Permitting Challenges With $PM_{2.5}$, Ozone, NO_2 and SO_2 Air Quality Standards

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More Information

We are advising our clients about the best ways to plan for compliance with the $PM_{2.5}$, ozone, NO_2, and SO_2 NAAQS.

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Key References

U.S. EPA's web site on National Ambient Air Quality Standards:
http://www.epa.gov/ttn/naaqs/

U.S. EPA's web site on dispersion modeling guidance:
http://www.epa.gov/scram

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Overview

U.S. EPA's revisions in recent years to National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$, SO_2, NO_2, and ozone and new EPA modeling requirements introduce implementation challenges regarding the application of dispersion models to assess compliance. Given that these NAAQS are lower than ever before, the customary degree of overestimation that is intentionally designed into EPA's modeling procedures is likely to limit the ability of regulators and applicants to conduct accurate and unbiased air quality compliance assessments. Due to the shrinking margin of compliance associated with these stricter standards, the skill of regulatory models such as AERMOD is being more severely tested, and refined methods for modeling and accounting for background concentrations are needed. This will be a principal area of focus for the implementation of EPA updates in the 2020 decade to guideline modeling procedures that were released in December 2016.

The promulgation of $PM_{2.5}$ Prevention of Significant Deterioration (PSD) increments and a lower annual $PM_{2.5}$ NAAQS as well as the probabilistic 1-hour NAAQS for SO_2 and NO_2 raise a number of model implementation issues and challenges to successful permitting. EPA's response to the Sierra Club petition to provide new modeling tools to predict single-source ozone and secondary $PM_{2.5}$ concentrations is also a significant challenge for permitting. AECOM has been at the forefront of these issues with its involvement in reviews on behalf of industry trade groups during the NAAQS rule development, its work with the "NAAQS Implementation Coalition" group, and its development of new, innovative modeling tools. AECOM has worked with EPA and the States to introduce modeling refinements discussed below that are likely to reduce model overprediction to the extent possible in addressing the new standards.

Strategies for Successful Dispersion Modeling Results

For the criteria pollutants noted above (SO_2, NO_2, ozone, and $PM_{2.5}$), the new standards are very restrictive, which places more importance on several aspects of the modeling process:

- Emissions characterization, especially for intermittent cases of high emission rates.
- Source characterization techniques to account for industrial heat releases, adjacent stacks in a line, or excess moisture in plumes.

- Use of optimal meteorological data input.
- For SO_2, NO_2, and primary $PM_{2.5}$, use of advanced AERMOD model technical features, including low wind speed options and consideration of industrial heat sources for urban-like local dispersion and liftoff effects that mitigate building downwash effects.
- For secondary $PM_{2.5}$ and ozone, EPA guidance references use of photochemical grid models (e.g., CAM_x) or advanced Lagrangian models such as SCICHEM for a refined Tier 2 analysis if the precursor emission rates are above the Model Emission Rates for Precursors. (MERPs). However, existing modeling information can be used in a screening (Tier 1) analysis even if emissions are above the MERPs, and EPA has changed its approach to favor this simpler approach.
- Selection of limited additional sources to include in AERMOD modeling, and use of "typical actual" emissions for modeling impact from background sources, even those unaffected sources at the facility being modified.
- Selection of unbiased regional background concentrations for AERMOD modeling.

These issues are discussed in more detail below.

The emission rate input to modeling is a key consideration because predicted concentrations are linearly proportional to the emission rate. As the averaging time for the NAAQS gets shorter, it becomes necessary to account for the effect of averaging time on the emission input and to deal with short-term, intermittent peak emission rates. In some cases, an argument can be made that certain rare emission cases are too infrequent to threaten the NAAQS, and they do not need to be modeled. In other cases, a way to deal with more frequent, but still intermittent high emissions for a 1-hour NAAQS, is to determine a complying 1-hour emission limit (which can be referred to as the "critical value"), but adopt a lower longer-term emission limit (e.g., a rolling 30-day average) if a demonstration can be made that this longer-term average still protects the 1-hour NAAQS.

A rigorous and effective approach for modeling infrequent emission peaks involves a blend of an EPA procedure that employs 100 simulated years of "randomly reassigned emissions" (RRE) and the Emissions Variability Processor (EMVAP) tool developed by AECOM for the Electric Power Research Institute (EPRI), referred to as the Emissions Variability Processor, or EMVAP. The RRE approach that blends EMVAP tools accounts for emission distributions comprised of discrete emission cases, each with a probability of occurrence. It also creates emission "events" (some with very high, intermittent emissions) that are tailored in their frequency, duration, and sequence of emission rates to the specific emission source. Modeling is then done for 100 simulated emission years that include these emission events, and the results are averaged over 5 years of meteorological data and then tested against the NAAQS. If all 100 sets of 5-year averages show NAAQS compliance, then the RRE approach is a rigorous modeling confirmation that the proposed emissions distribution shows NAAQS compliance.

Many modeling applications involve sources that act to modify the local dispersion environment as well as the conditions associated with plume buoyancy and final plume rise. The source characterizations affecting plume rise that have been proposed to EPA by AECOM include: 1) sources with large fugitive heat releases that result in a local urbanized effect, 2) stacks on or near individual buildings with large fugitive heat releases that tend to result in buoyant "liftoff" effects counteracting aerodynamic downwash effects, 3) stacks with considerable moisture content, which leads to additional heat of condensation during plume rise - an effect that is not considered by most dispersion models, and 4) stacks in a line that result in at least partial plume merging and buoyancy enhancement under certain conditions.

The use of optimal meteorological data could involve having multiple levels of wind, temperature, and turbulence data input to AERMOD. Many studies conducted by AECOM scientists have confirmed that without these multiple-height measurements, AERMOD is likely to assume restrictive dispersion and plume rise conditions, which usually lead to model overpredictions. In some cases, it may be advisable to invest in the gathering of new meteorological data to optimize modeling results. In other cases, the use of prognostic meteorological data could be beneficial.

AECOM is well aware of advanced AERMOD modeling features that can result in more accurate concentration predictions. We have been leading the effort to implement improved handling of low wind speed conditions in AERMOD, and recent EPA model releases have useful features in this regard that can be helpful in modeling all pollutants. Other new features such as the advanced Tier 2 "ambient ratio method 2" (ARM2) and updates to the Tier 3

Plume Volume Molar Ratio Method (PVMRM) are useful for modeling NO_2 concentrations.

EPA's requirement to consider secondary particulate formation from SO_2 and NO_x precursor emissions presents an additional challenge. AECOM is familiar with the available Lagrangian models (e.g., SCICHEM) or Eulerian photochemical models (e.g., CAM_x) that EPA is promoting for these modeling assessments. In many cases, however, the proposed project emissions are below the above-mentioned MERPs, which will provide the proposed project with a waiver of modeling requirements. In other cases, if emissions are not far above the MERPs and the existing concentrations (of ozone or $PM_{2.5}$) are below the NAAQS, then a Tier 1 scaling analysis can be done with existing modeling tools.

One aspect of modeling total concentration impacts is the consideration of other (background) source impacts. Some nearby emission sources need to be included in the modeling because their proximity causes differential concentration impacts over the area of interest, while more distant sources cause a more uniform impact and can be accounted for with the addition of a "regional" background component. Since these components are sometimes accounted for in duplicate fashion (since monitored concentrations also include impacts from sources separately modeled), it is important to limit the number of sources that are explicitly modeled and to use a relatively unbiased procedure to account for regional background.

The following considerations for handling the background component will result in the least overprediction tendency:

- Try to restrict sources to be explicitly modeled to those within about 10-20 km of the source of interest;
- Use a "Tier 2" regional background approach, which considers a season and hour-of–day lookup table, or a direction-specific lookup table; and
- Propose to use "typical actual" instead of potential emissions for sources not being changed as part of the permitting effort.

In some cases, site-specific modeling applications can provide needed relief from model overpredictions. Such applications need to have some monitoring data to provide information about the degree of model overprediction.

AECOM has extensive experience in assessing the nature of high modeled predictions and in determining how targeted monitoring studies could help to assess whether a site-specific model development task is warranted. Exploratory monitoring can also be used in this regard. Such monitoring can possibly be done with portable or temporary sensors, including passive samplers.

AECOM Support

AECOM's global environmental practice provides the complete range of air quality services needed to help New Source Review applicants to successfully obtain a PSD permit. Our 160 U.S. air quality staff has a combined

experience of 1,200 years and includes nationally recognized credentialed experts to provide emissions characterization, control technology analysis/conceptual design, impact assessment, risk assessment, strategic regulatory consulting and permitting, emissions testing and ambient monitoring. Working collaboratively from 70 offices, we ensure that the best available nationwide resources are available to serve specific client needs.

AECOM's experience with short-range (< 50 km) modeling includes a diversity of emission sources, including tall stacks, cooling towers, building vents, tank farms, landfills, fugitive dust and indirect transportation sources. We have performed numerous air quality research and development programs for industry associations, joint government consortiums, state agencies, national labs and private industrial clients.

AECOM scientists have assisted in the development and evaluation the state-of-the-art models that U.S. EPA has adopted as part of the Guideline on Air Quality Models. Even in advance of formal promulgation of the Guideline, we have applied these models in a regulatory context to more accurately evaluate compliance with ambient air quality standards. For example, AECOM scientists have participated in the development of AERMOD, U.S. EPA's currently approved dispersion model for short-to medium range applications. We have also developed innovative models for facilities located in unique dispersion environments where standard models are inaccurate.

By applying better science to determine more accurate compliance measures, AECOM has saved our clients millions of dollars in unnecessary compliance costs.

Companies turn to AECOM whenever standard modeling approaches overstate impacts or more refined methods are needed.