



Dynamic Resources for Environmental Solutions

Modeling Issues with the New National Ambient Air Quality Standards

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Overview

- What are the National Ambient Air Quality Standards? (NAAQS)
- SIP vs NSR
- What is modeling and how does it fit in?

Overview (continued)

- General Modeling Process
 - NO₂
 - SO₂
- Pre-2010 NAAQS
- New 2010 NAAQS
- Issues

NAAQS

- What is a National Ambient Air Quality Standard (NAAQS)?
 - Health- and welfare-based air concentration standard set by US EPA
 - 6 criteria pollutants
 - Various averaging periods

NAAQS

- Are set for 6 criteria pollutants:
 - Carbon monoxide (CO)
 - Lead (Pb)
 - Particulate matter (PM_{2.5})
 - Sulfur dioxide (SO₂)
 - Nitrogen dioxide (NO₂)
 - Ozone (O₃)

NAAQS

Pollutant	Averaging periods			
CO	1-hour	8-hour		
Pb	Quarterly			
PM _{2.5}	24-hour	Annual		
SO ₂	1-hour	3-hour	24-hour	Annual
NO ₂	1-hour	Annual		
O ₃	8-hour			

SIP

- State Implementation Plan (SIP) submitted by each State to EPA
 - Describes how the State will comply with all EPA Clean Air Act rules and regulations, including each NAAQS
 - Attainment vs nonattainment status for every part of State for each criteria pollutant NAAQS
 - For nonattainment areas, State must revise SIP to show how it will meet NAAQS

NSR

- New Source Review (NSR) permitting required for major and minor new sources of pollutants (criteria and non-criteria).
 - In Texas, NSR-required authorizations range from small increases that use a Permit-by-Rule to Standard Permits to minor source construction permits to federal Prevention of Significant Deterioration (PSD) permits.

NSR

- Pre-construction NSR and PSD permits require demonstration of compliance with all applicable rules, including NAAQS
 - Must show that the proposed emissions will not cause or contribute to a violation of the NAAQS:
 - **TCEQ §116.161. Source Located in an Attainment Area with a Greater than De Minimis Impact.** [TCEQ] may not issue a permit to any new major stationary source or major modification located in an area designated as attainment or unclassifiable...if ambient air impacts from the proposed source would cause or contribute to a violation of any NAAQS...

NSR

- So, how do I demonstrate compliance in meeting the NAAQS in my permit application?
 - Air dispersion modeling!

Dispersion Modeling

- A dispersion model is collection of algorithms, usually computerized, that simulate the transport and diffusion (and sometimes chemical transformation) of contaminants emitted into the air. Input data includes source information (e.g., emission rate, release height) and meteorological variables (e.g. wind speed and direction). Outputs are ground level concentrations.

Dispersion Modeling

- Because of complexity of process, EPA and TCEQ have developed modeling guidance documents:
 - EPA: Guideline on Air Quality Models (GAQM) and New Source Review Workshop Manual (“puzzle book”)
 - TCEQ: Air Quality Modeling Guidelines (RG-25) (currently under revision)
 - Periodic guidance memos from both agencies

Dispersion Modeling

- US EPA's AERMOD model (version 09292)
 - Handles concentration and deposition
 - Sequential hourly meteorological data
 - Point, area, volume, open pit sources
 - Building downwash (PRIME)
 - Flat, simple and complex terrain
- New AERMOD due very soon!

Modeling Process

- For criteria pollutant NAAQS modeling, a 2-step is used:
 - Preliminary impact: do my proposed sources make a significant impact upon ambient air quality? (SIL)
 - Full impact: if so, I must combine my proposed sources with all other existing background sources.
- Codified in EPA GAQM and TCEQ AQMG

Modeling Process

- Preliminary impact and cause or contribute to:
 - Significant impact level (SIL) or de minimis impact levels
 - Annual NO_2 – $1 \mu\text{g}/\text{m}^3$
 - 3-hour SO_2 – $25 \mu\text{g}/\text{m}^3$
 - 24-hour SO_2 – $5 \mu\text{g}/\text{m}^3$
 - Annual SO_2 – $1 \mu\text{g}/\text{m}^3$

Back to the NAAQS

- Pre-2010 NO₂ and SO₂ NAAQS:
 - NO₂ – 1 averaging period:
 - Annual – 100 µg/m³
 - SO₂ – 3 averaging periods:
 - 3-hour – 1,300 µg/m³
 - 24-hour – 365 µg/m³
 - Annual – 80 µg/m³

2010 NO₂ & SO₂ NAAQS

- EPA adopted a new 1-hour NO₂ National Ambient Air Quality Standard (NAAQS) on January 22, 2010, which became effective April 12, 2010
- EPA adopted a new 1-hour SO₂ NAAQS on June 2, 2010, which became effective August 23, 2010.
- The new NO₂ NAAQS is in addition to the existing annual NO₂ NAAQS, while the 1-hour SO₂ NAAQS replaces the existing 24-hour and annual SO₂ NAAQS. The existing 3-hour SO₂ NAAQS remains.

2010 NO₂ NAAQS

- “3-year average of the 98th-percentile of the annual distribution of daily maximum 1-hour concentrations”
- For full impact modeling, calculated at each receptor, then highest of these values is the “design value”, which is compared to level of standard.
- Level of standard is 100 ppb (188 µg/m³)

2010 SO₂ NAAQS

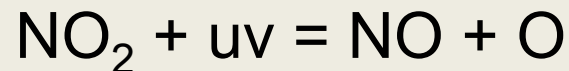
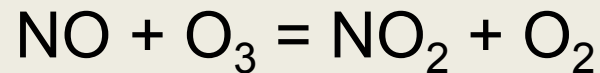
- “3-year average of the 99th percentile of the annual distribution of daily maximum 1-hour average concentrations”
- For full impact modeling, calculated at each receptor, then highest of these values is the “design value”, which is compared to level of standard.
- Level of standard is 75 ppb (195 µg/m³)

2010 NO₂ & SO₂ NAAQS

- Recapping, the new 1-hour standards base compliance demonstrations (via modeling) on new forms:
 - 1-hour NO₂ NAAQS - 98th percentile of the annual distribution of daily maximum 1-hour concentrations
 - 1-hour SO₂ NAAQS - 99th percentile of the annual distribution of daily maximum 1-hour concentrations
- However, AERMOD (v09292) does not provide 98th or 99th percentiles.

NO₂ Modeling

- Complicated by nature of NO₂ modeling:
 - Emission rates in terms of total oxides of nitrogen (NO_x), but standard is NO₂ and a function of atmospheric photochemistry:



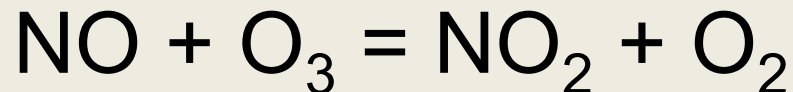
- EPA's 1-hour NO₂ modeling guidance makes use of the previously-acceptable 3-Tiered approach (from GAQM).

NO₂ Modeling

- EPA's 3-Tiered approach for 1-hour NO₂:
 - Tier I - Total conversion – all NO_x = NO₂
 - Tier II – Default NO₂/NO_x ratio of 0.75
 - Tier III – Case by case detailed screening methods, such as Ozone Limiting Method (OLM) and Plume Volume Molar Ratio Method (PVMRM). These are also currently considered non-regulatory default options and require approval by Regional Office.

NO₂ Modeling

- Tier III – OLM and PVMRM
 - Pollutant must be named NO2
 - Uses in-stack NO₂/NO_x ratio (both methods)
 - Uses equilibrium ratio (PVMRM)
 - Uses ozone data, either a constant background value and/or hourly ozone data to convert NO to NO₂:



NO₂ Modeling

- June 29, 2010 EPA guidance memo also includes interim Significant Impact Level (SIL) of 4 ppb (7.5 µg/m³)
- Compare to:
 - Highest of 5-year averages of max 1-hour concentrations at each receptor or
 - Highest modeled 1-hour max across all receptors for 1 year of on-site met or highest of multiyear averages of max 1-hour concentrations for each year at each receptor for 2 – 5 complete years of on-site data.

NO₂ Modeling

- Since AERMOD does not automatically generate the form of the 1-hour NO₂ design concentration (98th percentile), the modeler must post process the raw results.
- 2 options:
 - Use spreadsheet (e.g. Excel) to filter out the correct values or
 - Use a dedicated post-processor

SO₂ Modeling

- The new 1-hour SO₂ standard took effect yesterday. (August 23, 2010)
- Currently, no specific modeling guidance released by EPA.
- TCEQ interim guidance released August 4, 2010.
- TCEQ-suggested 1-hour SIL of 7.8 µg/m³

SO₂ Modeling

- Same post-processing issue applies to new SO₂ NAAQS:
 - Use spreadsheet (e.g. Excel) to filter out the correct values or
 - Use a dedicated post-processor

Issues

- Current version of AERMOD (09292) does not provide concentrations that can be compared to form of either new NAAQS
- Post-processing the raw model output means saving concentrations for every hour for every receptor. (POSTFILE)
- POSTFILE is ~ 1MB per each receptor in run. E.g. 1000 receptors = 1GB

Issues

- The new NAAQS are much more restrictive
 - Harder to demonstrate compliance, meaning more modeling iterations
 - May have source design issues

Issues

- Restrictiveness of new standards
- Using EPA's 1-hour to annual conversion factor of 0.08:
 - For NO₂, $188 \mu\text{g}/\text{m}^3 * 0.08 = 15.04$
 - Annual NO₂ standard = $100 \mu\text{g}/\text{m}^3$ (6.7 X)
 - For SO₂, $195 \mu\text{g}/\text{m}^3 * 0.08 = 15.60$
 - Former annual SO₂ standard = $80 \mu\text{g}/\text{m}^3$ (5.13 X)

Issues

- Source design issues:
 - Reduce proposed emissions via operating restrictions or additional control
 - May have to raise stack height (Good Engineering Practice (GEP))
 - May see effect of existing on- and off-property sources – non-project related “off-sets”

Issues

- Need to show that the proposed source does not exceed SIL at a receptor AND an hour where the new NAAQS is predicted to be exceeded (TCEQ §116.161) for all receptors and all hours (8760 hours in year)
- More modeling time needed per project

Finally

- Stay tuned for:
 - New version of AERMOD
 - Interim EPA SO₂ modeling guidance
 - Final EPA NO₂ and SO₂ modeling guidance
 - Revised TCEQ AQMG
 - NO₂ and SO₂ attainment designations and SIP revisions

Questions?

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