Missouri Department of Natural Resources

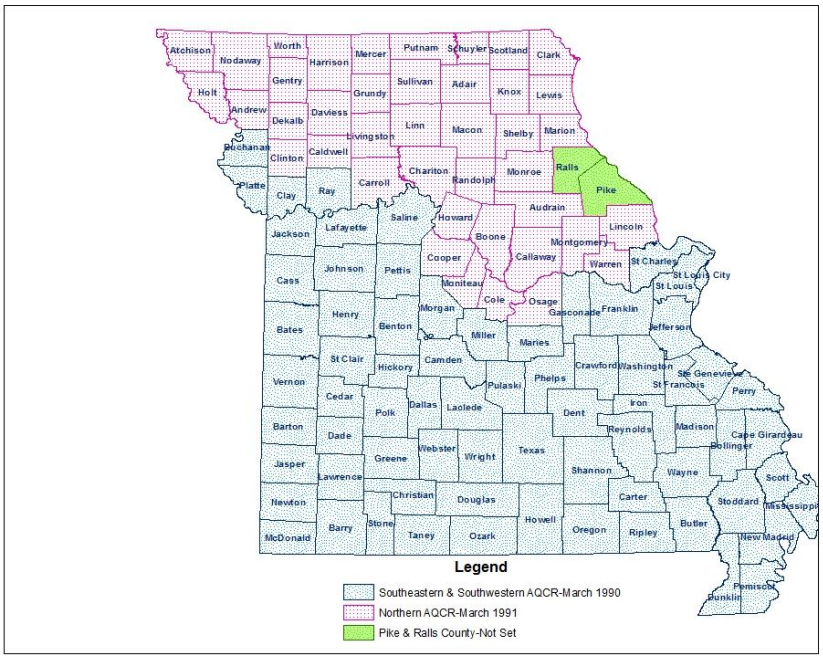
***Increment Standards-Nitrogen Dioxide***

Nitrogen dioxide ($NO_2$) is one component of a group of highly reactive gases known as oxides of nitrogen ($NO_x$). $NO_2$ rapidly forms in the atmosphere due to the release of emissions from vehicles and combustion processes. $NO_2$ is an ozone precursor and also contributes to the secondary formation of fine particulate matter. The scope of this document is limited to a discussion on demonstrating compliance with the increment standards. For a general discussion on increment, please refer to the document entitled "Increment Standards."

The major source baseline date and the trigger date for $NO_2$ are identical and were established in February of 1988. As referenced in Figure 1, the minor source baseline date has been triggered for the majority of the air quality control regions (AQCRs) within the State of Missouri with the exception of Pike and Ralls counties. The minor source baseline dates for those portions of the state where increment is being consumed is based upon two differing dates:

- March 1990-southeastern and southwestern AQCRs, and
- March 1991-northern A QCR.

Figure 1
$NO_2$ Minor Source Baseline Dates




Compliance with the Class II increment standard for $NO_2$ is based upon the maximum annual concentration that is predicted to occur at each receptor within the modeling domain, refer to Table 1.

| Table 1<br>Class II Increment Standard-$NO_2$ | | | |
|---|---|---|---|
| **Pollutant** | **Averaging Time** | **Increment** | **Comment** |
| | | ***($\mu g/m^3$)*** | |
| $NO_2$ | Annual | 25 | Not to be exceeded |

Because $NO_x$ is highly reactive, 40 CFR Part 51 Appendix W, "The Guideline on Air Quality Models," suggests that a three tiered screening approach be used to determine compliance with the annual averaging period.

**Tier 1**

The Tier 1 analysis assumes a total conversion of nitric oxide (NO) to $NO_2$. The maximum, annual average concentration predicted by the dispersion model over the five year period should be compared to the Class II increment standard of 25 $\mu g/m^3$. All comparisons to the increment standard should be based upon the combined impact due to the proposed source and interactive sources. The annual standard is not to be exceeded.

**Tier 2**

For the Tier 2 analysis, the Tier 1 results are multiplied by a default, $NO_2/NO_x$ ambient ratio of 0.75 for annual averaging period. All comparisons to the increment standard should be based upon the combined impact due to the proposed source and interactive sources. Again, the annual standard is not to be exceeded.

**Tier 3**

If an applicant fails to demonstrate compliance through the application of the Tier 2 ambient ratio method, a more detailed, screening method may be implemented on a case by case basis. A Tier 3 model analysis for $NO_2$ is considered a non-regulatory default option and requires approval from the Environmental Protection Agency Region VII in accordance with Section 3.2.2, paragraph (e) in 40 CFR Part 51 Appendix W.

In a memo dated June 29, 2010, entitled "Guidance Concerning the Implementation of the 1-hour $NO_2$ NAAQS for the Prevention of Significant Deterioration Program," the Environmental Protection Agency offered two differing NO to $NO_2$ conversion methods: the ozone limiting method (OLM) and the plume volume molar ratio method (PVMRM). To date, the Environmental Protection Agency has not stated a preference for either model option and will allow the use of either method provided adequate justification for a Tier 3 analysis is provided.

In order to conduct a model analysis using the OLM or the PVMRM method, the user must provide the following parameters: the in-stack $NO_2/NO_x$ ratio, a background ozone value and an optional equilibrium ratio. A default in-stack ratio of 0.50 can be input into the air quality model without further justification. If an applicant proposes the use of a differing $NO_2/NO_x$ ratio,

justification must be provided to the construction permit engineer reviewing the application. If inadequate justification is provided due to a lack of available data, post-construction stack testing will be required to confirm the accuracy of the ratio since it directly impacts the model predictions that are ultimately used to determine compliance.

Background ozone values can be input as a single value, temporally varying values or as hourly values. If the applicant chooses to use a single ozone value, the OZONEVAL keyword should be selected. The use of a single ozone value in most instances should result in conservative $NO_2$ estimates. The value chosen for use in the air quality analysis can be provided by the department's Air Pollution Control Program and is dependent upon the location where the facility will be located.

The applicant may also want to specify background ozone concentrations based upon season, day of the week or time of day. In this instance, the O3VALUES keyword should be selected in the control pathway. As noted above, the values chosen for input into the air quality model will be provided by the department's Air Pollution Control Program.

Lastly, hourly ozone concentrations can be input into the air quality model using a separate, concentration file through the use of the OZONEFILE keyword in the control pathway. The background ozone file must contain a record for each hour within the year being modeled. All hourly ozone values will be provided by the department's Air Pollution Control Program.

An ambient equilibrium ratio of 0.90 is the default value for the AERMOD modeling system. The user does not have to specify an equilibrium ratio if the default value is chosen. If an applicant chooses to enter a non-default equilibrium ratio; the optional NO2EQUIL keyword must be selected prior to model execution. Any deviation from the default 0.90 ratio must be pre-approved by the Construction Permit Modeling Unit and the Environmental Protection Agency Region VII.

If the predicted impact due to the proposed source and interactive sources is below the Class II increment standard for the annual averaging period, compliance has been demonstrated and no further analysis for the $NO_2$ increment standard will be necessary.

If, on the other hand, violations of the $NO_2$ increment standard are predicted to occur at one or more receptors, the applicant will be required to determine if the proposed project or modification has a significant ambient impact. If the source can demonstrate that it does not have a significant impact on a violating receptor(s), measured in time and space, a permit can be issued without further review of the standard. If the source cannot demonstrate less than significant impacts, the facility must consider emission limits, the installation of controls or other measures in order to reduce its ambient impact at violating receptors.

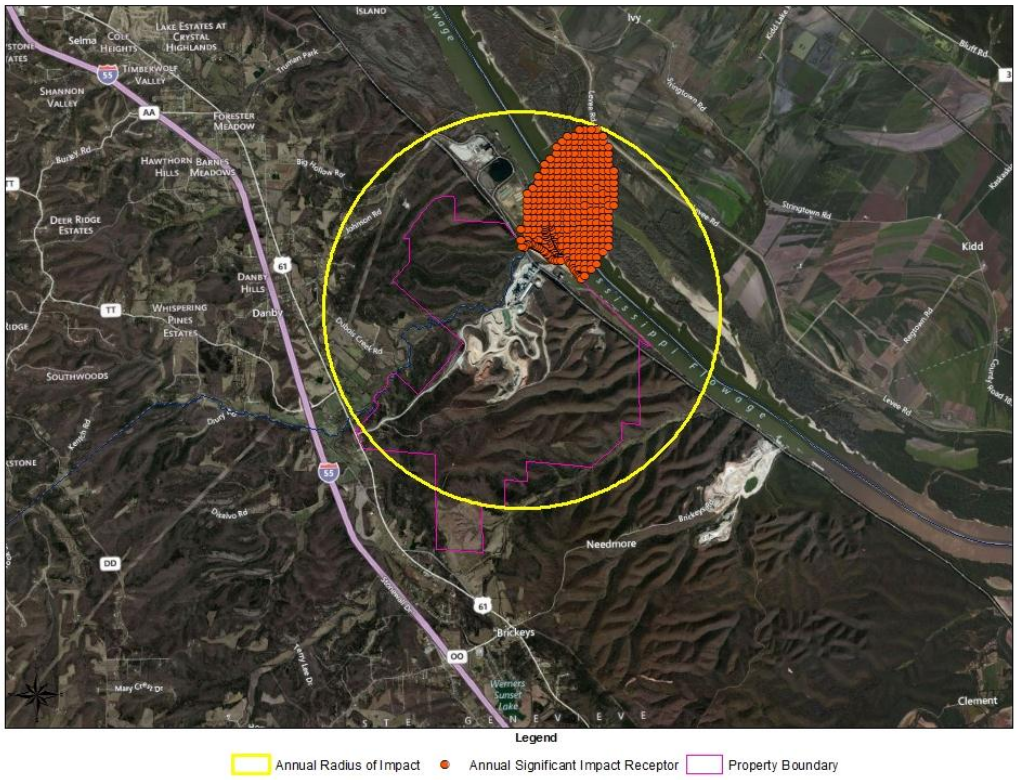
The following paragraphs provide a hypothetical example of a Class II increment evaluation for $NO_2$. The data describes a basic situation and is not meant to address all modeling scenarios and/or issues that might arise during the review process.

**Example Increment Demonstration**

Facility A is proposing to install a coal-fired boiler at a greenfield site. Based upon the emissions from the worst case operating load, the preliminary impact analysis (project emissions only), indicates that Facility A's radius of impact extends 1.52-kilometers beyond the center of the proposed facility, refer to Figure 2.

Because the ambient impact due to the proposed construction exceeds the annual significant impact threshold of 1.00 $\mu g/m^3$, a full impact analysis is required and must include an evaluation of compliance with the Class II increment standard.

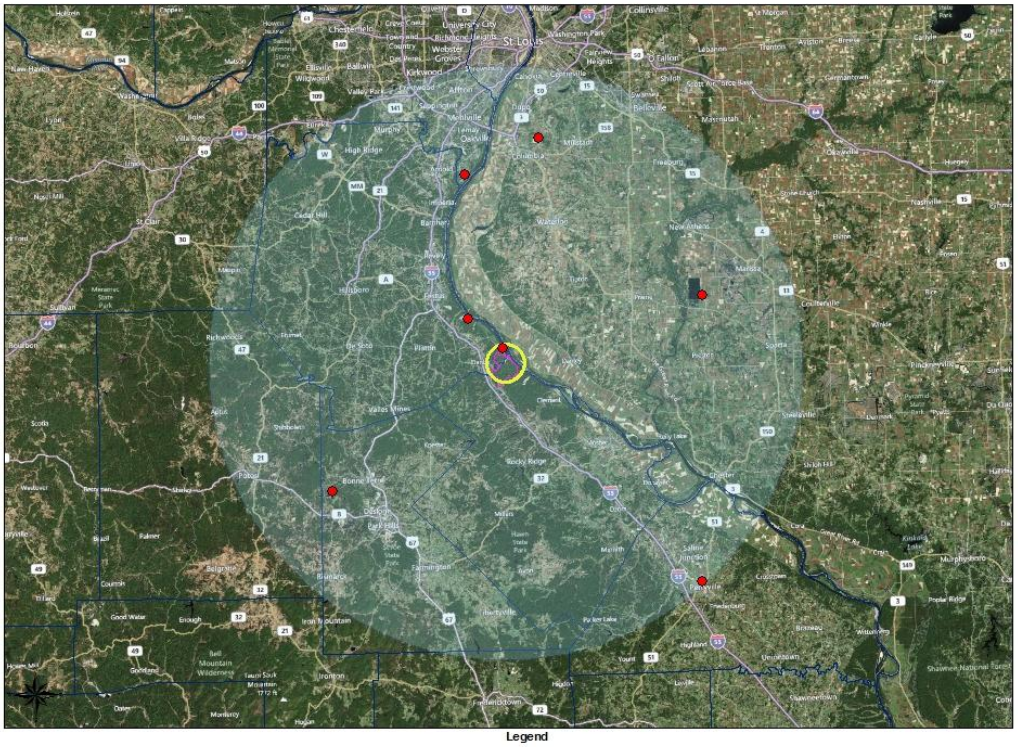
**Figure 2**
**$NO_2$ Significant Impact Determination**
**Annual Significant Impact Comparison**




As noted in the introduction, increment compliance is based upon the impact due to the combination of the emissions from the proposed source and existing "interactive" sources. In order to determine the impact due to the proposed source and interactive sources, the emissions from Facility A and existing $NO_2$ sources must be explicitly modeled and compared to the increment standard. The radius of impact due to the proposed project determined what sources were explicitly modeled for compliance purposes. The air quality analysis must consider

any emission source that could consume increment within the significant impact area of the facility under consideration, refer to Figure 3.

**Figure 3**
**$NO_2$ Prevention of Significant Deterioration Domain**
**Interactive Source Inventory Development**



**Legend**

Interactive Source Inventory | Facility A Radius of Impact | 50-Kilometer PSD Domain | Property Boundary

Emission rates and release parameters for each source within the inventory were input into the air quality model. The combined ambient impact due to the modeled sources were calculated and output on a receptor by receptor basis for use in the compliance demonstration. Table 2 contains the model outputs for a sampling of receptors that were evaluated for this example. The results reflect the Tier 1 model concentrations where a total conversion of NO to $NO_2$ is assumed.

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| Table 2<br>Tier 1 Increment Compliance Determination | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Annual Averaging Period<br>(Increment 25 μ/gm$^3$) | | | | | | | | | | |
| Easting | Northing | Elevation | Hill | 2003 | 2004 | 2005 | 2006 | 2007 | Max | Increment |
| *(Meters)* | *(Meters)* | *(Meters)* | *(Meters)* | *(μg/m$^3$)* | *(μg/m$^3$)* | *(μg/m$^3$)* | *(μg/m$^3$)* | *(μg/m$^3$)* | *(μg/m$^3$)* | *(μg/m$^3$)* |
| | | | | *(H1H)* | *(H1H)* | *(H1H)* | *(H1H)* | *(H1H)* | *(H1H)* | *(H1H)* |
| 733500 | 4229000 | 136.07 | 250.63 | 74.9604 | 72.1933 | 68.0504 | 74.7776 | 75.3785 | 75.3785 | 25.00 |
| 733500 | 4229500 | 131.02 | 250.63 | 69.2271 | 63.803 | 59.25913 | 62.4304 | 58.7712 | 69.2271 | 25.00 |
| 733500 | 4230000 | 140.56 | 215.67 | 66.62919 | 68.6382 | 59.4365 | 65.0716 | 60.4779 | 68.6382 | 25.00 |
| 734000 | 4229500 | 114.4 | 250.63 | 23.96769 | 20.418 | 24.48804 | 22.59625 | 19.48997 | 24.48804 | 25.00 |
| 732500 | 4229000 | 148.56 | 208.98 | 20.01656 | 16.92957 | 20.55613 | 20.06094 | 18.12312 | 20.55613 | 25.00 |
| 734000 | 4230000 | 114.29 | 250.63 | 8.70069 | 10.29164 | 12.25663 | 11.94081 | 11.28596 | 12.25663 | 25.00 |

The first four columns contain information regarding the location of the receptor under review, followed by the predicted concentration from the dispersion model for each year under consideration. For the annual averaging period, the maximum concentration for the five year period was obtained and compared to the increment standard. Based upon the results contained within Table 2, the top three annual concentrations exceed the increment standard of 25.0 μg/m$^3$. Because increment violations are predicted to occur, the applicant must determine if Facility A has a significant impact on a violating receptor, refer to Table 3.

| Table 3<br>Tier 1 $NO_2$ Increment Violations vs. Significant Impact | | | | | |
|---|---|---|---|---|---|
| Annual Increment (25.0 μg/m$^3$) vs. Significance (1.0 μg/m$^3$) | | | | | |
| Easting | Northing | Elevation | Hill | Increment | Significant Impact Concentration |
| *(Meters)* | *(Meters)* | *(Meters)* | *(Meters)* | *(μg/m$^3$)* | *(μg/m$^3$)* |
| | | | | *(H1H)* | *(H1H)* |
| 733500 | 4229000 | 136.07 | 250.63 | 75.3785 | 10.23 |
| 733500 | 4229500 | 131.02 | 250.63 | 69.2271 | 1.25 |
| 733500 | 4230000 | 140.56 | 215.67 | 68.6382 | 0.928 |

Facility A had a significant impact on a portion of the violating receptors; as such, Facility A's compliance with the increment standard has not been demonstrated and additional review is necessary.

Prior to reviewing additional control measures, a Tier 2 $NO_2$ analysis should be performed. The Tier 2 analysis, commonly referred to as the ambient ratio method, applies a $NO_2/NO_x$ conversion rate of 0.75 to the annual concentrations. The ambient ratio method can be applied to <u>both</u> the increment concentrations and the significant impact concentrations in order to determine if a significant ambient impact takes place at the same time as a violation. Table 4 contains the predicted concentrations that result after the application of the ambient ratio method to the increment and significant impact values.

| Table 4<br>Application of the Tier 2 Ambient Ratio Method<br>Increment Compliance Determination | | | | | | | |
|---|---|---|---|---|---|---|---|
| Annual Increment (25.00 μg/m$^3$) vs. Significance (1.0 μg/m$^3$) | | | | | | | |
| Easting | Northing | Elevation | Hill | Increment | Significant Impact Concentration | Increment | Significant Impact Concentration |
| | | | | | | *Ambient Ratio Method* | |
| *(Meters)* | *(Meters)* | *(Meters)* | *(Meters)* | *(μg/m$^3$)* | *(μg/m$^3$)* | *(μg/m$^3$)* | *(μg/m$^3$)* |
| | | | | *(H1H)* | *(H1H)* | *(H1H)* | *(H1H)* |
| 733500 | 4229000 | 136.07 | 250.63 | 75.3785 | 10.23 | 56.53388 | 7.6725 |
| 733500 | 4229500 | 131.02 | 250.63 | 69.2271 | 1.25 | 51.92033 | 0.9375 |

After the application of the Tier 2 ambient ratio method, annual increment violations remain evident. However, it is important to note that at one of the violating receptors, the impact due to the proposed project falls below the significance threshold of 1.0 μg/m$^3$ through the application of the Tier 2 approach. As such, compliance with the annual increment for $NO_2$ at that receptor has been demonstrated.

Given the conservative nature of the Tier 2 approach, a third model run was conducted using the PVMRM described previously in the Tier 3 analysis section of this document. Tier 3 analyses should only be pursued after consultation with the permit granting authority and the Environmental Protection Agency Region VII. Any assumptions that are made must be pre-approved prior to their use in a compliance demonstration.

In order to conduct a model analysis using the PVMRM method, the applicant had to input an in-stack $NO_2/NO_x$ ratio, a background ozone value and an optional equilibrium ratio. For this example, default values for the in-stack ratio and equilibrium ratio of 0.50 and 0.90 were input into the air quality model. Additionally, a single ozone value was used in the analysis rather than an hourly ozone file. Table 5 contains the predicted concentrations that result after the application of PVMRM in the increment input file for the annual averaging period.

| Table 5<br>Tier 3 $NO_2$ Increment Compliance Determination | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Annual Averaging Period<br>(Increment 25 μ/gm$^3$) | | | | | | | | | | |
| Easting | Northing | Elevation | Hill | 2003 | 2004 | 2005 | 2006 | 2007 | Max | Increment |
| *(Meters)* | *(Meters)* | *(Meters)* | *(Meters)* | *(μg/m$^3$)* | *(μg/m$^3$)* | *(μg/m$^3$)* | *(μg/m$^3$)* | *(μg/m$^3$)* | *(μg/m$^3$)* | *(μg/m$^3$)* |
| | | | | *(H1H)* | *(H1H)* | *(H1H)* | *(H1H)* | *(H1H)* | *(H1H)* | *(H1H)* |
| 733500 | 4229000 | 136.07 | 250.63 | 17.9604 | 17.1933 | 18.0504 | 24.0776 | 24.3785 | 24.3785 | 25.00 |

The concentrations predicted for the annual averaging period experienced significant reductions after the application of the Tier 3 screening methods. Based upon the results, no violations remain and no further analysis is necessary.