perceive to be a lack of clarity in EPA's modeling guidance, there were concerns that modeling analyses and the associated regulatory review will now take longer and be more costly than before.

As of this writing EPA has not published the final rule for these proposed changes. Currently this final rulemaking is expected to occur in the summer of 2016.

B. Revisions to AERMOD

On June 30, 2015, EPA updated the regulatory version of AERMOD to address several bug fixes and introduce some new technical features that are currently "beta" to allow for public testing and evaluation. One of the key changes proposed to AERMOD is the inclusion of a buoyant line source as a new source type. To understand the reason for this change, some background is in order.

In the late 1970s and early 1980s the aluminum industry identified an issue with the performance of the standard air dispersion model used at that time and how it was not able to replicate properly dispersion from the hot (buoyant) emissions from the tops of the long potline buildings found at aluminum reduction plants. Specifically, the model could not handle the buoyant line source (as opposed to buoyant emissions from a point source, which it could handle), nor could it handle the structure downwash issues associated with very long buildings. So, the aluminum industry commissioned for the development of the Buoyant Line and Point Source model (BLP) to address these issues, which ultimately became an accepted model by EPA.

While BLP has not been updated since 1999, EPA has continued to update and improve AERMOD, including taking advantage of the latest National Weather Service (NWS) meteorological data collection techniques. Moreover, with the advent of new ambient air quality standards that were not addressed by BLP (i.e., the 1-hr SO_2, 1-hr Nitrogen Dioxide (NO_2), and 24-hr $PM_{2.5}$ NAAQS), the aluminum industry (and others with long, buoyant sources not well-represented by AERMOD) were left without a current model that suited their needs.

Consequently, in its updated version of AERMOD (15181) EPA has incorporated BLP into AERMOD. This will enable sources previously modeled with BLP to use a model that has the latest dispersion algorithms, that can address the forms of the new NAAQS, and that can use the most up-to-date meteorological data available.

C. New techniques to create meteorological datasets

The proposed revisions to the GAQM call for two significant changes to the way meteorological datasets are created for use in AERMOD. The first is for the use of AERMINUTE to process 1-minute meteorological observations from NWS sites, and the second is for the use of the Mesoscale Model Interface (MMIF) program to create

meteorological datasets for areas in which there are not representative meteorological data available. Each of these changes is addressed below.

1. AERMINUTE

   Beginning in 1991 NWS meteorological observations began transitioning from human-based observations to an Automated Surface Observing System (ASOS). This change in the observation technique led to some challenges in the air dispersion modeling community primarily because ASOS wind speeds tended to be less than observer-based wind speeds and because ASOS data tend to have a preponderance of calm winds, both of which lead to higher predicted concentrations.

   Beginning in 2000 the NWS began archiving 1-minute ASOS wind data. Accordingly, EPA developed the meteorological data preprocessor AERMINUTE in 2011 to process these 1-minute data, taking advantage of the higher resolution wind data and thus addressing the low wind speed issues initially identified with the ASOS data. While AERMINUTE has been used in regulatory dispersion modeling in some situations over the past few years, with these updates to the GAQM EPA is proposing that AERMINUTE be used in most cases when processing 1-minute NWS ASOS wind data.

   In March 2013 EPA published a memorandum entitled "Use of ASOS meteorological data in AERMOD dispersion modeling"[5] that provides guidance on the use of ASOS meteorological data in modeling analyses.

2. MMIF

   One of the key tenets of air dispersion modeling is to use representative meteorological data. In most instances there are NWS data available from a nearby airport that is close enough to be representative. In cases where that is not true, sources often had to explore other options, including the erection of an onsite meteorological tower to gather data for at least a year—thus adding significant time and expense to the modeling analysis.

   For many years prognostic meteorological data—essentially data from weather forecasting programs—have been available for use in some dispersion models (but not AERMOD). These programs take existing meteorological observations from many stations over a large area and, in conjunction with information pertaining to local topography and land use, calculate meteorological conditions over a user-specified modeling domain.

   The Mesoscale Model Interface (MMIF) program was developed to convert prognostic meteorological model output into formats required for direct input into air dispersion models. The second version of MMIF included support for

[5] http://www3.epa.gov/ttn/scram/guidance/clarification/20130308_Met_Data_Clarification.pdf

AERMOD, and with this update to the GAQM EPA is proposing that MMIF be the tool to be implemented when using prognostic meteorological data in AERMOD modeling analyses.

In July 2015 EPA published a document entitled "Guidance on the Use of the Mesoscale Model Interface Program (MMIF) for AERMOD Applications"[6] that provides guidance on using MMIF for AERMOD analyses.

D. Clarification on $PM_{2.5}$ modeling procedures

The modeling of $PM_{2.5}$ has always posed a challenge for the modeling community, because unlike emissions of other pollutants such as SO_2, NO_2, and Carbon Monoxide, $PM_{2.5}$ consists of both a primary (i.e., directly emitted from a source) and a secondary (i.e., the result of a chemical reaction in the atmosphere) component. While there are some models that account for secondary formation of $PM_{2.5}$, AERMOD does not.

On January 4, 2012, the EPA granted a Sierra Club petition submitted on July 28, 2010 that requested EPA initiate rulemaking to establish air quality models for $PM_{2.5}$ (as well as ozone) for use by sources when undergoing PSD review[7]. The revisions to the GAQM include a new chapter on secondarily formed pollutants, thus satisfying EPA's commitment in the petition grant.

The revised GAQM recommends the use of AERMOD to assess primary $PM_{2.5}$ impacts. The procedures for addressing secondary $PM_{2.5}$ impacts is far more complicated, and far less prescribed.

EPA recognizes that assessing secondary $PM_{2.5}$ impacts depends on the nature of the source, its emissions, and the nearby environment. EPA therefore is proposing a two-tiered demonstration approach for assessing secondary $PM_{2.5}$ impacts. First, if available, the applicant should use technically credible, previously existing information concerning relationships between precursor emissions and a source's impacts (e.g., previously conducted modeling). In situations where existing relevant information is not available, the applicant should conduct dispersion modeling.

How that modeling should be conducted is addressed in EPA's May 20, 2014 memorandum entitled "Guidance for $PM_{2.5}$ Permit Modeling."[8] This 144-page guidance document contained the following table which outlines what kinds of analyses EPA recommends based on emissions of $PM_{2.5}$ precursor emissions (NO_x and SO_2) relative to Significant Emission Rates (SERs):

[6] http://www3.epa.gov/ttn/scram/11thmodconf/Draft_MMIF_Guidance.pdf
[7] January 4, 2012 EPA letter, Gina McCarthy to Robert Ukeiley.
http://www3.epa.gov/ttn/scram/10thmodconf/review_material/Sierra_Club_Petition_OAR-11-002-1093.pdf
[8] http://www3.epa.gov/ttn/scram/guidance/guide/Guidance_for_PM25_Permit_Modeling.pdf

Assessment Case	Description	Approach to Addressing Primary or Secondary Impacts	
		Primary	**Secondary**
Case 1: No Air Quality Analysis	Direct $PM_{2.5}$ emissions < 10 tpy SER NO_x and SO_2 emissions < 40 tpy SER	N/A	N/A
Case 2: Primary Air Quality Impacts Only	Direct $PM_{2.5}$ emissions ≥ 10 tpy SER NO_x and SO_2 < 40 tpy SER	Appendix W preferred or approved alternative dispersion model	N/A
Case 3: Primary and Secondary Air Quality Impacts	Direct $PM_{2.5}$ emissions ≥ 10 tpy SER NO_x and/or SO_2 emissions ≥ 40 tpy SER	Appendix W preferred or approved alternative dispersion model	1. Qualitative 2. Hybrid of qualitative/quantitative 3. Full quantitative photochemical grid modeling
Case 4: Secondary Air Quality Impacts Only	Direct $PM_{2.5}$ emissions < 10 tpy SER NO_x and/or SO_2 emissions ≥ 40 tpy SER	N/A	1. Qualitative 2. Hybrid of qualitative/quantitative 3. Full quantitative photochemical grid modeling

In the preamble to the proposed revisions to the GAQM, EPA discusses that, as a follow-up to this table, it intends to introduce a tool called "Model Emission Rates for Precursors" (MERP) which would represent a level of emissions of precursors that is not expected to contribute significantly to concentrations of secondarily-formed $PM_{2.5}$. EPA anticipates that a source with precursor emissions below the MERP level will have ambient impacts small enough such that the MERP would serve as a sufficient demonstration that the source would not cause or contribute to a violation of the $PM_{2.5}$ NAAQS or PSD Increments. EPA intends for the MERP to replace the first-tier "Qualitative" approach presented in the table above.

The modeling community has questioned how EPA will determine the MERP, and has expressed concerns that the lack of the availability of the MERP at this time will cause delays in the preparation of modeling analyses and ultimately the issuance of permits.

EPA has published a memorandum entitled "Proposed Approach for Demonstrating $PM_{2.5}$ PSD Compliance"[9] that provides more details concerning existing guidance pertaining to addressing impacts from secondary $PM_{2.5}$ emissions and how the proposed changes to the GAQM interact with that existing guidance.

E. Demotion of CALPUFF

CALPUFF was recommended by the Interagency Workshop on Air Quality Model Phase 2 report[10] in 1998 as the appropriate model for long-range transport (i.e., distances more

[9] http://www3.epa.gov/ttn/scram/11thmodconf/20150630-PM25_Docket_Memo.pdf
[10] http://www3.epa.gov/scram001/7thconf/calpuff/phase2.pdf

than 50 km), and was adopted by EPA as an approved model in 2003. In addition, CALPUFF was considered on a case-by-case basis for near-field analyses involving complicated topography. CALPUFF has been used throughout the United States for almost all Class I analyses, and is very commonly used throughout the world.

As part of these changes to GAQM EPA is proposing to remove CALPUFF as a preferred model for long-range transport and is recommending it as a screening technique for PSD increment analyses beyond 50 km. The screening technique that EPA suggests is as follows:

- Step 1: use the appropriate near-field model (likely AERMOD) to determine the significance of predicted impacts at a distance of 50 km from the source
- Step 2: consult with EPA Regional Office to determine a screening approach using CALPUFF or another model to address the significance of predicted impacts at Class I areas of concern
- Step 3: conduct full cumulative impact assessments as necessary, selecting an alternative model per Section 3.2.2(e) of GAQM.

When explaining its rationale for demoting CALPUFF EPA claims that it has issue with the "management" of CALPUFF. CALPUFF is somewhat unique in the regulatory modeling world in that it was not developed, nor has it been maintained, by EPA. Rather, CALPUFF was developed in the private sector and has always been provided to EPA at no cost. Moreover, the private sector has updated CALPUFF throughout the years, both for bug fixes and enhancements.

That EPA does not have control over CALPUFF, plus the fact that the ownership of the model has changed companies several times over the past few years, has caused EPA to adopt the position that the regulatory use of CALPUFF has been "unduly complicated."[11]

The demotion of CALPUFF is perhaps the most controversial of the proposed changes to the GAQM, and has been met with widespread resistance from the modeling community, both in the United States and abroad. Many believe that removing CALPUFF as a preferred model for long-range transport and instead using a screening technique that involves coordination with the EPA regional office on the choice of an appropriate model will unnecessarily complicate and delay modeling efforts. There are also many in the modeling community that believe CALPUFF is a superior model from a technical standpoint in many instances, and that CALPUFF is being demoted mostly for political purposes.

Ultimately, the modeling community is concerned that EPA choosing not to have a recommended long-range transport model will only complicate modeling efforts (adding time and cost to the permitting process), and could lead to over-prediction of concentrations if a model not appropriate for long-range transport (e.g., AERMOD) is used.

[11] http://www3.epa.gov/ttn/scram/11thmodconf/presentations/1-11_11thMC_LRT.pdf

III. SO_2 DATA REQUIREMENTS RULE

On September 21, 2015 EPA published a final Sulfur Dioxide (SO_2) Data Requirements Rule (DRR) which requires States and other air agencies (for the purposes of this article, "States") to gather and submit information to EPA to help inform attainment determinations pertaining to the 2010 SO_2 National Ambient Air Quality Standard (NAAQS). The DRR has the potential to have substantial impacts on industries with significant SO_2 emissions. This article summarizes the DRR and provides insight into how the Pennsylvania Department of Environmental Protection (PADEP) is administering this rule.

A. DRR Overview

Attainment determinations for other pollutants rely on ambient air quality monitoring data. In the case of the 2010 SO_2 NAAQS, EPA is allowing the use of air quality modeling to determine the attainment status. Because most States do not have the resources necessary to comply with the DRR, often they are reaching out to industrial sources to obtain their assistance in compiling the required information. States must inform EPA by July 1, 2016, of the approach they plan to use to determine the SO_2 attainment status for all sources applicable to the DRR.

B. DRR Applicability

The DRR applies to sources with actual emissions of 2000 tons per year (tpy) or greater during the most recent year for which emissions data are available. States have the option of including additional sources based on more stringent thresholds. For instance, PADEP has developed the following additional applicability criteria:

- Clusters of facilities with cumulative 2014 actual emissions greater than or equal to 2000 tpy
- Facilities with 2014 actual emissions greater than or equal to 500 tpy that are located within 5 km of an environmental justice community

Each state was required to submit a list of their targeted sources to EPA by January 15, 2016. PADEP met that deadline, and then sent letters to sources identified as being subject to the DRR in late January. In February and March the PADEP met individually with subject sources to discuss how they would prefer to meet the DRR.

C. Courses of Action Available to Industries Subject to DRR

For each industry identified as subject to the DRR a State has the following three options as to how to provide information to EPA to inform the 2010 SO_2 NAAQS determination, each of which is described below.

1. Monitoring Option

A source subject to the DRR may choose to conduct air quality monitoring to provide the State with the necessary information for inclusion in the State's submission to EPA. In December 2013 EPA provided the SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistance Document[12] to provide guidance on how to conduct this monitoring. The monitoring station or stations (multiple stations may be required) must be part of the State and Local Air Monitoring Stations network, and must meet various criteria presented in 40 CFR 58 including data certification and reporting requirements, and must be operational by January 1, 2017. The monitoring data will be used to calculate an SO_2 design value based on data collected during the three-year period from 2017 – 2019.

PADEP is encouraging sources to not use the monitoring option to satisfy the DRR because there is not sufficient time to site, purchase, and install a monitoring station prior to January 2017.

2. Permit Limit Option

A source subject to the DRR may choose to accept a permit restriction limiting their SO_2 emissions to less than 2000 tpy. The permit limit must be federally enforceable, and must be in effect by January 13, 2017.

At the time of this writing it is not clear what emission rate would be necessary for a "cluster" source in Pennsylvania to accept as a permit limit to satisfy the DRR.

3. Modeling Option

A source subject to the DRR may choose to conduct air quality modeling to provide the State with the necessary information for inclusion in the State's submission to EPA. The DRR puts forth a somewhat aggressive schedule for these modeling analyses, requiring sources to submit Modeling Protocols to States by July 1, 2016 and for States to submit the final modeling analyses to EPA by January 13, 2017.

This modeling analysis is different from modeling analyses typically conducted as part of traditional permitting efforts (e.g., PSD). In December 2013 EPA provided the SO_2 NAAQS Designations Modeling Technical Assistance Document[13] to provide guidance on how to conduct this modeling analysis. The most substantial difference between the DRR modeling and traditional modeling is that, rather than using allowable emissions, the DRR modeling may use actual emissions over the most recent three years of operation.

It is important to note that once attainment has been demonstrated through modeling, the State may have to continue to demonstrate to EPA that the region remains in attainment. For instance, if actual emissions are used to show attainment the State will have to provide a report to EPA by July 1 of every year with a report of actual

[12] http://www3.epa.gov/airquality/sulfurdioxide/pdfs/SO2MonitoringTAD.pdf
[13] http://www3.epa.gov/airquality/sulfurdioxide/pdfs/SO2ModelingTAD.pdf

emissions from latest year, reasons for any increases in emissions relative to the previous year, and the State's recommendations as to whether or not additional modeling is warranted to confirm the attainment status. Although the decision to require additional modeling is on a case-by-case basis, EPA's guidance states that modeling should be conducted if the previous analysis showed a design concentration greater than or equal to 90% of the NAAQS, or if the previous modeling showed a design concentration between 50% and 90% of the NAAQS and emissions for that year have increased by 15% or more. EPA guidance also suggests that future modeling would not be required if the modeled design concentration is less than 50% of the NAAQS. If additional modeling is required, it would be due to EPA within 18 months from the end of a given calendar year.

IV. CONCLUSIONS

The field of air dispersion modeling is constantly changing as the state of the science and regulatory environment evolves. The recent changes to the GAQM as well as the SO_2 DRR reflect both of these concepts.

With the changes to the GAQM, future regulatory modeling analyses will very likely be conducted differently than in the past, sometimes in a subtle way (e.g., a different technique to create a meteorological dataset) and sometimes in a more obvious manner (e.g., no longer having CALPUFF as a regulatory-approved short-range dispersion model). There are significant concerns that the changes to the GAQM will add time and expense to the permitting process.

The SO_2 DRR represents a new type of dispersion modeling, one that is conducted as a surrogate for ambient monitoring data. Responsibilities for this modeling will likely fall to industry during 2016 as well as potentially in the future, which represents another burden on the regulated community.