Summary of AERMOD Implementation Workgroup (AIWG) Case Studies for 1-hour NO₂ and SO₂ NAAQS

In 2011, EPA redirected the AERMOD Implementation Workgroup (AIWG) with a focus on the new 1-hour NO₂ and SO₂ NAAQS. The purpose of the workgroup was to provide insight into the potential challenges in modeling compliance under the new standards by working with “real world” examples. These examples would then provide a valuable basis to assess EPA’s existing guidance for NO₂ and SO₂ as well as indicate areas for new guidance. The AIWG workgroup was composed of over 50 members with EPA staff from the Regional offices and the Office of Air Quality Planning and Standards (OAQPS), and modelers from state, territorial, and local air quality agencies (see Table 4 for full list of members). The workgroup was co-chaired by Erik Snyder of Region 6 and James Thurman of OAQPS.

The workgroup was charged with completing its work in two phases:

1. Single source modeling case studies,
2. Cumulative modeling scenarios involving multiple facilities and background concentrations

For the first phase, the workgroup compiled a list of facilities that were of most interest to various state and local agencies. The workgroup began with an initial list of facility types and then workgroup members focused on those facility types that were of interest in their state or local area. Table 1 lists the final list of facility types that were modeled by the workgroup as part of the first phase.
Table 1. Facilities, pollutants and modelers of single source modeling scenarios.

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Pollutant(s)</th>
<th>Modeler(s)</th>
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<tbody>
<tr>
<td>Secondary steel mill</td>
<td>NO₂</td>
<td>Doris Jung (CO)</td>
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<tr>
<td>Ethanol plant</td>
<td>NO₂, SO₂</td>
<td>Dawn Froning (MO); Jennifer Krzak (IA)</td>
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<td>Materials recycler</td>
<td>NO₂</td>
<td>Steven Sherman (IN)</td>
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<td>Natural gas turbine</td>
<td>NO₂</td>
<td>Margaret Valis (NY); Bruce Ferguson (MS)</td>
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<td>Coal fired EGU</td>
<td>NO₂, SO₂</td>
<td>Eric Milligan (OK); James Thurman (EPA-OAQPS)</td>
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<td>Biomass facility</td>
<td>NO₂</td>
<td>Dennis Becker (MN)</td>
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<td>Natural gas processing plant</td>
<td>NO₂</td>
<td>Krystin Bablinskas (AK); Andy Hawkins (EPA-R7)</td>
</tr>
<tr>
<td>Refinery</td>
<td>NO₂, SO₂</td>
<td>Glenn Reed (SJV); Leland Villalvazo (SJV)</td>
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<td>Natural gas compressors</td>
<td>NO₂</td>
<td>Ashley Mohr (EPA-R6); Erik Snyder (EPA-R6); Chiu Foong (EPA-R6)</td>
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<td>Cement kiln</td>
<td>NO₂</td>
<td>Dawn Froning (MO); Tracy Price (SC)</td>
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<td>Landfill gas turbine</td>
<td>NO₂</td>
<td>Lisa Landry (NH); Todd Moore (NH)</td>
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<tr>
<td>Fuel oil turbine</td>
<td>NO₂</td>
<td>Haidar Al-Rawi (TN)</td>
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<td>Pulp &amp; paper</td>
<td>SO₂</td>
<td>Leigh Bacon (AL); Jim Owen (AL)</td>
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<tr>
<td>Flare</td>
<td>SO₂</td>
<td>Annamaria Coulter (EPA-R2)</td>
</tr>
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</table>

For each modeled facility, emissions and source parameters were based on real facilities but were modified by the workgroup to be a generic facility type. For each facility type, there were several modeling scenarios such as addition of controls, changing stack height, varying fence-line distances, etc. Also for NO₂ sources, modeling scenarios involved comparing the use of the Plume Volume Molar Ratio Method (PVPRM) and Ozone Limiting Method (OLM) techniques within AERMOD as the approaches to model NOx to NO₂ conversion. Details about the modeling inputs for each scenario are provided for each facility type in Appendix A.

**Summary of findings**

A listing of modeled sources with maximum design values for multiple scenarios can be found in Table 2 for NO₂ and Table 3 for SO₂. A more detailed listing of maximum design values across scenarios for each modeled facility type can be found in Appendix A, which also contains spatial plots for several of the modeled sources. Based on the results of the modeling results, several preliminary observations have been made:

1. Many factors may contribute to NAAQS violations in addition to emissions levels. Other variables such as distance to ambient air (ethanol plant scenarios), urban/rural classification (NO₂ refinery and biomass facility), presence of terrain (refinery), meteorology, downwash influences, and stack heights can affect design value concentrations.
2. Short stacks and small facility footprints (SO$_2$ ethanol plant) can be problematic in attaining the NAAQS with violations occurring just beyond the fenceline. However, the area showing potential modeled violations in these cases may be very small.

3. In some cases the largest units in terms of emissions are not the major contributors to the maximum design values. Modeling scenarios where controls or stack height changes were made to the larger emitting stacks at times did not affect the maximum design value concentration, which were dominated by smaller units with short stacks (e.g., ethanol plant, coal fired EGU).

4. Increasing stack heights (within GEP regulations) for some sources with short stacks may be as effective as additional emission controls in eliminating modeled violations.

5. For NO$_2$, modeling results highlight the importance of the use of the OLM or PVMRM Tier 3 options, the initial NO$_2$/NOx in-stack ratio, and input ozone background concentrations to modeled design values.
<table>
<thead>
<tr>
<th>Facility</th>
<th>Emissions (tpy)</th>
<th>Maximum DV ($\mu g/m^3$) (ppb)</th>
<th>Sensitivity test</th>
<th>Maximum DV ($\mu g/m^3$) (ppb)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel mill</td>
<td>Base: 711</td>
<td>318 (169) – OLM; &lt; 1% receptors exceed</td>
<td>65 m stack ht (units &gt; 1 g/s); Emissions unchanged</td>
<td>250 (133) – PVMRM: 1 receptor exceeds</td>
<td>Sensitivity to NOx to NO₂ method</td>
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<tr>
<td>Ethanol plant</td>
<td>Base: 1,180</td>
<td>1,289 (685); 5% receptors exceed</td>
<td>NO₂/NOx ratio 0.5, controls &amp; increased stack ht on one unit; Emissions: 170 tpy</td>
<td>1,289 (685); 5% receptors exceed</td>
<td>50 m fenceline; no change in maximum DV with controls &amp; stack ht increase</td>
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<tr>
<td>Materials recycler</td>
<td>Base: 70</td>
<td>401 (214); NO₂/NOx ratio 0.2; &lt; 1% receptors exceed</td>
<td>Stack ht increase (&gt; 25 m); Emissions unchanged</td>
<td>17 (9)</td>
<td>Violations &lt; 500 m for base case.</td>
</tr>
<tr>
<td>Natural gas turbine (NY)</td>
<td>Base: 450</td>
<td>145 (77)</td>
<td>Increase stack ht &amp; controls (390 tpy)</td>
<td>122 (65)</td>
<td>No downwash</td>
</tr>
<tr>
<td>Natural gas turbine (MS)</td>
<td>Base: 450</td>
<td>16 (8)</td>
<td>Increase stack ht &amp; controls (390 tpy)</td>
<td>No downwash</td>
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<tr>
<td>Coal EGU</td>
<td>Base 1,870</td>
<td>234 (125); &lt; 1% receptors exceed</td>
<td>Stack ht increase, controls &amp; higher exit velocity (610 tpy)</td>
<td>234 (125); &lt; 1% receptors exceed</td>
<td>No change in maximum DV with controls &amp; stack ht increase</td>
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<tr>
<td>Biomass facility</td>
<td>Base: 240</td>
<td>22 (11)</td>
<td>Stack height increase &amp; no controls (1,220 tpy)</td>
<td>45 (24)</td>
<td>Sensitivities to urban/rural classification &amp; NOx to NO₂ algorithm</td>
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<tr>
<td>Natural gas processing plant</td>
<td>Uncontrolled: 3,190</td>
<td>1,440 (766); 60% receptors exceed</td>
<td>Increase stack ht &amp; controls (330 tpy)</td>
<td>85 (45)</td>
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<tr>
<td>Refinery</td>
<td>Base: 8,770</td>
<td>189 (100)</td>
<td>Increase stack ht &amp; controls (5200 tpy)</td>
<td>171 (91)</td>
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<tr>
<td>Natural gas compressors</td>
<td>Uncontrolled (4069)</td>
<td>1,674 (890); 21% receptors exceed;</td>
<td>Increase stack ht &amp; controls (626 tpy)</td>
<td>43 (23)</td>
<td>Violations &lt; 7 km</td>
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<tr>
<td>Cement kiln</td>
<td>Base: 7,170</td>
<td>44 (24)</td>
<td>Controls (2,180 tpy)</td>
<td>8 (4)</td>
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<tr>
<td>Landfill gas turbine</td>
<td>Base: 80</td>
<td>29 (15)</td>
<td>Increase stack ht; emissions unchanged</td>
<td>4 (2)</td>
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<tr>
<td>Fuel oil turbine</td>
<td>Less controlled: 2,230</td>
<td>484 (257); 1% receptors exceed</td>
<td>Increase stack ht &amp; controls (1,190 tpy)</td>
<td>337 (179); &lt; 1% receptors exceed</td>
<td>Violations &lt; 2 km</td>
</tr>
<tr>
<td>Asphalt plant</td>
<td>Base: 188</td>
<td>470 (250); 20% receptors exceed</td>
<td>Increase stack ht &amp; controls; daytime operation only (38 tpy)</td>
<td>162 (86)</td>
<td>Violations &lt; 1 km; Maximum DV associated with ozone of 80 ppb.</td>
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</tbody>
</table>

Table 2. NO₂ modeling results
Table 3. SO\(_2\) modeling results.

<table>
<thead>
<tr>
<th>Facility</th>
<th>Emissions (tpy)</th>
<th>Maximum DV ((\mu g/m^3)) (ppb)</th>
<th>Sensitivity test</th>
<th>Maximum DV ((\mu g/m^3)) (ppb)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol plant</td>
<td>Base: 890</td>
<td>296 (113); 1 receptor exceed</td>
<td>65 m stack ht &amp; controls on one unit (195 tpy)</td>
<td>296 (113); 1 receptor exceed</td>
<td>Sensitivity to fenceline distance. 300 m fenceline – no exceedances</td>
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<tr>
<td>Coal EGU (OAQPS)</td>
<td>Uncontrolled: 10,713</td>
<td>905 (346); &lt; 1% receptors exceed</td>
<td>Stack increase, controls &amp; higher exit velocity; Emissions 2,074 tpy</td>
<td>33 (13)</td>
<td>Exceedances &lt; 8km; stack ht=65 m</td>
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<tr>
<td>Coal EGU (OK)</td>
<td>Base: 4,959</td>
<td>48 (18)</td>
<td>Stack increase, controls &amp; higher exit velocity; Emissions 2,074 tpy</td>
<td>28 (11)</td>
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<tr>
<td>Refinery</td>
<td>Base: 4,020</td>
<td>272 (104)</td>
<td>Stack height increases; emissions unchanged</td>
<td>36 (14)</td>
<td>Sensitivity to urban/rural classification and terrain</td>
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<tr>
<td>Cement kiln</td>
<td>Base: 3,129</td>
<td>34 (13)</td>
<td>Controls; Emissions 348 tpy</td>
<td>4 (2)</td>
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<tr>
<td>Pulp &amp; paper</td>
<td>Base: 3,403</td>
<td>924 (353); 28% receptors exceed</td>
<td>Stack height increase &amp; controls; Emissions 1,630</td>
<td>212 (81); &lt; 1% receptors violate;</td>
<td>Exceedances &lt; 4 km for base case; Exceedances &lt; 1 km for stack ht increase &amp; controls</td>
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<td>Landfill gas turbine</td>
<td>Base: 45</td>
<td>17 (7)</td>
<td>Stack height increases; Emissions unchanged</td>
<td>2 (0.8)</td>
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<tr>
<td>Fuel oil turbine</td>
<td>Base: 417</td>
<td>257 (98); &lt; 1% receptors exceed</td>
<td>Stack height increases; Emissions unchanged</td>
<td>178 (63)</td>
<td>Base case exceedances 0.5 to 1 km from source</td>
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<tr>
<td>Flare</td>
<td>Base: 6,083</td>
<td>324 (124); &lt; 1% receptors exceed</td>
<td>65 m stack ht &amp; controls; Emissions 626 tpy</td>
<td>9 (4)</td>
<td>Exceedances 6 to 7 km from source</td>
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<tr>
<td>Asphalt plant</td>
<td>Base: 13</td>
<td>3790 (1449); 27% receptors exceed</td>
<td>Increase stack hts; emissions unchanged</td>
<td>37 (14)</td>
<td>Exceedances &lt; 1 km; results include downwash and continuous operations;</td>
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Table 4. AERMOD Implementation Workgroup (AIWG) Members.

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<thead>
<tr>
<th>Name</th>
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<td>Lisa Landry</td>
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<td>James Thurman*</td>
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<tr>
<td>Tyer Fox</td>
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<td>OAQPS</td>
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* AIWG co-chairs
Appendix A: Model Inputs for Phase 1 Case Studies

Following are the model inputs for the various single source scenarios modeled by AIWG.
Steel mill

Pollutant(s): NO₂

Terrain: Yes

Meteorology: Alva, OK (2006-2010)

Ozone data: Oklahoma (2006-2010)

Scenarios:

1. Base

2. Increase in stack height to 45 m for stack with emissions > 2 g/s (Stack ht 2)

3. Increase in stack height to 65 m for stacks with emissions > 2 g/s (Stack ht 3)

All scenarios modeled with 0.1 NO₂/NOx in-stack ratio and results were compared using OLM and PVMRM
<table>
<thead>
<tr>
<th>Source</th>
<th>Type</th>
<th>NOx (g/s)</th>
<th>Stack ht 1 (m)</th>
<th>Stack temperature (K)</th>
<th>Stack velocity (m/s)</th>
<th>Diameter (m)</th>
<th>Stack ht 2 (m)</th>
<th>Stack ht 3 (m)</th>
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**Steel mill volume sources**

<table>
<thead>
<tr>
<th>Source</th>
<th>Type</th>
<th>NOx (g/s)</th>
<th>Center of volume (m)</th>
<th>( \sigma_x ) (m)</th>
<th>( \sigma_z ) (m)</th>
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**Ethanol plant**

Pollutant(s): NO\textsubscript{2}, SO\textsubscript{2}

Terrain: Yes

Meteorology: Moline, IL (2000-04), Springfield, MO (2005-09), St. Louis, MO (2005-09), and Waterloo, IA (2000-04)

Ozone: Moline: 0.067 ppm; Springfield, Hillcreset (2005-09); St. Louis, Maryland Heights (2005-09); Waterloo, 0.066 ppm

Scenarios (both pollutants):

1. Base
2. Increase stack height to 65 for C0004 (Stack ht 2)
3. Controlled emissions for C0004 with 65 m stack height (NO\textsubscript{x} 2 and SO\textsubscript{2} 2 with Stack ht 2)
4. Additional controls for C0004 with 65 m stack height (NO\textsubscript{x} 3 and SO\textsubscript{2} 3 with Stack ht 2)

All scenarios modeled with the following sensitivities:

1. 300 m vs. 50 m fenceline

Additionally for NO\textsubscript{2}, the following were modeled:

2. 0.1 NO\textsubscript{2}/NO\textsubscript{x} in-stack ratio for all sources vs. 0.05 ratio for C0004 and 0.1 for other sources
3. 0.25 NO\textsubscript{2}/NO\textsubscript{x} in-stack ratio vs. 0.5 ratio for all sources (50 m fenceline only)

All scenarios modeled with four different meteorological datasets listed above.
<table>
<thead>
<tr>
<th>Source</th>
<th>Type</th>
<th>NOx (g/s)</th>
<th>SO₂ (g/s)</th>
<th>Stack ht 1 (m)</th>
<th>Stack temperature (K)</th>
<th>Stack velocity (m/s)</th>
<th>Diameter (m)</th>
<th>Stack ht 2 (m)</th>
<th>NOx 2 (g/s)</th>
<th>SO₂ 2 (g/s)</th>
<th>NOx 3 (g/s)</th>
<th>SO₂ 3 (g/s)</th>
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Ethanol plant volume source

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<th>Type</th>
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<th>Center of volume (m)</th>
<th>σₓ (m)</th>
<th>σᵧ (m)</th>
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Materials recycler

Pollutant(s): NO₂

Terrain: Flat

Meteorology: Indianapolis, IN (2006-10)

Scenarios:

1. Base

2. Increase stack heights #1 (Stack ht 2)

3. Increase stack heights #2 (Stack ht 3)

All scenarios modeled with 0.1 NO₂/NOx in-stack ratio, PVMRM, and 40 ppb ozone concentration.

<table>
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<th>Type</th>
<th>NOx (g/s)</th>
<th>Stack ht 1 (m)</th>
<th>Stack temperature (K)</th>
<th>Stack velocity (m/s)</th>
<th>Diameter (m)</th>
<th>Stack ht 2 (m)</th>
<th>Stack ht 3 (m)</th>
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**Natural gas turbine**

Pollutant(s): NO$_2$

Terrain: Yes

Meteolology: NY – Poughkeepsie, NY (2006-10); MS – Mobile, AL (2005-09)

Ozone: NY – Millbrook, NY (2006-10); MS – Average seasonal/hour of day

Scenarios:

1. Base

2. Increase stack heights #1 (Stack ht 2)

3. Increase stack heights #2 (Stack ht 3)

4. Scenario 3 stack heights with controlled emissions (NOx 2 and Stack ht 3)

New York also modeled sensitivities

1. Base with 100% and 80% conversion

2. Base with OLM with 0.05 NO$_2$/NOx in-stack ratio (no downwash)

3. Scenarios 2-4 with PVMRM comparing 0.05 NO$_2$/NOx ratio (with and without downwash) and 0.1 ratio (with downwash)

Mississippi modeled all scenarios with 0.05 NO$_2$/NOx ratio and 0.1 ratio
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<th>Stack temperature (K)</th>
<th>Stack velocity (m/s)</th>
<th>Diameter (m)</th>
<th>Stack ht 2 (m)</th>
<th>Stack ht 3 (m)</th>
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</table>
Coal EGU

Pollutant(s): NO₂, SO₂

Terrain: Yes

Meteorology: OAQPS – Charleston, SC (2005-09); OK- Springfield, MO (2006-10)

Ozone: OAQPS – Spartanburg, SC; OK – NEOK (2006-10)

Scenarios:

1. Base

2. Increase stack heights #1 (Stack ht 2)

3. Controlled emissions with base stack heights (NOx 2 and SO₂ 2 with Stack ht 1)

4. Scenario 2 stack heights with controlled emissions (NOx 2 and SO₂ 2 and Stack ht 2)

5. Scenario 3 emissions with further increase in stack ht (NOx 2 and SO₂ 2 and Stack ht 3)

6. Scenario 5 with higher exit velocity and new diameter ((NOx 2 and SO₂ 2, Stack ht 3, Stack velocity 2 and Diameter 2)

Note, controlled emissions for Oklahoma modeling for SO₂ were 112 g/s. OAQPS also modeled all NO₂ scenarios with 100% and 80% conversion. OAQPS also modeled all SO₂ scenarios with uncontrolled emissions (290 g/s) for C0001. For SO₂, OAQPS modeled the base scenario with a 65 m stack height for base emissions and uncontrolled emissions.
<table>
<thead>
<tr>
<th>Source</th>
<th>Type</th>
<th>NOx (g/s)</th>
<th>SO$_2$ (g/s)</th>
<th>Stack ht 1 (m)</th>
<th>Stack temperature (K)</th>
<th>Stack velocity (m/s)</th>
<th>Diameter (m)</th>
<th>Stack ht 2 (m)</th>
<th>NOx 2 (g/s)</th>
<th>SO$_2$ 2 (g/s)</th>
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<td>150</td>
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<td>25</td>
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</table>
Biomass facility

Pollutant(s): NO₂

Terrain: Flat
Meteorology: Twin-Cities, MN (2006-10);
Ozone: 40 ppb

Scenarios:

1. Base
2. Increase stack heights #1 (Stack ht 2)
3. Scenario 2 stack heights with no controls on emissions (NOx 2 and Stack ht 2)

All three scenarios were also modeled with the following sensitivities:

1. Urban vs. rural
2. 100% and 80% conversion
3. OLM vs. PVMRM with 0.1 NO₂/NOx in-stack ratio
4. OLM vs. PVMRM with 0.15 NO₂/NOx in-stack ratio

<table>
<thead>
<tr>
<th>Source</th>
<th>Type</th>
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<th>Stack temperature (K)</th>
<th>Stack velocity (m/s)</th>
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<th>Stack ht 2 (m)</th>
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</table>
Natural gas processing plant

Pollutant(s): NO₂

Terrain: Flat

Meteorology: Barrow, AK (2001-05)

Ozone: AK hourly data and 40 and 80 ppb constant concentrations

Scenarios:

1. Base
2. Increase stack heights #1 (Stack ht 2)
3. Increase stack heights #2 (Stack ht 3)
4. Increase stack heights #3 (Stack ht 4)
5. Base stack parameters with uncontrolled emissions (NOx 2 and Stack ht 1)

All scenarios modeled with PVMRM with the following in-stack ratios:

1. 0.1 vs. 0.25

The base scenario was also modeled with a 0.25 NO₂/NOx in-stack ratio and using a constant ozone concentration of 40 vs. 80 ppb.
<table>
<thead>
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<th>Source</th>
<th>Type</th>
<th>NOx (g/s)</th>
<th>Stack ht 1 (m)</th>
<th>Stack temperature (K)</th>
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<th>Diameter (m)</th>
<th>Stack ht 2 (m)</th>
<th>Stack ht 3 (m)</th>
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Refinery

Pollutant(s): NO$_2$, SO$_2$

Terrain: Flat, Elevated

Meteorology: Bakersfield, CA (2005-09)

Ozone: Bakersfield, CA (2005-09)

Scenarios:

For NO$_2$:

1. Base

2. Stack height increase #1 (Stack ht 2)

3. Stack height increase #2 (Stack ht 3)

4. Controlled emissions with base stack heights (NOx 2 and Stack ht 1)

5. Controlled emissions with Scenario 3 stack heights (NOx 2 and Stack ht 3)

All scenarios were modeled comparing OLM vs. PVMRM and flat vs. including terrain. The NO2/NOx in-stack ratio was 0.1

For SO$_2$:

1. Base

2. Stack height increase #1 (Stack ht 2)

3. Stack height increase #2 (Stack ht 3)
4. Uncontrolled emissions with Scenario 3 stack heights (NOx 2 and Stack ht 3)

5. Uncontrolled emissions with base stack heights (NOx 2 and Stack ht 3)

All SO$_2$ scenarios were modeled comparing urban vs. rural dispersion and flat vs. use of terrain.
### NO₂ refinery emissions

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Natural gas compressors

Pollutant(s): NO₂

Terrain: Yes

Meteorology: Austin, TX (1983-84; 1986-88)

Ozone: NEOKN

Scenarios:

1. Base

2. Less controls for 3 of 4 stations and stack height increase #2 (NOx 2 and stack ht 3)

3. Stack height increase #1 (Stack ht 2)

4. Stack height increase #2 (Stack ht 3)

5. Less controls for 3 of 4 stations and base stack heights (NOx 3 and stack ht 1)

All scenarios modeled with 0.1 NO₂/NOx in-stack ratio and PVMRM
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Cement kiln

Pollutant(s): NO₂, SO₂

Terrain: Yes

Meteorology: Charleston, SC (2002-06)

Ozone: Spartanburg, SC (2002-06)

Scenarios (both pollutants):

1. Base
2. Controls (NOx 2 and SO₂ 2)
3. Additional controls (NOx 3 and SO₂ 3)

NO₂ base scenario modeled with PVMRM and:

1. Comparison of NO₂/NOx in-stack ratios of 0.05, 0.1, 0.25, and 0.5
2. Comparison of ozone concentrations of 40 and 80 ppb with NO2/NOx ratio of 0.1

Scenario 2 modeled with NO₂/NOx in-stack ratios of 0.05 and 0.1

Scenario 3 modeled with NO₂/NOx ratios of 0.05, 0.1, 0.25, and 0.5
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<th>Stack temperature (K)</th>
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<th>Diameter (m)</th>
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**Landfill gas turbine**

Pollutant(s): NO₂, SO₂

Terrain: Yes

Meteorology: Pease AFB, NH (2000-04)

Ozone: 40 ppb

Scenarios (both pollutants):

1. Base

2. Stack height increase #1 (Stack ht 2)

3. Stack height increase #2 (Stack ht 3)

For NO₂, comparisons were made for PVMRM with NO₂/NOx in-stack ratios of 0.05 and 0.1 for all scenarios

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Fuel oil turbine

Pollutant(s): NO$_2$, SO$_2$

Terrain: Yes

Meteorology: Bristol, TN (2004-08)

Ozone: 60 ppb and Sullivan County, TN (2004-08)

NO$_2$ Scenarios:

1. Base
2. Stack height increase #1 (Stack ht 2)
3. Stack height increase #2 (Stack ht 3)
4. Scenario 3 heights with increased emissions (NOx 2 and Stack ht 3)

All NO$_2$ scenarios also compared:

1. OLM with 60 ppb ozone concentrations with NO$_2$/NOx in-stack ratios of 0.05 and 0.1
2. PVMRM with 60 ppb ozone concentrations with NO$_2$/NOx in-stack ratios of 0.05 and 0.1
3. PVMRM with actual ozone concentrations with NO$_2$/NOx in-stack ratios of 0.05 and 0.1

SO$_2$ Scenarios:

1. Base
2. Stack height increase #1 (Stack ht 2)
3. Stack height increase #2 (Stack ht 3)

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Asphalt plant

Pollutant(s): NO$_2$, SO$_2$

Terrain: Yes

NO$_2$ Meteorology: San Juan, NM (1993)


Ozone: San Juan (1993-1994), 40 and 60 ppb

NO$_2$ & SO$_2$ scenarios:

1. Base

2. Stack height increase #1 (Stack ht 2)

3. Stack height increase #2 (Stack ht 3)

4. Stack height increase #1 with controls (NO$_2$ only) (Stack ht 2 + NOx 2)

All scenarios for both pollutants modeled as continuous and daytime operations (12 hour operation). All NO$_2$ scenarios also modeled as continuous operations with 40 and 60 ppb ozone concentrations. All SO$_2$ scenarios modeled with and without downwash for continuous operations (no downwash for daytime operations for SO$_2$). Base scenario for SO$_2$ also modeled with alternate fuel (0.5 % sulfur content)
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Pulp & paper

Pollutant(s): SO₂

Terrain: Yes

Meteorology: Mobile, AL (2001-05)

Scenarios:

1. Base

2. Increase stack height #1 (Stack ht 2)

3. Increase stack height #2 (Stack ht 3)

4. Scenario 3 stack heights and controlled emissions (SO₂ 2 and Stack ht 3)

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Flare

Pollutant(s): SO₂

Terrain: Yes

Meteorology: Poughkeepsie, NY (2006-10)

Scenarios:

1. Base

2. Increase stack height #1 (Stack ht 2)

3. Increase stack height #2 (Stack ht 3)

4. Scenario 3 stack heights and controlled emissions (SO₂ 2 and Stack ht 3)

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<th>Type</th>
<th>SO₂ (g/s)</th>
<th>Stack ht 1 (m)</th>
<th>Stack temperature (K)</th>
<th>Stack velocity (m/s)</th>
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Appendix B: AIWG Phase 1 Results
Single Source Case Studies
NO$_2$ results
Steel Mill: NO₂

- **Base**: NO
- **45 m stack height or higher for all sources > 1 g/s**: OLM
- **65 m stack height or higher for all sources > 1 g/s**: PVMRM

The chart shows the concentration of NO₂ in µg/m³ for different stack heights and emission rates. The NAAQS (National Ambient Air Quality Standard) is indicated by the horizontal line.
Base: PVMRM
Max DV: 300 μg/m³
45 m stack ht: OLM
Max DV: 153 μg/m³
45 m stack ht: PVMRM
Max DV: 271 μg/m³
65 m stack ht: OLM
Max DV: 128 µg/m³
65 m stack ht: PVMRM
Max DV: 250 μg/m³
Ethanol Plant (Moline): NO₂

- Base Increase stack ht
- Unit 4
- Increase stack ht Unit 4 w/ controls
- Increase stack ht Unit 4 w/ additional controls

NAAQS
Base: 0.1 NO$_2$/NOx ratio
300 m FL
Max DV: 543 µg/m$^3$
Base 0.05 NO₂/NOx ratio unit #4
300 m FL
Max DV: 543 µg/m³
Baseline: 0.1 NO$_2$/NOx ratio
50 m FL
Max DV: 810 µg/m$^3$
Baseline: 0.05 NO$_2$/NOx ratio unit #4
50 m FL
Max DV: 930 µg/m$^3$
Base: 0.25 NO$_2$/NOx ratio
50 m FL
Max DV: 1000 µg/m$^3$
Base 0.5 NO$_2$/NOx ratio
50 m FL
Max DV: 1289 μg/m$^3$
Increase stack ht C0004
0.1 NO₂/NOx ratio
300 m FL
Max DV: 543 μg/m³
Increase stack ht C0004
0.05 NO₂/NOx ratio C0004
300 m FL
Max DV: 543 μg/m³

Legend

- <=50
- 51 - 100
- 101 - 150
- 151 - 196
- 197 - 250
- 251 - 500
- 501 - 750
- 751 - 1,000
- 1,001 - 1,250
- 1,251 - 1,289
Increase stack ht C0004
0.1 NO₂/NOx ratio
50 m FL
Max DV: 810 μg/m³
Increase stack ht C0004
0.05 NO₂/NOx ratio C0004
50 m FL
Max DV: 930 μg/m³
Increase stack ht C0004 + controls
0.1 NO$_2$/NOx ratio
300 m FL
Max DV: 543 µg/m$^3$
Increase stack ht C0004 + controls
0.05 NO₂/NOx ratio C0004
300 m FL
Max DV: 543 µg/m³
Increase stack ht C0004 + controls
0.1 NO$_2$/NOx ratio
50 m FL
Max DV: 810 µg/m$^3$
Increase stack ht C0004 + controls
0.05 NO₂/NOx ratio C0004
50 m FL
Max DV: 930 μg/m³
Increase stack ht C0004 + additional controls
0.1 NO₂/NOx ratio
300 m FL
Max DV: 543 μg/m³
Increase stack ht C0004 + additional controls
0.05 NO₂/NOx ratio C0004
300 m FL
Max DV: 543 μg/m³
Increase stack ht C0004 + additional controls
0.1 NO$_2$/NOx ratio
50 m FL
Max DV: 810 µg/m$^3$
Increase stack ht C0004 + additional controls
0.05 NO₂/NOx ratio C0004
50 m FL
Max DV: 930 µg/m³
Increase stack ht C0004 + additional controls
0.25 NO₂/NOx ratio
50 m FL
Max DV: 1000 μg/m³
Increase stack ht C0004 + additional controls
0.50 NO$_2$/NOx ratio
50 m FL
Max DV: 1000 µg/m$^3$
Ethanol Plant (Springfield): NO₂

- Base
- Increase stack ht Unit 4
- Increase stack ht Unit 4 w/ controls
- Increase stack ht Unit 4 w/ additional controls

Concentration (µg/m³)

- NO₂/NOx 0.1 (300 m FL)
- NO₂/NOx 0.05 Unit 4 (300 m FL)
- NO₂/NOx 0.1 (50 m FL)
- NO₂/NOx 0.05 Unit 4 (50 m FL)
- NO₂/NOx 0.25 (50 m FL)
- NO₂/NOx 0.5 (50 m FL)

NAAQS
Base: 0.1 NO$_2$/NOx ratio
300 m FL
Max DV: 298 µg/m$^3$
Base 0.05 NO$_2$/NOx ratio unit #4
300 m FL
Max DV: 298 µg/m$^3$
Baseline: 0.1 NO₂/NOx ratio
50 m FL
Max DV: 496 μg/m³
Baseline: 0.05 NO$_2$/NOx ratio unit #4

50 m FL

Max DV: 841 µg/m$^3$
Base: 0.25 NO$_2$/NOx ratio
50 m FL
Max DV: 719 µg/m$^3$
Base 0.5 NO₂/NOx ratio
50 m FL
Max DV: 1131 μg/m³
Increase stack ht C0004
0.1 NO$_2$/NOx ratio
300 m FL
Max DV: 298 µg/m$^3$
Increase stack ht C0004
0.05 NO₂/NOx ratio C0004
300 m FL
Max DV: 298 μg/m³
Increase stack ht C0004
0.1 NO$_2$/NOx ratio
50 m FL
Max DV: 496 µg/m$^3$
Increase stack ht C0004
0.05 NO₂/NOx ratio C0004
50 m FL
Max DV: 841 µg/m³
Increase stack ht C0004 + controls
0.1 NO$_2$/NOx ratio
300 m FL
Max DV: 298 µg/m$^3$
Increase stack ht C0004 + controls
0.05 NO$_2$/NOx ratio C0004
300 m FL
Max DV: 298 µg/m$^3$
Increase stack ht C0004 + controls
0.1 NO$_2$/NOx ratio
50 m FL
Max DV: 496 µg/m$^3$
Increase stack ht C0004 + controls
0.05 NO₂/NOx ratio C0004
50 m FL
Max DV: 841 µg/m³
Increase stack ht C0004 + additional controls
0.1 NO₂/NOx ratio
300 m FL
Max DV: 298 μg/m³
Increase stack ht C0004 + additional controls
0.05 NO₂/NOx ratio C0004
300 m FL
Max DV: 298 µg/m³
Increase stack ht C0004 + additional controls
0.1 NO₂/NOx ratio
50 m FL
Max DV: 496 μg/m³

Legend
- <=25
- 26 - 50
- 51 - 75
- 76 - 100
- 101 - 125
- 126 - 150
- 151 - 188
- 189 - 400
- 401 - 800
- 801 - 1,000
- 1,001 - 1,131

Springfield
Increase stack ht C0004 + additional controls
0.05 NO₂/NOx ratio C0004
50 m FL
Max DV: 841 μg/m³
Increase stack ht C0004 + additional controls
0.25 NO₂/NOx ratio
50 m FL
Max DV: 719 µg/m³
Increase stack ht C0004 + additional controls
0.50 NO₂/NOx ratio
50 m FL
Max DV: 1131 µg/m³
Ethanol Plant (St. Louis): NO₂

- NO₂/NOₓ 0.1 (300 m FL)
- NO₂/NOₓ 0.05 Unit 4 (300 m FL)
- NO₂/NOₓ 0.1 (50 m FL)
- NO₂/NOₓ 0.05 Unit 4 (50 m FL)
- NO₂/NOₓ 0.25 (50 m FL)
- NO₂/NOₓ 0.5 (50 m FL)

Concentration (μg/m³)

NAAQS
Base: 0.1 NO₂/NOx ratio
300 m FL
Max DV: 293 μg/m³
Base 0.05 NO₂/NOx ratio unit #4
300 m FL
Max DV: 293 μg/m³
Baseline: 0.1 NO₂/NOx ratio
50 m FL
Max DV: 441 µg/m³
Baseline: 0.05 NO₂/NOx ratio unit #4
50 m FL
Max DV: 748 µg/m³
Base: 0.25 NO\textsubscript{2}/NO\textsubscript{x} ratio
50 m FL
Max DV: 712 μg/m\textsuperscript{3}
Base 0.5 NO$_2$/NOx ratio
50 m FL
Max DV: 1180 µg/m$^3$
Increase stack ht C0004
0.1 NO$_2$/NOx ratio
300 m FL
Max DV: 293 µg/m$^3$
Increase stack ht C0004
0.05 NO$_2$/NOx ratio C0004
300 m FL
Max DV: 293 μg/m$^3$
Increase stack ht C0004
0.1 NO₂/NOx ratio
50 m FL
Max DV: 441 µg/m³
Increase stack ht C0004
0.05 NO₂/NOx ratio C0004
50 m FL
Max DV: 748 μg/m³

Legend

- <=25
- 26 - 50
- 51 - 75
- 76 - 100
- 101 - 125
- 126 - 150
- 151 - 188
- 189 - 400
- 401 - 600
- 601 - 800
- 801 - 1,000
- 1,001 - 1,180

St. Louis
Increase stack ht C0004 + controls
0.1 NO₂/NOx ratio
300 m FL
Max DV: 293 µg/m³
Increase stack ht C0004 + controls
0.05 NO₂/NOx ratio C0004
300 m FL
Max DV: 293 μg/m³
Increase stack ht C0004 + controls
0.1 NO₂/NOx ratio
50 m FL
Max DV: 441 μg/m³

Legend
- <=25
- 26 - 50
- 51 - 75
- 76 - 100
- 101 - 125
- 126 - 150
- 151 - 188
- 189 - 400
- 401 - 600
- 601 - 800
- 801 - 1,000
- 1,001 - 1,160

St. Louis
Increase stack ht C0004 + controls
0.05 NO₂/NOx ratio C0004
50 m FL
Max DV: 748 μg/m³
Increase stack ht C0004 + additional controls
0.1 NO₂/NOx ratio
300 m FL
Max DV: 293 µg/m³
Increase stack ht C0004 + additional controls
0.05 NO$_2$/NOx ratio C0004
300 m FL
Max DV: 293 µg/m$^3$
Increase stack ht C0004 + additional controls
0.1 NO₂/NOx ratio
50 m FL
Max DV: 441 μg/m³
Increase stack ht C0004 + additional controls
0.05 NO$_2$/NOx ratio C0004
50 m FL
Max DV: 748 µg/m$^3$
Increase stack ht C0004 + additional controls
0.25 NO₂/NOx ratio
50 m FL
Max DV: 712 μg/m³
Increase stack ht C0004 + additional controls
0.50 NO$_2$/NOx ratio
50 m FL
Max DV: 1180 µg/m$^3$
Ethanol Plant (Waterloo): NO₂

<table>
<thead>
<tr>
<th>Scenario</th>
<th>NO₂/NOx Concentration (μg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
<td>400</td>
</tr>
<tr>
<td>Increase stack ht Unit 4</td>
<td>800</td>
</tr>
<tr>
<td>Increase stack ht Unit 4 w/ controls</td>
<td>1200</td>
</tr>
<tr>
<td>Increase stack ht Unit 4 w/ additional controls</td>
<td>1600</td>
</tr>
</tbody>
</table>

NAAQS: 200 μg/m³
Base: 0.1 NO$_2$/NOx ratio
300 m FL
Max DV: 389 µg/m$^3$
Base 0.05 NO₂/NOx ratio unit #4
300 m FL
Max DV: 389 μg/m³

Legend
- <=25
- 26 - 50
- 51 - 75
- 76 - 100
- 101 - 125
- 126 - 150
- 151 - 196
- 197 - 400
- 401 - 600
- 601 - 800
- 801 - 1,000
- 1,001 - 1,134
Baseline: 0.1 NO₂/NOx ratio
50 m FL
Max DV: 725 μg/m³
Baseline: 0.05 NO$_2$/NOx ratio unit #4
50 m FL
Max DV: 831 $\mu$g/m$^3$
Base: 0.25 NO$_2$/NOx ratio
50 m FL
Max DV: 878 µg/m$^3$
Base 0.5 NO$_2$/NOx ratio
50 m FL
Max DV: 1134 µg/m$^3$
Increase stack ht C0004
0.1 NO₂/NOx ratio
300 m FL
Max DV: 389 µg/m³
Increase stack ht C0004
0.05 NO₂/NOx ratio C0004
300 m FL
Max DV: 389 μg/m³
Increase stack ht C0004
0.1 NO₂/NOx ratio
50 m FL
Max DV: 725 μg/m³

Legend
- <=25
- 26 - 50
- 51 - 75
- 76 - 100
- 101 - 125
- 126 - 150
- 151 - 196
- 197 - 400
- 401 - 600
- 601 - 800
- 801 - 1,000
- 1,001 - 1,134
Increase stack ht C0004
0.05 NO₂/NOx ratio C0004
50 m FL
Max DV: 831 μg/m³
Increase stack ht C0004 + controls
0.1 NO₂/NOx ratio
300 m FL
Max DV: 389 µg/m³
Increase stack ht C0004 + controls
0.05 NO₂/NOx ratio C0004
300 m FL
Max DV: 389 µg/m³
Increase stack ht C0004 + controls
0.1 NO₂/NOx ratio
50 m FL
Max DV: 725 μg/m³
Increase stack ht C0004 + controls
0.05 NO\textsubscript{2}/NOx ratio C0004
50 m FL
Max DV: 831 \textmu g/m\textsuperscript{3}
Increase stack ht C0004 + additional controls
0.1 NO$_2$/NOx ratio
300 m FL
Max DV: 389 µg/m$^3$
Increase stack ht C0004 + additional controls
0.05 NO$_2$/NO$_x$ ratio C0004
300 m FL
Max DV: 389 µg/m$^3$
Increase stack ht C0004 + additional controls
0.1 NO₂/NOx ratio
50 m FL
Max DV: 725 μg/m³
Increase stack ht C0004 + additional controls
0.05 NO$_2$/NOx ratio C0004
50 m FL
Max DV: 831 $\mu$g/m$^3$
Increase stack ht C0004 + additional controls
0.25 NO$_2$/NOx ratio
50 m FL
Max DV: 878 µg/m$^3$
Increase stack ht C0004 + additional controls
0.50 NO₂/NOx ratio
50 m FL
Max DV: 1134 µg/m³
Base
0.1 NO$_2$/NOx ratio
Max DV: 244 µg/m$^3$
Base
0.2 NO₂/NOx ratio
Max DV: 401 µg/m³
Stack ht increase #1
0.1 NO₂/NOx ratio
Max DV: 39 μg/m³
Stack ht increase #1
0.2 NO$_2$/NO$_x$ ratio
Max DV: 46 µg/m$^3$
Stack ht increase #2
0.1 NO₂/NOx ratio
Max DV: 22 µg/m³
Stack ht increase #2
0.2 NO$_2$/NOx ratio
Max DV: 29 $\mu$g/m$^3$
Stack ht increase #3 0.1 NO₂/NOx ratio
Max DV: 16 μg/m³
Stack ht increase #3
0.2 NO₂/NOx ratio
Max DV: 17 μg/m³
Natural Gas Turbine (Poughkeepsie): NO₂

**Baseline Stack ht**

- Increase #1
- Increase #2
- Increase #2 with controls

**NO₂/NOx 0.05 (OLM no DW)**

**NO₂/NOx 0.05 (PVMRM no DW)**

**NO₂/NOx 0.05 (PVMRM DW)**

**NO₂/NOx 0.1 (PVMRM DW)**

**NAAQS**

**Concentration (μg/m³)**

- Baseline
- Stack ht increase #1
- Stack ht increase #2
- Stack ht increase #2 with controls
Base
100% conversion (no DW)
Max DV: 195 μg/m³

Legend

- ≤25
- 26 - 50
- 51 - 75
- 76 - 100
- 101 - 125
- 126 - 150
- 151 - 188
- 169 - 195
Base
80% conversion (no DW)
Max DV: 156 µg/m³
Base
OLM (0.05 NO₂/NOx ratio) (no DW)
Max DV: 85 μg/m³
Base
PVMRM (0.05 NO₂/NOx ratio) (no DW)
Max DV: 145 μg/m³
Legend

- <=25
- 26 - 50
- 51 - 75
- 76 - 100
- 101 - 125
- 126 - 150
- 151 - 188
- 169 - 195

Base
PVMRM (0.05 NO$_2$/NOx ratio) (DW)
Max DV: 130 µg/m$^3$
Baseline
PVMRM (0.10 NO₂/NOx ratio) (DW)
Max DV: 138 μg/m³
Stack ht increase #1
PVMRM (0.05 NO₂/NOx ratio) (no DW)
Max DV: 124 μg/m³
Stack ht increase #1
PVMRM (0.05 NO$_2$/NOx ratio) (DW)
Max DV: 105 µg/m$^3$
Stack ht increase #1
PVMRM (0.10 NO₂/NOx ratio) (DW)
Max DV: 112 µg/m³
Stack ht increase #2

PVMRM (0.05 NO$_2$/NOx ratio) (no DW)

Max DV: 117 $\mu$g/m$^3$
Stack ht increase #2
PVMRM (0.05 NO₂/NOx ratio) (DW)
Max DV: 98 μg/m³
Stack ht increase #2:
PVMRM (0.10 NO₂/NOx ratio) (DW)
Max DV: 105 µg/m³
Stack ht increase #2 + controls
PVMRM (0.05 NO$_2$/NOx ratio) (no DW)
Max DV: 122 $\mu$g/m$^3$
Stack ht increase #2 + controls
PVMRM (0.05 NO₂/NOx ratio) (DW)
Max DV: 104 μg/m³
Stack ht increase #2 + controls
PVMRM (0.10 NO$_2$/NOx ratio) (DW)
Max DV: 110 $\mu$g/m$^3$
Natural Gas Turbine (Mobile): NO₂

- Baseline
- Stack ht increase #1
- Stack ht increase #2
- Stack ht increase #2 w/ controls

Concentration (µg/m³)

NAAQS

- NO₂/NOx 0.05 (PVMRM no DW)
- NO₂/NOx 0.1 (PVMRM no DW)
Base
PVMRM (0.05 NO₂/NOx ratio) (no DW)
Max DV: 16 μg/m³
Baseline
PVMRM (0.10 NO₂/NOx ratio) (DW)
Max DV: 16 µg/m³
Stack ht increase #1
PVMRM (0.05 NO$_2$/NOx ratio) (no DW)
Max DV: 11 µg/m$^3$
Stack ht increase #1
PVMRM (0.10 NO$_2$/NOx ratio) (DW)
Max DV: 11 µg/m$^3$
Stack ht increase #2
PVMRM (0.05 NO₂/NOx ratio) (no DW)
Max DV: 10 µg/m³
Stack ht increase #2
PVMRM (0.10 NO₂/NOx ratio) (DW)
Max DV: 10 μg/m³
Stack ht increase #2 + controls
PVMRM (0.05 NO₂/NOx ratio) (no DW)
Max DV: 11 μg/m³
Stack ht increase #2 + controls
PVMRM (0.1 NO₂/NOx ratio) (no DW)
Max DV: 11 μg/m³
Base
0.05 NO₂/NOx ratio
Max DV: 203 μg/m³
Base
0.10 NO$_2$/NOx ratio
Max DV: 220 µg/m$^3$
Base
100% conversion
Max DV: 749 μg/m³
Base
80% conversion
Max DV: 600 µg/m³
Stack ht increase
0.05 NO$_2$/NOx ratio
Max DV: 203 $\mu$g/m$^3$
Stack ht increase
0.10 NO$_2$/NOx ratio
Max DV: 220 µg/m$^3$
Stack ht increase
100% conversion
Max DV: 749 µg/m³
Controls
0.05 NO₂/NOx ratio
Max DV: 203 µg/m³
Controls
0.10 NO$_2$/NOx ratio
Max DV: 220 $\mu$g/m$^3$
Controls
100% conversion
Max DV: 749 μg/m³
Stack ht increase + controls
0.05 NO$_2$/NOx ratio
Max DV: 203 $\mu$g/m$^3$
Stack ht increase + controls
0.10 NO$_2$/NOx ratio
Max DV: 220 $\mu$g/m$^3$
Stack ht increase + controls
100% conversion
Max DV: 749 μg/m³
Stack ht increase + controls
80% conversion
Max DV: 600 μg/m³
Stack ht increase + additional controls
0.05 NO$_2$/NOx ratio
Max DV: 203 µg/m$^3$
Stack ht increase + additional controls
0.10 NO$_2$/NOx ratio
Max DV: 220 µg/m$^3$
Stack ht increase + additional controls
100% conversion
Max DV: 749 μg/m³
Stack ht increase + additional controls
80% conversion
Max DV: 600 µg/m³
Stack ht increase + additional controls + higher exit velocity
0.05 NO$_2$/NOx ratio
Max DV: 203 µg/m$^3$
Stack ht increase + additional controls + higher exit velocity
0.10 NO$_2$/NOx ratio
Max DV: 220 $\mu$g/m$^3$
Stack ht increase + additional controls +
higher exit velocity
100% conversion
Max DV: 749 μg/m³
Stack ht increase + additional controls + higher exit velocity
80% conversion
Max DV: 600 µg/m³
Base (Rural)
100% conversion
Max DV: 22 μg/m³
Base (Rural)
80% conversion
Max DV: 18 μg/m³
Base (Rural)
OLM (0.1 NO$_2$/NOx ratio)
Max DV: 21 μg/m$^3$
Base (Rural)
OLM (0.15 NO$_2$/NOx ratio)
Max DV: 21 µg/m$^3$
Base (Rural)
PVMRM (0.1 NO$_2$/NOx ratio)
Max DV: 16 µg/m$^3$
Base (Rural)
PVMRM (0.15 NO\textsubscript{2}/NO\textsubscript{x} ratio)
Max DV: 16 \mu\text{g}/m\textsuperscript{3}
Stack ht increase (Rural)
100% conversion
Max DV: 8 μg/m³

Legend
- ≤5
- 6 - 10
- 11 - 15
- 16 - 20
- 21 - 25
- 26 - 30
- 31 - 35
- 36 - 40
- 41 - 45
- 46 - 50

0 1,250 2,500 5,000 7,500 10,000 Meters
Stack ht increase (Rural)
80% conversion
Max DV: 6 μg/m³
Stack ht increase (Rural)
OLM (0.1 NO₂/NOx ratio)
Max DV: 7 μg/m³
Stack ht increase (Rural)
OLM (0.15 NO$_2$/NOx ratio)
Max DV: 7 µg/m$^3$
Stack ht increase (Rural)
PVMRM (0.1 NO₂/NOx ratio)
Max DV: 7 µg/m³
Stack ht increase (Rural)
PVMRM (0.15 NO₂/NOx ratio)
Max DV: 7 μg/m³
Stack ht increase + no controls (Rural)
100% conversion
Max DV: 40 µg/m³
Stack ht increase + no controls (Rural)
80% conversion
Max DV: 32 µg/m³

Legend

- ≤5
- 6 - 10
- 11 - 15
- 16 - 20
- 21 - 25
- 26 - 30
- 31 - 35
- 36 - 40
- 41 - 45
- 46 - 50

0 1,250 2,500 5,000 7,500 10,000 Meters
Stack ht increase + no controls (Rural)
OLM (0.1 NO₂/NOx ratio)
Max DV: 36 μg/m³
Stack ht increase + no controls (Rural)
OLM (0.15 NO₂/NOx ratio)
Max DV: 36 µg/m³
Stack ht increase + no controls (Rural)
PVMRM (0.1 NO\textsubscript{2}/NO\textsubscript{x} ratio)
Max DV: 26 µg/m\textsuperscript{3}
Stack ht increase + no controls (Rural)
PVMRM (0.15 NO₂/NOx ratio)
Max DV: 26 µg/m³
Biomass facility (urban): NO₂

Baseline
Stack ht increase
Stack ht increase w/ no controls

Concentration (µg/m³)

NAAQS

100% conversion
80% ARM
NO₂/NOx 0.1 (OLM)
NO₂/NOx 0.15 (OLM)
NO₂/NOx 0.1 (PVMRM)
NO₂/NOx 0.15 (PVMRM)
Base (Urban)
100% conversion
Max DV: 24 μg/m³

Legend
- <=5
- 6 - 10
- 11 - 15
- 16 - 20
- 21 - 25
- 26 - 30
- 31 - 35
- 36 - 40
- 41 - 45
- 46 - 50

DRAFT
Base (Urban)
80% conversion
Max DV: 19 μg/m³
Base (Urban) OLM (0.1 NO₂/NOx ratio) Max DV: 22 μg/m³
Base (Urban)
OLM (0.15 NO₂/NOx ratio)
Max DV: 22 µg/m³
Base (Urban)
PVMRM (0.1 NO₂/NOx ratio)
Max DV: 15 μg/m³
Base (Urban)
PVMRM (0.15 NO\textsubscript{2}/NOx ratio)
Max DV: 16 μg/m\textsuperscript{3}
Stack ht increase (Urban)
100% conversion
Max DV: 10 µg/m³
Stack ht increase (Urban)
80% conversion
Max DV: 8 μg/m³
Stack ht increase (Urban)
OLM (0.1 NO$_2$/NOx ratio)
Max DV: 9 $\mu$g/m$^3$
Stack ht increase (Urban)
OLM (0.15 NO₂/NOx ratio)
Max DV: 9 µg/m³
Stack ht increase (Urban)
PVMRM (0.1 NO₂/NOx ratio)
Max DV: 9 μg/m³
Stack ht increase (Urban)
PVMRM (0.15 NO₂/NOx ratio)
Max DV: 9 µg/m³
Stack ht increase + no controls (Urban)
100% conversion
Max DV: 50 μg/m³
Stack ht increase + no controls (Urban)
80% conversion
Max DV: 40 \( \mu g/m^3 \)
Stack ht increase + no controls (Urban)
OLM (0.1 NO₂/NOx ratio)
Max DV: 45 μg/m³
Stack ht increase + no controls (Urban) OLM (0.15 NO₂/NOx ratio) Max DV: 45 μg/m³
Stack ht increase + no controls (Urban)
PVMRM (0.1 NO₂/NOx ratio)
Max DV: 36 µg/m³
Stack ht increase + no controls (Urban)
PVMRM (0.15 NO$_2$/NOx ratio)
Max DV: 38 µg/m$^3$
Base + no controls
0.1 NO₂/NOx ratio
Max DV: 665 µg/m³
Base + no controls

0.25 NO$_2$/NOx ratio
Max DV: 1440 µg/m$^3$
Base
0.1 NO₂/NOx ratio
Max DV: 289 μg/m³
Base
0.25 NO$_2$/NOx ratio
Max DV: 335 µg/m$^3$
Base
0.25 NO₂/NOx ratio
O₃=40 ppb
Max DV: 351 µg/m³
Base
0.25 NO₂/NOx ratio
O₃=80 ppb
Max DV: 463 µg/m³
Stack ht increase #1
0.1 NO₂/NOx ratio
Max DV: 106 μg/m³
Stack ht increase #1

0.25 NO₂/NOx ratio

Max DV: 110 µg/m³
Stack ht increase #2
0.1 NO$_2$/NOx ratio
Max DV: 86 µg/m$^3$
Stack ht increase #2
0.25 NO₂/NOx ratio
Max DV: 88 µg/m³
Stack ht increase #3
0.1 NO$_2$/NOx ratio
Max DV: 85 µg/m$^3$
Stack ht increase #3
0.25 NO₂/NOx ratio
Max DV: 85 μg/m³
Legend

- <=50
- 51 - 75
- 76 - 100
- 101 - 125
- 126 - 150
- 151 - 188
- 189 - 190

Base OLM/Flat
Max DV: 150 μg/m³
Base
PVMRM/Flat
Max DV: 189 µg/m³
Base OLM/Terrain
Max DV: 150 μg/m³
Stack ht increase #1
OLM/Flat
Max DV: 135 µg/m³
Stack ht increase #1
PVMRM/Flat
Max DV: 175 μg/m³
Stack ht increase #1
OLM/Terrain
Max DV: 135 μg/m³
Stack ht increase #1
PVMRM/Terrain
Max DV: 174 μg/m³
Stack ht increase #2
OLM/Flat
Max DV: 132 μg/m³
Stack ht increase #2
PVMRM/Flat
Max DV: 174 μg/m³
Stack ht increase #2
OLM/Terrain
Max DV: 128 μg/m³
Stack ht increase #2
PVMRM/Terrain
Max DV: 173 μg/m³
Controls + base stack ht
OLM/Flat
Max DV: 129 µg/m³
Controls + base stack ht
OLM/Terrain
Max DV: 127 µg/m³
Controls + base stack ht
PVMRM/Terrain
Max DV: 171 μg/m³
Controls + stack ht increase #2
OLM/Flat
Max DV: 127 μg/m³
Controls + stack ht increase #2
PVMRM/Flat
Max DV: 171 μg/m³
Controls + stack ht increase #2
OLM/Terrain
Max DV: 124 μg/m³
Controls + stack ht increase #2
PVMRM/Terrain
Max DV: 170 μg/m³
Natural Gas Compressor Station (All): NO₂

- Baseline
- Stack ht increase #1
- Stack ht increase #2
- Less controls for 3 of 4 facilities & stack ht increase #2
- Less controls for 3 of 4 facilities

Concentration (µg/m³)

- 100% conversion
- 80% ARM
- NO₂/NOx 0.1 (PVMRM)
- NO₂/NOx 0.25 (PVMRM)
- NO₂/NOx 0.5 (PVMRM)
- NO₂/NOx 0.1 (OLM)
- NO₂/NOx 0.25 (OLM)
- NO₂/NOx 0.5 (OLM)

NAAQS
Base:
100% conversion
Max DV: 1839 µg/m³
Base:
80% ARM
Max DV: 1471 μg/m³
Base: PVMRM
0.1 NO₂/NOₓ ratio
Max DV: 1067 μg/m³
Base: PVMRM
0.25 NO₂/NOₓ ratio
Max DV: 1245 µg/m³
Base: PVMRM
0.5 NO$_2$/NOx ratio
Max DV: 1519 $\mu$g/m$^3$
Legend

- <=25
- 26 - 50
- 51 - 75
- 76 - 100
- 101 - 125
- 126 - 150
- 151 - 188
- 189 - 250
- 251 - 300
- 301 - 350
- 351 - 400
- 401 - 450
- 451 - 600

Base: OLM

0.1 NO$_2$/NO$_x$ ratio
Max DV: 293 µg/m$^3$
Legend

- <=25
- 26 - 50
- 51 - 75
- 76 - 100
- 101 - 125
- 126 - 150
- 151 - 188
- 189 - 250
- 251 - 300
- 301 - 350
- 351 - 400
- 401 - 450
- 451 - 500

Base: OLM
0.25 NO₂/NOx ratio
Max DV: 556 µg/m³
Base:
OLM 0.5 NO$_2$/NOx ratio
Max DV: 1012 $\mu$g/m$^3$
Stack ht increase #1
100% conversion
Max DV: 191 µg/m³
Stack ht increase #1
80% ARM
Max DV: 153 \( \mu \text{g/m}^3 \)
Stack ht increase #1
PVMRM
0.1 NO₂/NOx in-stack ratio
Max DV: 65 μg/m³
Stack ht increase #1
PVMRM
0.25 NO₂/NOx in-stack ratio
Max DV: 83 μg/m³
Stack ht increase #1
PVMRM
0.5 NO₂/NOx in-stack ratio
Max DV: 121 μg/m³
Stack ht increase #2
100% conversion
Max DV: 73 μg/m³
Stack ht increase #2
80% ARM
Max DV: 58 µg/m³
Stack ht increase #2
PVMRM
0.1 NO₂/NOx in-stack ratio
Max DV: 43 μg/m³
Stack ht increase #2
PVMRM
0.25 NO₂/NOx in-stack ratio
Max DV: 43 µg/m³
Less controls for 3 of 4 facilities & stack ht increase #2
100% ARM
Max DV: 496 µg/m³
Less controls for 3 of 4 facilities & stack ht increase #2
80% ARM
Max DV: 397 μg/m³
Less controls for 3 of 4 facilities & stack ht increase #2
PVMRM
0.1 NO$_2$/NOx in-stack ratio
Max DV: 163 $\mu$g/$m^3$
Less controls for 3 of 4 facilities & stack ht increase #2
PVMRM
0.25 NO₂/NOx in-stack ratio
Max DV: 163 µg/m³
Less controls for 3 of 4 facilities & stack ht increase #2
PVMRM
0.5 NO₂/NOx in-stack ratio
Max DV: 1262 μg/m³
Less controls for 3 of 4 facilities
100% conversion
Max DV: 13129 µg/m³
Less controls for 3 of 4 facilities
80% ARM
Max DV: 10503 μg/m³
Less controls for 3 of 4 facilities
PVMRM
0.1 NO₂/NOx in-stack ratio
Max DV: 1674 µg/m³
Cement Kiln: NO₂

Baseline Controls More stringent controls

\[\text{Concentration (µg/m}^3\text{)}\]

- \(\text{NO}_2/\text{NOx 0.1}\)
- \(\text{NO}_2/\text{NOx 0.05}\)
- \(\text{NO}_2/\text{NOx 0.25}\)
- \(\text{NO}_2/\text{NOx 0.5}\)
- \(\text{NO}_2/\text{NOx 0.1 O}_3=40 \text{ ppb}\)
- \(\text{NO}_2/\text{NOx 0.1 O}_3=80 \text{ ppb}\)
Base

0.1 NO$_2$/NOx in-stack ratio

Max DV: 40 $\mu$g/m$^3$
Base
0.05 NO$_2$/NOx in-stack ratio
Max DV: 39 µg/m$^3$
Base
0.25 NO₂/NOx in-stack ratio
Max DV: 44 μg/m³
Base

0.5 NO$_2$/NOx in-stack ratio

Max DV: 52 µg/m$^3$
Base
0.05 NO₂/NOx in-stack ratio
O₃=40 ppb
Max DV: 36 μg/m³

Legend
- <=5
- 6 - 10
- 11 - 15
- 16 - 20
- 21 - 25
- 26 - 30
- 31 - 35
- 36 - 40
- 41 - 45
- 46 - 50
Base

0.05 NO$_2$/NOx in-stack ratio

O$_3$=80 ppb

Max DV: 42 µg/m$^3$
Controls
0.05 $\text{NO}_2/\text{NOx}$ in-stack ratio
Max DV: 17 $\mu$g/m$^3$
Controls
0.1 NO$_2$/NOx in-stack ratio
Max DV: 17 µg/m$^3$
More stringent controls
0.05 NO₂/NOx in-stack ratio
Max DV: 8 µg/m³
More stringent controls
0.1 NO$_2$/NOx in-stack ratio
Max DV: 8 $\mu$g/m$^3$
More stringent controls
0.25 NO₂/NOx in-stack ratio
Max DV: 8 µg/m³
More stringent controls
0.5 NO$_2$/NOx in-stack ratio
Max DV: 8 µg/m$^3$
Landfill Gas Turbine: NO₂

Baseline Stack ht

Stack ht increase #1

Stack ht increase #2

Concentration (µg/m³)

NO₂/NOx 0.05

NO₂/NOx 0.1

NAAQS
Base PVMRM
0.05 NO₂/NOx in-stack ratio
Max DV: 28 μg/m³

Legend

- <= 2.5
- 2.8 - 5
- 5.1 - 10
- 10.1 - 15
- 15.1 - 20
- 20.1 - 25
- 25.1 - 28.8

0 625 1,250 2,500 3,750 5,000 Meters
Base
PVMRM
0.1 NO$_2$/NOx in-stack ratio
Max DV: 29 µg/m$^3$
Stack ht increase #1
PVMRM
0.05 NO₂/NOx in-stack ratio
Max DV: 8 µg/m³
Stack ht increase #1
PVMRM
0.1 NO₂/NOx in-stack ratio
Max DV: 8 μg/m³
Stack ht increase #2
PVMRM
0.05 NO2/NOx in-stack ratio
Max DV: 4 µg/m³
Stack ht increase #2
PVMRM
0.1 NO\textsubscript{2}/NOx in-stack ratio
Max DV: 4 \textmu g/m\textsuperscript{3}
Base
OLM ($O_3=60$ ppb)
0.05 NO$_2$/NOx in-stack ratio
Max DV: 143 $\mu$g/m$^3$
Base
OLM (O₃=60 ppb)
0.1 NO₂/NOx in-stack ratio
Max DV: 173 µg/m³
Base
PVMRM \( (O_3=60 \text{ ppb}) \)
0.05 \( \text{NO}_2/\text{NOx} \) in-stack ratio
Max DV: 378 \( \mu g/m^3 \)
Base
PVMRM ($O_3$=60 ppb)
0.1 $NO_2/NO_x$ in-stack ratio
Max DV: 404 $\mu g/m^3$
Base
PVMRM (2004-2008 O₃)
0.05 NO₂/NOₓ in-stack ratio
Max DV: 465 µg/m³
Base
PVMRM (2004-2008 O₃)
0.1 NO₂/NOx in-stack ratio
Max DV: 484 µg/m³
Stack ht increase #1
OLM (O₃=60 ppb)
0.05 NO₂/NOx in-stack ratio
Max DV: 140 μg/m³
Stack ht increase #1

OLM ($O_3$=60 ppb)

0.1 $NO_2$/NOx in-stack ratio

Max DV: 167 $\mu$g/m$^3$
Stack ht increase #1
PVMRM ($O_3$=60 ppb)
0.05 NO$_2$/NOx in-stack ratio
Max DV: 331 μg/m$^3$
Stack ht increase #1
PVMRM ($O_3=60$ ppb)
$0.1 \text{ NO}_2/\text{NOx}$ in-stack ratio
Max DV: $355 \, \mu g/m^3$
Stack ht increase #1
PVMRM (2004-2008 $O_3$)
0.05 $NO_2/NO_x$ in-stack ratio
Max DV: 398 $\mu g/m^3$
Stack ht increase #1
PVMRM (2004-2008 $O_3$)
0.1 $NO_2/NO_x$ in-stack ratio
Max DV: 413 $\mu g/m^3$
Stack ht increase #2
OLM (O₃=60 ppb)
0.05 NO₂/NOₓ in-stack ratio
Max DV: 133 μg/m³
Stack ht increase #2
OLM (O₃=60 ppb)
0.1 NO₂/NOx in-stack ratio
Max DV: 154 μg/m³
Stack ht increase #2
PVMRM ($O_3=60$ ppb)
$0.05\ NO_2/NO_x$ in-stack ratio
Max DV: 269 $\mu g/m^3$
Stack ht increase #2
PVMRM (O₃=60 ppb)
0.1 NO₂/NOx in-stack ratio
Max DV: 289 µg/m³
Stack ht increase #2
PVMRM (2004-2008 O₃)
0.05 NO₂/NOx in-stack ratio
Max DV: 329 μg/m³
Stack ht increase #2
PVMRM (2004-2008 O₃)
0.1 NO₂/NOx in-stack ratio
Max DV: 338 μg/m³
Stack ht increase #2 + increased emissions
OLM (O₃=60 ppb)
0.05 NO₂/NOx in-stack ratio
Max DV: 173 μg/m³
Stack ht increase #2 + increased emissions
OLM ($O_3=60$ ppb)
0.1 NO$_2$/NOx in-stack ratio
Max DV: 233 $\mu$g/m$^3$
Stack ht increase #2 + increased emissions
PVMRM ($O_3=60$ ppb)
$0.05 \text{ NO}_2/\text{NOx}$ in-stack ratio
Max DV: 410 $\mu g/m^3$
Stack ht increase #2 + increased emissions
PVMRM ($O_3=60$ ppb)
$0.1 \text{ NO}_2/\text{NOx in-stack ratio}$
Max DV: $464 \mu g/m^3$
Stack ht increase #2 + increased emissions

PVMRM (2004-2008 O₃)

0.05 NO₂/NOx in-stack ratio

Max DV: 534 μg/m³
Stack ht increase #2 + increased emissions
PVMRM (2004-2008 O₃)
0.1 NO₂/NOx in-stack ratio
Max DV: 592 μg/m³
Asphalt Plant (San Juan): NO$_2$
Base
Continuous operations
0.1 NO₂/NOx ratio
Max DV: 280 μg/m³
Base
Daytime operations
0.1 NO₂/NOx ratio
Max DV: 176 µg/m³
Base
Continuous operations
0.2 NO₂/NOx ratio
Max DV: 329 μg/m³
Base
Daytime operations
0.2 NO₂/NOx ratio
Max DV: 237 μg/m³
Base
Continuous operations
0.3 NO₂/NOx ratio
Max DV: 383 µg/m³
Base
Daytime operations
0.3 NO₂/NOx ratio
Max DV:  299 μg/m³
Base
Continuous operations
0.3 NO₂/NOx ratio
O₃=40 ppb
Max DV: 397 μg/m³
Base
Daytime operations
0.3 $\text{NO}_2$/NOx ratio
$O_3=80$ ppb
Max DV: 470 $\mu\text{g/m}^3$
Stack ht increase #1
Continuous operations
0.1 NO$_2$/NOx ratio
Max DV: 227 µg/m$^3$
Stack ht increase #1
Daytime operations
0.1 NO₂/NOx ratio
Max DV: 162 μg/m³
Stack ht increase #1
Continuous operations
0.2 NO$_2$/NOx ratio
Max DV: 269 µg/m$^3$
Stack ht increase #1
Daytime operations
0.2 NO₂/NOx ratio
Max DV: 188 μg/m³
Stack ht increase #1
Continuous operations
0.3 NO₂/NOx ratio
Max DV: 313 μg/m³
Stack ht increase #1
Daytime operations
0.3 NO$_2$/NOx ratio
Max DV: 215 $\mu$g/m$^3$
Stack ht increase #1
Continuous operations
0.3 NO₂/NOx ratio
O₃ = 40 ppb
Max DV: 322 μg/m³
Stack ht increase #1
Daytime operations
0.3 NO₂/NOx ratio
O₃ = 80 ppb
Max DV: 368 μg/m³
Stack ht increase #2
Continuous operations
0.1 NO₂/NOx ratio
Max DV: 225 μg/m³
Stack ht increase #2
Daytime operations
0.1 NO₂/NOx ratio
Max DV: 160 µg/m³
Stack ht increase #2
Continuous operations
0.2 NO₂/NOx ratio
Max DV: 267 μg/m³
Stack ht increase #2
Daytime operations
0.2 NO₂/NOx ratio
Max DV: 187 μg/m³
Stack ht increase #2
Continuous operations
0.3 NO$_2$/NOx ratio
Max DV: 311 µg/m$^3$
Stack ht increase #2
Daytime operations
0.3 NO$_2$/NOx ratio
Max DV: 214 μg/m$^3$
Stack ht increase #2
Continuous operations
0.3 NO₂/NOx ratio
O₃=40 ppb
Max DV: 320 μg/m³
Stack ht increase #2
Daytime operations
0.3 NO₂/NOx ratio
O₃=80 ppb
Max DV: 365 μg/m³
Stack ht increase #1 + controls
Continuous operations
0.1 NO$_2$/NOx ratio
Max DV: 227 $\mu$g/m$^3$
Stack ht increase #1 + controls
Daytime operations
0.1 NO$_2$/NOx ratio
Max DV: 162 µg/m$^3$
Stack ht increase #1 + controls
Continuous operations
0.2 NO₂/NOx ratio
Max DV: 269 µg/m³
Stack ht increase #1 + controls
Daytime operations
0.2 NO$_2$/NOx ratio
Max DV: 188 $\mu$g/m$^3$
Stack ht increase #1 + controls
Continuous operations
0.3 NO₂/NOx ratio
Max DV: 313 µg/m³
Stack ht increase #1 + controls
Daytime operations
0.3 NO$_2$/NOx ratio
Max DV: 215 μg/m$^3$
Stack ht increase #1 + controls
Continuous operations
0.3 NO$_2$/NOx ratio
O$_3$=40 ppb
Max DV: 322 $\mu$g/m$^3$
Stack ht increase #1 + controls
Daytime operations
0.3 NO₂/NOₓ ratio
O₃=80 ppb
Max DV: 368 µg/m³
SO₂ results
Ethanol Plant (Moline): SO\textsubscript{2}

- Baseline
- Increase stack ht Unit 4
- Increase stack ht Unit 4 w/ controls
- Increase stack ht Unit 4 w/ additional controls

NAAQS
Base: 300 m FL
Max DV: 114 µg/m³
Base
50 m FL
Max DV: 296 µg/m³
Increase stack ht C0004
300 m FL
Max DV: 114 μg/m³
Increase stack ht C0004
50 m FL
Max DV: 296 µg/m³
Increase stack ht C0004 + controls
300 m FL
Max DV: 114 µg/m³
Increase stack ht C0004 + controls
50 m FL
Max DV: 296 µg/m³
Increase stack ht C0004 + additional controls
300 m FL
Max DV: 114 μg/m³
Increase stack ht C0004 + additional controls
50 m FL
Max DV: 296 µg/m³
Ethanol Plant (Springfield): SO$_2$

- Baseline
- Increase stack ht Unit 4
- Increase stack ht Unit 4 w/ controls
- Increase stack ht Unit 4 w/ additional controls

Concentration (µg/m$^3$)

NAAQS

- 300 m FL
- 50 m FL
Base:
300 m FL
Max DV: 131 μg/m³
Base
50 m FL
Max DV: 356 μg/m³
Increase stack ht C0004
300 m FL
Max DV: 131 µg/m³
Increase stack ht C0004
50 m FL
Max DV: 356 μg/m³
Increase stack ht C0004 + controls
300 m FL
Max DV: 131 μg/m³
Increase stack ht C0004 + controls
50 m FL
Max DV: 356 μg/m³
Increase stack ht C0004 + additional controls
300 m FL
Max DV: 131 µg/m³
Increase stack ht C0004 + additional controls
50 m FL
Max DV: 356 µg/m³

Legend
- Green ≤25
- Light green 26 - 50
- Yellow 51 - 75
- Orange 76 - 100
- Light orange 101 - 125
- Dark yellow 126 - 150
- Brown 151 - 196
- Orange brown 197 - 250
- Red orange 251 - 300
- Red 301 - 356

Springfield
Ethanol Plant (St. Louis): SO$_2$

- Baseline
- Increase stack ht Unit 4
- Increase stack ht Unit 4 w/ controls
- Increase stack ht Unit 4 w/ additional controls

**Concentration (µg/m$^3$)**

- **NAAQS**

**Legend**
- 300 m FL
- 50 m FL
Base:
300 m FL
Max DV: 112 μg/m³
Base
50 m FL
Max DV: 268 μg/m³

Legend
- <=25
- 26 - 50
- 51 - 75
- 76 - 100
- 101 - 125
- 126 - 150
- 151 - 175
- 176 - 196
- 197 - 225
- 226 - 268

St. Louis
Increase stack ht C0004
300 m FL
Max DV: 112 μg/m³
Increase stack ht C0004
50 m FL
Max DV: 268 μg/m³
Increase stack ht C0004 + controls
300 m FL
Max DV: 112 μg/m³
Increase stack ht C0004 + controls
50 m FL
Max DV: 268 µg/m³
Increase stack ht C0004 + additional controls
300 m FL
Max DV: 112 µg/m³
Increase stack ht C0004 + additional controls
50 m FL
Max DV: 268 µg/m³
Ethanol Plant (Waterloo): SO$_2$

- Baseline
- Increase stack ht Unit 4
- Increase stack ht Unit 4 w/ controls
- Increase stack ht Unit 4 w/ additional controls

NAAQS
Base: 300 m FL
Max DV: 130 µg/m³
Base
50 m FL
Max DV: 328 μg/m³
Increase stack ht C0004
300 m FL
Max DV: 130 μg/m³
Increase stack ht C0004
50 m FL
Max DV: 328 µg/m³
Increase stack ht C0004 + controls
300 m FL
Max DV: 130 µg/m³
Increase stack ht C0004 + controls
50 m FL
Max DV: 328 μg/m³
Increase stack ht C0004 + additional controls
300 m FL
Max DV: 130 μg/m³
Increase stack ht C0004 + additional controls
50 m FL
Max DV: 328 µg/m³
Coal EGU (Springfield): $\text{SO}_2$

Baseline
Stack ht increase
Controls
Stack ht increase w/ controls
Stack ht increase w/ additional controls
Stack ht increase w/ additional controls & higher exit velocity

NAAQS
Springfield

Base
Max DV: 48 μg/m³

Legend

- <=18
- 17 - 20
- 21 - 24
- 25 - 23
- 29 - 32
- 33 - 38
- 37 - 40
- 41 - 44
- 45 - 49

0 1,300 2,600 5,200 7,800 10,400 Meters
Stack ht increase #1
Max DV: 38 μg/m³
Springfield

Controls
Max DV: 39 µg/m³
Springfield

Stack ht increase #1 + controls
Max DV: 31 μg/m³
Stack ht increase #2 + controls
Max DV: 27 μg/m³
Stack ht increase #2 + controls + higher exit velocity
Max DV: 28 μg/m³
Coal EGU (Charleston): SO$_2$

- **Baseline H=65 m**
- **Stack ht increaser**
- **Controls**
- **Stack ht increase w/ controls**
- **Stack ht increase w/ additional controls**
- **Stack ht increase w/ additional controls & higher exit velocity**

**DRAFT**
Uncontrolled
Base parameters (h=65)
Max DV: 905 µg/m³
Charleston

Uncontrolled
Base parameters
Max DV: 65 μg/m³
Uncontrolled Stack height increase #1
Max DV: 54 μg/m³
Charleston

Uncontrolled Stack ht increase #2
Max DV: 45 \( \mu g/m^3 \)
Uncontrolled
Stack ht increase #2 + higher exit velocity
Max DV: 47 μg/m³
Charleston

Base
h=65 m
Max DV: 445 μg/m³
Charleston
Max DV: 33 μg/m³
Charleston

Stack ht increase #1
Max DV: 33 μg/m³

Legend
- <=34
- 35 - 50
- 51 - 100
- 101 - 150
- 151 - 196
- 197 - 300
- 301 - 400
- 401 - 500
- 501 - 600
- 601 - 700
- 701 - 800
- 801 - 905

0 1,300 2,600 5,200 7,800 10,400 Meters
Stack ht increase #1 + controls
Max DV: 33 μg/m³
Stack ht increase #2 + controls
Max DV: 33 μg/m³
Charleston

Stack ht increase #2 + controls + higher exit velocity

Max DV: 33 μg/m³
Refinery: SO₂

Graph showing concentration (µg/m³) of SO₂ under various conditions:
- Base with no controls
- Stack height increase #2 with no controls on 2 units
- Base
- Stack height increase #1
- Stack height increase #2

Legend:
- Rural flat
- Urban flat
- Rural terrain
- Urban terrain

NAAQS line at 200 µg/m³.
Uncontrolled
Flat, Rural
Max DV: 163 μg/m³
Uncontrolled Terrain, Rural
Max DV: 272 µg/m³
Uncontrolled Terrain, Urban
Max DV: 263 μg/m³
Uncontrolled + stack ht increase #2
Flat, Rural
Max DV: 145 µg/m³
Uncontrolled + stack ht increase #2
Flat, Urban
Max DV: 229 μg/m³
Uncontrolled + stack ht increase #2
Terrain, Rural
Max DV: 242 μg/m³
Uncontrolled + stack ht increase #2
Terrain, Urban
Max DV: 228 μg/m³
Base
Flat, Rural
Max DV: 25 µg/m³
Base
Flat, Urban
Max DV: 41 μg/m³
Base Terrain, Rural
Max DV: 38 µg/m³
Base Terrain, Urban
Max DV: 41 μg/m³
Stack ht increase #1
Flat, Rural
Max DV: 25 μg/m³
Stack ht increase #1
Flat, Urban
Max DV: 41 μg/m³
Stack ht increase #1
Terrain, Rural
Max DV: 37 μg/m³
Stack ht increase #1
Terrain, Urban
Max DV: 41 μg/m³
Stack ht increase #2
Flat, Rural
Max DV: 24 μg/m³
Stack ht increase #2
Flat, Urban
Max DV: 36 $\mu$g/m$^3$
Stack ht increase #2
Terrain, Rural
Max DV: 36 µg/m³
Stack ht increase #2
Terrain, Urban
Max DV: 35 μg/m³
Cement Kiln: SO$_2$

- Baseline Controls
- More stringent controls

Concentration (µg/m$^3$)

NAAQS
Base
Max DV: 34 µg/m³
Controls
Max DV: 11 μg/m³
More stringent controls
Max DV: 4 μg/m³
Pulp & paper: SO$_2$

![Bar chart showing concentration of SO$_2$ for different scenarios: Base, Stack ht increase #1, Stack ht increase #2, and Stack ht increase #2 & controls. The NAAQS line is shown as a horizontal line at 200 μg/m$^3$. The Base scenario has the highest concentration, far exceeding the NAAQS limit.](image-url)
Base
Max DV: 924 μg/m³
Stack ht increase #1
Max DV: 553 μg/m³
Stack ht increase #2
Max DV: 212 µg/m³
Stack ht increase #2 + controls
Max DV: 212 µg/m³
Max DV: 17 μg/m³
Stack ht increase #1
Max DV: 5 μg/m³
Stack ht increase #2
Max DV: 2 µg/m³
Stack ht increase #1
Max DV: 238 μg/m³
Stack ht increase #2
Max DV: 178 μg/m³
Legend

- ≤50
- 51 - 100
- 101 - 150
- 151 - 200
- 201 - 250
- 251 - 300
- 301 - 354

Baseline
Max DV: 324 μg/m³
Stack ht increase to 45
Max DV: 219 µg/m³
Stack ht increase to 65 + controls
Max DV: 9 μg/m³
Asphalt Plant (Alva): SO$_2$

Baseline Stack ht increase

Stack ht increase #1

Stack ht increase #2

NAAQS

Continuous (no DW)
Daytime ops (no DW)
Continuous with DW
Continuous with DW (alternate fuel)
Base
Continuous operations
No downwash
Max DV: 874 µg/m³
Base
Daytime operations
No downwash
Max DV: 874 µg/m³
Base
Continuous operations
With downwash
Max DV: 1254 μg/m³
Base
Continuous operations
With downwash
0.5% sulfur content fuel oil
Max DV: 1255 µg/m³
Stack ht increase #1
Continuous operations
No downwash
Max DV: 82 μg/m³
Stack ht increase #1
Daytime operations
No downwash
Max DV: 82 µg/m³
Stack ht increase #1
Continuous operations
With downwash
Max DV: 359 µg/m³
Stack ht increase #2
Continuous operations
No downwash
Max DV: 17 µg/m³
Stack ht increase #2
Daytime operations
No downwash
Max DV: 17 μg/m³
Stack ht increase #2
Continuous operations
With downwash
Max DV: 23 μg/m³
Asphalt Plant (Boise): SO$_2$

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Baseline</th>
<th>Stack ht increase #1</th>
<th>Stack ht increase #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous (no DW)</td>
<td>600</td>
<td>400</td>
<td>100</td>
</tr>
<tr>
<td>Daytime ops (no DW)</td>
<td>500</td>
<td>300</td>
<td>80</td>
</tr>
<tr>
<td>Continuous with DW</td>
<td>400</td>
<td>200</td>
<td>50</td>
</tr>
<tr>
<td>Continuous with DW (alternate fuel)</td>
<td>300</td>
<td>100</td>
<td>20</td>
</tr>
</tbody>
</table>

NAAQS: 200 µg/m$^3$
Base
Continuous operations
No downwash
Max DV: 592 µg/m³
Base
Daytime operations
No downwash
Max DV: 460 μg/m³
Base
Continuous operations
With downwash
Max DV: 1520 μg/m³
Base
Continuous operations
With downwash
0.5% sulfur content fuel oil
Max DV: 1520 μg/m³
Stack ht increase #1
Continuous operations
No downwash
Max DV: 102 µg/m³
Stack ht increase #1
Daytime operations
No downwash
Max DV: 98 μg/m³
Stack ht increase #1
Continuous operations
With downwash
Max DV: 347 μg/m³
Stack ht increase #2
Continuous operations
No downwash
Max DV: 17 μg/m³
Stack ht increase #2
Daytime operations
No downwash
Max DV: 17 μg/m³
Stack ht increase #2
Continuous operations
With downwash
Max DV: 19 μg/m³
Asphalt Plant (Empire Abo): SO$_2$

Baseline Stack ht increase

#1 Stack ht increase

#2 NAAQS

- Continuous (no DW)
- Daytime ops (no DW)
- Continuous with DW
- Continuous with DWV (alternate fuel)
Base
Continuous operations
No downwash
Max DV: 681 μg/m³
Base
Daytime operations
No downwash
Max DV: 602 μg/m³
Base
Continuous operations
With downwash
Max DV: 1401 μg/m³

Legend
- <=10
- 11-25
- 26-50
- 51-75
- 76-100
- 101-125
- 126-150
- 151-175
- 176-196
- 197-400
- 401-600
- 601-800
- 801-1,120

Empire Abo
Base
Continuous operations
With downwash
0.5% sulfur content fuel oil
Max DV: \(1401 \, \mu g/m^3\)
Stack ht increase #1
Continuous operations
No downwash
Max DV: 106 $\mu$g/m$^3$
Stack ht increase #1
Daytime operations
No downwash
Max DV: 99 µg/m³
Stack ht increase #1
Continuous operations
With downwash
Max DV: 371 µg/m³
Stack ht increase #2
Continuous operations
No downwash
Max DV: 18 μg/m³
Stack ht increase #2
Daytime operations
No downwash
Max DV: 18 μg/m³
Stack ht increase #2
Continuous operations
With downwash
Max DV: 18 μg/m³
Asphalt Plant (San Juan): SO$_2$

- Baseline Stack height increase
- Stack height increase #1
- Stack height increase #2

Concentration ($\mu$g/m$^3$)

- Continuous (no DW)
- Daytime ops (no DW)
- Continuous with DW
- Continuous with DW (alternate fuel)
Base
Continuous operations
No downwash
Max DV: 886 μg/m³
Base
Daytime operations
No downwash
Max DV: 810 μg/m³
Base
Continuous operations
With downwash
Max DV: 3790 μg/m³
Base
Continuous operations
With downwash
0.5% sulfur content fuel oil
Max DV: 3790 µg/m³
Stack ht increase #1
Continuous operations
No downwash
Max DV: 103 μg/m³
Stack ht increase #1
Daytime operations
No downwash
Max DV: 103 µg/m³
Stack ht increase #1
Continuous operations
With downwash
Max DV: 341 \( \mu g/m^3 \)
Stack ht increase #2
Continuous operations
No downwash
Max DV: 29 μg/m³
Stack ht increase #2
Daytime operations
No downwash
Max DV: 29 µg/m³

Legend

- 10
- 11 - 25
- 26 - 50
- 51 - 75
- 76 - 100
- 101 - 125
- 126 - 150
- 151 - 175
- 176 - 196
- 197 - 400
- 401 - 600
- 601 - 800
- 801 - 1,006

San Juan
Stack ht increase #2
Continuous operations
With downwash
Max DV: 37 μg/m³
Base
Continuous operations
No downwash
Max DV: 492 μg/m³
Base
Daytime operations
No downwash
Max DV: 364 µg/m³
Base
Continuous operations
With downwash
Max DV: 1394 μg/m³
Base
Continuous operations
With downwash
0.5% sulfur content fuel oil
Max DV: 1394 μg/m³
Stack ht increase #1
Continuous operations
No downwash
Max DV: 106 μg/m³
Stack ht increase #1
Daytime operations
No downwash
Max DV: 100 µg/m³
Stack ht increase #1
Continuous operations
With downwash
Max DV: 337 µg/m³
Stack ht increase #2
Continuous operations
No downwash
Max DV: 18 μg/m³
Stack ht increase #2
Daytime operations
No downwash
Max DV: 18 μg/m³
Stack ht increase #2
Continuous operations
With downwash
Max DV: 18 μg/m³