The U.S. Environmental Protection Agency (EPA) recently added an entirely new section to the *Guideline on Air Quality Models—Appendix W*—and associated guidance documents addressing methods to assess secondarily formed pollutants, ozone and secondary fine particulate matter. The importance of EPA issuing an update to the *Appendix W* regulation rather than issuing guidance through technical guidance documents and memoranda cannot be understated: the *Appendix W Guideline* is legally binding, infrequently updated, and takes precedent over any other conflicting guidance. This article summarizes this latest regulation revision and associated guidance documents for assessing secondarily formed pollutants.
How Did We Get Here?
Completing a compliant air dispersion modeling evaluation can be a risky proposition these days. At one time, for Prevention of Significant Deterioration (PSD)-level permitting, the Best Available Control Technology (BACT) analysis was the primary driver for permit limits and timelines and the focus of concern for industrial facilities. Historically, air dispersion modeling was much less of a concern for air permitting purposes. However, over time, and especially with the promulgation of the 1-hr average National Ambient Air Quality Standards (NAAQS) for nitrogen dioxide (NO₂) and sulfur dioxide (SO₂) in 2010, and promulgation of tightened fine particulate matter (PM₂.₅) NAAQS in 2006 and 2012, in conjunction with updated air dispersion models and guidance, compliant modeling demonstrations have become much more challenging. Project scopes at industrial facilities are now regularly altered to avoid dispersion modeling entirely (i.e., by reducing the scope of the project, addition of emission controls, etc.); or to define the project emission increases based on achieving model results below the applicable Significant Impact Levels (SILs) for the pollutants evaluated, in order to avoid full impact NAAQS modeling.

Now, there are two more challenges to consider: the requirements to assess secondary PM₂.₅ and ozone (O₃). Secondary PM₂.₅ is formed when precursor compounds (e.g., SO₂ and oxides of nitrogen, NOₓ) react atmospherically to form very fine particulate compounds, such as ammonium sulfate and ammonium nitrate. Volatile organic compounds (VOCs) and ammonia can also react to form secondary PM₂.₅; however, the Guideline and associated guidance focuses on SO₂ and NOₓ as precursors, because the EPA rules do not require regulation of VOCs (or ammonia) as precursors to PM₂.₅ for the PSD program. These secondary PM₂.₅ compounds are measured by ambient PM₂.₅ monitoring networks, and can contribute significantly (depending on the season and area of the country) to ambient monitored PM₂.₅. If secondary PM₂.₅ is so important, then why hasn’t it been considered historically on a wide scale as part of permit modeling assessments? Simply put, the EPA-approved model for near-field dispersion modeling assessments (AERMOD) is not capable of simulating the atmospheric reactions necessary to accurately predict secondary PM₂.₅ concentrations.

The same can be said regarding single-source impacts of O₃. Assessment of O₃ impacts from a single source can be very difficult, because the atmospheric chemistries involved in the formation of ground-level O₃ can be complex, requiring large regional-scale-type models (i.e., CMAQ/CAMx) that have not been historically utilized in permit modeling assessments.

In 2012, EPA granted a petition by the Sierra Club to “engage in rulemaking to evaluate updates to Appendix W and, as appropriate, incorporate new analytical techniques or models for O₃ and secondary PM₂.₅.”

Appendix W
The much anticipated revisions to Appendix W proposed in July 2015 and finalized in January 2017 technically did include analytical techniques for O₃ and PM₂.₅; however, the rule was extremely short on detail. EPA’s reasoning for omission of detailed guidance from Appendix W—that the details are better issued in technical guidance documents, which allow more flexibility to update guidance in step with updating science and technology—was reasonable; however, the delay in issuing a draft document containing most of the associated detailed guidance until December 2016 (17 months later), left the dispersion modeling community in limbo. Even now that the promised detailed technical guidance has been issued and the final Appendix W rule published, much uncertainty remains as to the precise modeling methods or assessment techniques that will be accepted by the reviewing authorities.

While short on detail, the proposed and final Appendix W revisions did include notable content in the brand new Section 5.0, “Models for Ozone and Secondarily Formed Particulate Matter”. The following list summarizes the key points in Section 5.0.

1. **Recommends a two-tier approach.**
   - Tier 1—consists of using existing technically credible and appropriate relationships between emissions and impacts developed from previous modeling that is deemed sufficient for evaluating a source's impacts.
   - Includes Modeling Emissions Rates for Precursors (MERPs) as a Tier 1 technique. MERPs are defined by EPA as representing “a level of emissions of precursors that is not expected to contribute significantly to concentrations of O₃ or secondarily formed PM₂.₅.”
   - Note that the draft rule (preamble) initially described applying the MERPs as an initial step prior to Tier 1 techniques, and the final rule (preamble) characterized use of MERPs as one type of Tier 1 assessment technique.
   - Tier 2—consists of more sophisticated case-specific modeling analyses.
     - While EPA does not list a preferred model, these more sophisticated analyses are expected to be conducted using some type of photochemical model grid model such as CAMx or CMAQ, or possibly a Lagrangian model such as SCIPUFF or CALPUFF.
2. Does not include the term MERPs anywhere in the rule text of Appendix W itself (however, MERPs are discussed extensively in the preamble).
3. Does not include a preferred model or technique in order to offer flexibility.
4. Emphasizes use of chemical transport models (Tier 2) only for a handful of situations.
5. Reiterates the importance of consulting with the reviewing authority and submitting a detailed modeling protocol.

   - This consultation needs to take place early, including as part of the decision of the appropriate tier for a given application.

Case-by-case decisions are stressed heavily throughout Section 5.0, potentially leading to inconsistency. This inconsistency would be in direct contrast to the theme throughout the guideline and the preamble, which points out that many of the recommendations are made in order to promote consistency.

**MERPs Guidance**

EPA initially planned to establish MERPs through rulemaking on a national level as described in the preamble of the July 2015 proposed Appendix W rulemaking. Instead, EPA issued a draft technical guidance document in December 2016, 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. The draft December 2016 MERPs guidance document provides initial answers to some of these questions, but many uncertainties remain.

When first introduced, the concept of the MERPs to define a level of emissions of precursors that is not expected to contribute significantly to concentrations of O₃ or secondary PM₂.₅ (and thus not require further assessment), offered the potential of a streamlined pathway to navigate through the complex issues involved in assessing secondarily formed pollutants. However, in July 2015 when EPA introduced the concept, many questions were left unanswered, including: what the MERPs levels may be, how the MERPs would be defined, and how the MERPs would be implemented.

The draft December 2016 MERPs guidance document provides initial answers to some of these questions, but many uncertainties remain. In the guidance, EPA has provided a framework for applicants or states to develop regional MERPs and has included several examples based on photochemical modeling conducted by EPA. These EPA examples are summarized in the document by listing the most conservative MERPs by region (Western, Central, and Eastern):

- 126 tons per year (tpy) – 184 tpy NOₓ for O₃;
- 948 – 1049 tpy VOCs for O₃;
- 1,075 – 2,295 tpy NOₓ for PM₂.₅; and
- 210 – 628 tpy SO₂ for PM₂.₅.

However, definitive statements clarifying how or whether the examples may be used directly are absent from the guidance.

**December 2016 EPA Guidance**

In December 2016, EPA issued a new finalized guidance document titled, Guidance on the Use of Models for Assessing the Impacts of Emissions from Single Sources on the Secondarily Formed Pollutants: Ozone and PM₂.₅. This guidance focuses heavily on the Tier 2 methodologies for direct modeling of secondary PM₂.₅ and O₃, through discussions of the types of modeling systems that could be used for executing such modeling, necessary inputs and methodologies for conducting such modeling, and so forth. Tier 2 modeling would be a very difficult prospect for many industrial facilities and permitting authorities, because the complex photochemical models require substantially more computational resources and expertise. Such a modeling exercise would require consultation with both the EPA regional office, and the EPA model clearinghouse. Additionally, many permitting agencies do not have
the capability themselves of conducting such modeling.

The 2016 guidance document also includes a helpful discussion on potential methodologies for a Tier 1 assessment of single-source impacts on secondary PM$_{2.5}$ and O$_3$, which complements the Tier 1 modeling methodology discussions within the draft MERPs guidance document.

**Conclusion**

While Appendix W addresses secondary PM$_{2.5}$ and O$_3$ modeled impacts, it provides limited detail and simply points to published guidance documentation for implementation of such modeling. Much of the guidance regarding modeling of secondary PM$_{2.5}$ and O$_3$ stresses the case-by-case nature of such modeling, attempting to provide leeway to applicants and permitting authorities in how such evaluations would be conducted. However, this will potentially lead to differences in how different permitting authorities wish to address such modeling, breeding inconsistency. Single-source modeling of secondary PM$_{2.5}$ and O$_3$ is still a developing issue; how Appendix W and its accompanying guidance will be implemented and the precedents set over the next months and years may influence the secondary pollutant assessment procedures for decades.

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**References**


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