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## **Special cases to consider when developing a receptor grid**

In most cases, the property line is well defined and all sources of emissions are on the property. However, for some activities, such as marine loading, sources may be located off-property and emitting directly into ambient air. For these cases, the following guidance for determining the points of evaluation is appropriate for the technical review process and applies whether the analysis is for a standard or effects screening level (ESL), with one exception. The Texas legislature enacted Section 382.066 in the Texas Health and Safety Code (THSC) [House Bill (HB) 3040] for shipyard facilities. This section exempts shipbuilding or ship repair operations from modeling and effects review for non-criteria pollutants over coastal waters. Therefore, for these facilities, the following guidance only applies to reviews concerning criteria pollutants. For non-criteria pollutants, no receptors are required over water.

## **Off-property receptors over water**

There are three basic approaches that could be used to determine where receptors should be placed when a source is located off-property in ambient air. These could be used individually or in combination. These distances would apply for technical review purposes only. The applicant must still comply with all the Agency's rules and regulations.

- *Set distance*: A fixed distance for modeled receptor grid points of 25 meters is normally used for low-level fugitive-type emissions and for emissions from stacks that could be affected by downwash. The points start at the property line and extend from about 100-200 meters before the suggested grid spacing changes. If the activity is located off-property in the water, the source of emissions is considered to be part of the property during actual operations. Since the general public would not be present at the source, receptors should be placed starting at a distance 25 meters from the edge of the source instead of on the actual property line.
- *Controlled or restricted distance*: There are two general distance limit scenarios.
  - *Controlled*: If the applicant can limit access to an area near the source of emissions for the duration of the operation such that the general public and off-site workers would not be exposed, the modeled receptor grid points could begin at the edge of the control area, as well as, on the property line in the

uncontrolled areas. Use of buoys would be an example of a way to limit access.

- Restricted: If the applicant can show that access is restricted, the modeled receptor grid points could begin at the edge of the restricted area, as well as, on the property line in the unrestricted areas. For the purposes of modeling and effects review, a restricted area is accessible only to the applicant's employees, including personnel associated with marine vessel operations. If other individuals have access to the area, then the area is not restricted, and receptors would be placed in the area. Examples of restricted areas could be a coastal easement agreement with the General Land Office that allows the applicant to restrict access, or any other authority that allows the applicant to post signs that prohibit access to anyone other than the applicant's personnel. The applicant should provide documentation for restricted areas, including specific coordinates and any applicable specified conditions for the area, to the permit reviewer. Note that a restricted area could be a water area, shore area, or both.
- *Model limitation distance*: There is another consideration, in addition to the set or controlled distance consideration. The model may not be able to calculate a concentration immediately adjacent to the source. In that case, the modeled receptor grid points should begin at the closest point that the model can calculate a concentration from the source at or beyond 25 meters from the edge of the source. The distance of the grid points from the edge of the source would be linked to the limiting algorithm in the model. This distance could be a minimum of one meter for a point, pseudo-point, or an area source to about 47 meters from the center of a volume source with about a 91-meter base.

Note that a model's limitation is not related to a "property line" but to an algorithm in the model. Therefore, there may be sources that are located on a property at a distance that would prevent the model from calculating a concentration on a property line or on a grid receptor placed on a land location off the property.

## **Following are some receptor placement examples**

*Receptor Placement Example 1*: Consider a site that has emissions from a stack on a ship that is moored at a dock in the water off the actual property of the applicant. Receptors should be placed starting at a distance of 25 meters from the edge of the ship in the water and out a sufficient distance to record the highest predicted concentrations and to demonstrate that concentrations are declining with distance.

*Receptor Placement Example 2*: Consider a site that conducts blasting operations in two locations at a site: a dock, located in the water off the applicant's actual property; and, outside a building located in the center of the property. Operations are such that the permit reviewer determines that PM<sub>10</sub> (a criteria pollutant) should be evaluated per HB3040. During blasting at the dock, the applicant can control access out to a distance of 40 meters over water from all sides of the ship. For the controlled area, receptors should be placed at the start of the area. Normal receptor placement procedures would be used for the property-line receptors over land, and away from the controlled area

over the water. Receptors over both land and water should extend out a sufficient distance to record the highest predicted concentrations and to demonstrate that concentrations are declining with distance.

If the dock and building operations can occur at the same time, then the controlled area for the dock operation will drive the creation of the receptor grid over water. However, if the operations can occur independently, and the area near the dock will not be controlled during operations at the building, then a separate model run may be required for this scenario depending on factors such as the amount of emissions and distance from the water. In this case, the receptors should start at the property line and extend directly over water.

*Receptor Placement Example 3:* Consider a site where the applicant unloads container ships at a dock. Assume that the width of the ship is 20 meters. In addition, assume that the operation can be represented by a volume created by the movement of a multiple scoop conveyor lifting material out of a compartment and onto another conveyor. The length and width of the volume are 16 meters based on the size of the compartment. With no other adjustments to the initial dimensions, receptors over water could be placed starting at a distance of about 9 meters from the center of the volume. However, since this distance is less than 25 meters from the edge of the ship, the greater distance should be used.

In this case, the receptors over water would begin at a distance of 45 meters from the dock (25 meters from the edge of the ship) and should continue out a sufficient distance over the water to record the highest predicted concentrations and to demonstrate that concentrations are declining. Normal receptor placement would be used for the property-line receptors away from the water. If the distance from the center of the volume to a non-water property line is less than 9 meters, the receptors over land would start at 9 meters from the center of the volume.

## **Appendix N - Surface Characteristics of the Modeling Domain**

The modeling domain is the region that will influence the dispersion of the emissions from the facilities under review. Surface characteristics for the modeling domain should be evaluated when determining representative dispersion coefficients. Air dispersion models utilize dispersion coefficients to determine the rate of dispersion for a plume. Dispersion coefficients are influenced by factors such as land-use / land-cover (LULC), terrain, averaging period, and meteorological conditions.

Evaluating the LULC within the modeling domain is an integral component to air dispersion modeling. The data obtained from a LULC analysis can be used to determine representative dispersion coefficients. The selection of representative dispersion coefficients may be as simple as selecting between rural or urban land-use types. For more complex analyses, representative dispersion coefficients can be determined by parameters that are directly related to the LULC within the modeling domain.

### **LULC Analysis for ISC, ISC-PRIME, and SCREEN3**

For the ISC, ISC-PRIME, and SCREEN3 models, the dispersion coefficients are based on whether the area is predominately rural or urban. The classification of the land use in the vicinity of sources of air pollution is needed because dispersion rates differ between rural and urban areas. In general, urban areas cause greater rates of dispersion because of increased turbulent mixing and buoyancy-induced mixing. This mixing is due to the combination of greater surface roughness caused by more buildings and structures and greater amounts of heat released from concrete and similar surfaces.

The Environmental Protection Agency (EPA) guidance provides two procedures to determine whether the character of an area is predominantly rural or urban. One procedure is based on land-use typing and the other is based on population density. Both procedures require an evaluation of characteristics within a three-kilometer radius from a source. The land-use typing method is based on the work of August Auer (Auer, 1978) and is preferred because it is more directly related to the surface characteristics of the evaluated area that affects dispersion rates.

While the Auer land-use typing method is more direct, it can be labor-intensive to apply. A simplified technique can be used as a screening tool. If the land-use designation is clear; that is, about 70 percent or more of the total land use is either rural or urban, then further refinement is not necessary.

## Simplified Auer Land-Use Analysis

The Auer land-use approach considers four primary land-use types: Industrial (I), Commercial (C), Residential (R), and Agricultural (A). Within these primary types, subtypes are identified in Table N-1.

**Table N-1. Land Use Types and Corresponding Dispersion Classification**

Type	Description	Class
I1	Heavy Industrial	Urban
I2	Light/Moderate Industrial	Urban
C1	Commercial	Urban
R1	Common Residential (Normal Easements)	Rural
R2	Compact Residential (Single-Family)	Urban
R3	Compact Residential (Multi-Family)	Urban
R4	Estate Residential (Multi-Acre)	Rural
A1	Metropolitan Natural	Rural
A2	Agricultural	Rural
A3	Undeveloped (Grass/Weeds)	Rural
A4	Undeveloped (Heavily Wooded)	Rural
A5	Water Surfaces	Rural

The goal in a simplified Auer land-use analysis is to estimate the percentage of the area within a three-kilometer radius of the source to be evaluated that is either rural or urban. Both land-use types do not need to be evaluated since the land use type that has the greatest percentage will be the representative type.

The primary assumption for the simplified procedure is based on the premise that many facilities should have clear-cut rural or urban designations; that is, the percentage of the primary designation should be greater than about 70 percent. If the land-use designation represents less than 70 percent of the total, supplement the analysis with current aerial photography of the area surrounding the sources or with a detailed drive-through summary to support the land-use designation to be used in the modeling demonstration.

## LULC Analysis for AERMOD and AERSCREEN

For AERMOD and AERSCREEN, dispersion coefficients are determined by parameters that are directly related to the LULC within the modeling domain. For example, albedo, Bowen ratio, and surface roughness length all vary for different land-use types and all three parameters affect processes that take place in the surface boundary layer.

- **Albedo** - defined as the ratio of reflected flux density to incident flux density, referenced to some surface. A high albedo value is associated with a greater amount of reflection of incoming solar radiation. An increase in the reflection of incoming solar radiation will result in less energy available for sensible or latent heat loss and thus a decrease in convective turbulence.
- **Bowen Ratio** - defined as the ratio of sensible heat flux to latent heat flux from the earth's surface up into the air. A low Bowen ratio is associated with a surface that has a larger latent heat flux than sensible heat flux. A large latent heat flux means less energy is available for sensible heat loss, and will result in a decrease in convective turbulence.
- **Surface Roughness Length** - defined as the height above the displacement plane at which the mean wind becomes zero when extrapolating the logarithmic wind speed profile downward through the surface layer. A high surface roughness length will result in greater mechanical turbulence and increased vertical mixing.

There are numerous field studies and references that document different values for these surface characteristic parameters based on LULC, as well as for different seasons of the year. In addition, a tool has been developed by the EPA (AERSURFACE) that can be used to process land cover data to determine the surface characteristic values of the modeling domain. To download AERSURFACE and the corresponding documentation, refer to: [www.epa.gov/scram/air-quality-dispersion-modeling-related-model-support-programs#aersurface](http://www.epa.gov/scram/air-quality-dispersion-modeling-related-model-support-programs#aersurface)

Provide the technical justification for model options selected, including any references for parameter values in the air quality analysis (AQA).

AERMOD and AERSCREEN also include an urban option so that the model can be run using urban algorithms. The urban option used in AERMOD and AERSCREEN is not the same as urban dispersion coefficients used with ISC, ISC-PRIME, and SCREEN3. The urban option in AERMOD and AERSCREEN is used to account for the dispersive nature of the “convective-like” boundary layer that forms during nighttime conditions due to the urban heat island effect. The urban heat island effect is due to industrial and urban development. In rural areas, a large part of the incoming solar energy is used to evaporate water from vegetation and soil. In cities, where less vegetation and exposed soil exists, the majority of the sun's energy is absorbed by urban structures and asphalt. At night, the solar energy (stored as vast quantities of heat in city buildings and roads) is slowly released into the city air. Additional city heat is given off at night by vehicles and factories, as well as by industrial and domestic heating and cooling units. The slow release of heat tends to keep nighttime city temperatures higher than those of the faster

cooling rural areas. The magnitude of the urban heat island effect is driven by the urban-rural temperature difference that develops at night.

The urban option is used to enhance the turbulence for urban nighttime conditions over that which is expected in the adjacent rural, stable boundary layer. For most applications, the Land Use Procedure described in Section 7.2.1.1 of the Guideline on Air Quality Models (GAQM) is sufficient for determining the urban/rural status. However, there may be sources located within an urban area but located close enough to a body of water or to other non-urban land-use categories to result in a predominately rural land use classification within three kilometers of the source following that procedure. Users are therefore cautioned against applying the Land Use Procedure on a source-by-source basis, but should also consider the potential for urban heat island influences across the full modeling domain. This is consistent with the fact that the urban heat island is not a localized effect, but is more regional in character.

For additional information about the urban option and the corresponding required input parameters for the urban option, see the guidance contained in the *AERMOD Implementation Guide*:

[www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models#aermod](http://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models#aermod)

## **Terrain**

Much of Texas can be characterized as having relatively flat terrain; however, some areas of the state have simple-to-complex terrain. The Air Dispersion Modeling Team (ADMT) defines flat terrain as terrain equal to the elevation of the stack base; simple terrain as terrain lower than the height of the stack top; and, complex terrain as terrain above the height of the plume centerline (for screening modeling, complex terrain is terrain above the height of the stack top). Terrain above the height of the stack top but below the height of the plume centerline is known as intermediate terrain.

Evaluate the geography within the modeling domain to determine how terrain elevations should be addressed. There are many sources of terrain elevation data that can be used in air dispersion modeling demonstrations. However, the sources of terrain elevation data may differ in sampling interval, geographic reference system, areas covered, and accuracy of data. For example, Universal Transverse Mercator (UTM) is just one of many map projections used to represent locations on a flat surface. Also, be aware that there are several horizontal data coordinate systems or datum (North American Datum (NAD) 27, World Geodetic System (WGS) 72, NAD83, and WGS84) that are used to represent locations on the earth's surface in geographic coordinates (latitude and longitude). When representing receptor, building, and source locations in UTM coordinates, make certain that all of the coordinates originated in, or are converted to, the same horizontal datum.





## Appendix O - Meteorological Data

The Air Dispersion Modeling Team (ADMT) has prepared meteorological data sets for modeling demonstrations in order to establish consistency among modeling demonstrations across the state. These data sets are available by county for download from the ADMT Internet page as follows:

For ISC/ISC-PRIME

[www.tceq.texas.gov/permitting/air/modeling/admtmet.html](http://www.tceq.texas.gov/permitting/air/modeling/admtmet.html)

For AERMOD

[www.tceq.texas.gov/permitting/air/modeling/aermod-datasets.html](http://www.tceq.texas.gov/permitting/air/modeling/aermod-datasets.html)

In addition to the meteorological data sets, the Internet pages above include information on how the meteorological data sets were developed, as well as the file naming conventions of the meteorological data sets.

For AERMOD, meteorological data sets have been developed using three surface roughness categories (low, medium, and high). Refer to Appendix N for additional guidance on determining the appropriate surface roughness category.

For minor New Source Review (NSR) permit applications, the use of one year of National Weather Service (NWS) meteorological data may be sufficient. However, if five years of NWS meteorological data are used, then use the same five-year meteorological data for all applicable averaging periods for consistency. For Prevention of Significant Deterioration (PSD) demonstrations, use the most recent, readily available five years of NWS meteorological data. The Guideline on Air Quality Models (GAQM) also provides an option to use prognostic meteorological data for a regulatory modeling application where there is no representative NWS station, and it is prohibitive or not feasible to collect adequately representative site-specific data. The Environmental Protection Agency (EPA) released the Mesoscale Model Interface Program (MMIF) that converts the prognostic meteorological data (Mesoscale Model 5 or Weather Research and Forecasting) into a format suitable for dispersion modeling applications. When processing prognostic meteorological data for AERMOD, the MMIF should be used to process data to generate AERMET inputs and the data subsequently processed through AERMET for input into AERMOD. The GAQM also notes that at least three years of prognostic meteorological data are required, and an operational evaluation of the meteorological modeling data for all model years (i.e., statistical or graphical) should be completed. The use of these data will need to be coordinated with the ADMT.

Provide an ASCII version of the model-ready data with the air quality analysis (AQA) submittal.





- Universal Transverse Mercator (UTM) coordinates along the vertical and horizontal borders. Please do not use plant or other coordinates.
- Include the datum of your coordinates.
- Reference UTM coordinates and locations of all emission points including fugitive sources modeled.
- Labels/IDs and coordinates for emission points on the plot plan should correlate with the information contained in the AQA.
- Buildings and structures on-property or off-property which could cause downwash. Include length, width, and height.

## Area Map

- For minor New Source Review (NSR) Analyses,
  - Include a copy of the area map submitted with the air permit application. The map should cover the area within a 1.9 mile (three-kilometer) radius of the facility if used for the Auer land-use analysis.
  - The area map should include all property lines. For sites with a single property line designation (SPLD), include all property lines associated with the SPLD. Also include a copy of the SPLD agreement and order with the AQA.
  - Add UTMs to the horizontal and vertical dimensions of the map section, as well as the date and title of the map. Include the datum of your coordinates.
  - Annotate schools within 3,000 feet of the sources nearest to the property line.
  - For the Health Effects Review, annotate the nearest non-industrial receptor of any type. Include any additional non-industrial receptors requested by the Toxicology Division.
- For PSD Analyses,
  - Include a copy of the area map submitted with the air permit application. The map should cover the area within a 1.9 mile (three-kilometer) radius of the facility if used for the Auer land-use analysis.
  - The area map should include all fence lines.
  - Add UTMs to the horizontal and vertical dimensions of the map section, as well as the date and title of the map. Include the datum of your coordinates.
  - Include maps that show the location of:
    - PSD Class I areas within 10 kilometers (6.2 miles) or 100 kilometers (62 miles).
    - Urban areas, non-attainment areas, and topographic features within 50 kilometers (31 miles) or the distance to which the source has a significant impact, whichever is less.

- Any on-site or local meteorological stations, both surface and upper air.
- State/local/on-site ambient air monitoring sites used for background concentrations.

## **Air Quality Monitoring Data**

- For minor NSR and PSD National Ambient Air Quality Standards (NAAQS) Analyses,
  - Provide the monitor ID, county, and address for each monitor.
  - Discuss how ambient background concentrations were obtained.
  - Include a summary of observations for each constituent and averaging time, if available.
  - Provide all calculations, including electronic spreadsheets and substitution data.
- For the Health Effects Review, identify monitored data that was used to supplement or substitute for modeling. Demonstrate that the data represent near worst-case operational and meteorological conditions.

## **Modeling Emissions Inventory**

- On-Property Sources to be Permitted,
  - Include a copy of the Table 1(a) that was submitted with the air permit application and subsequently approved by the permit reviewer. Ensure additional entries are provided on the Table 1(a) if stack parameters for any averaging period or load level could be different.
  - Identify special source types or characterizations such as covered stacks, horizontal exhausts, fugitive sources, area sources, open-pit sources, volume sources, stockpiles, and flares.
  - Include all assumptions and calculations used to determine as appropriate the size, sides, rotation angles, heights of release, initial dispersion coefficients, effective stack diameter, gross heat release and weighted (by volume) average molecular weight of the mixture being burned.
  - Specify particulate emissions as a function of particle size; mass fraction for each particle size category; and particle density for each particle size category, as applicable.
- Other On-Property and Off-Property Sources,
  - Include the Air Permits Allowable Database (APAD) retrieval for each constituent.
  - Include an additional list for each constituent for any sources modeled but were not included in the APAD retrieval. This list should contain all the information required by the Table 1(a).

- For PSD Analyses, include a list of secondary emissions, if applicable. Secondary emissions occur from any facility that is not a part of the facility being reviewed, that would only be constructed or would have an increase of emissions as a result of the permitted project.

### **Table Correlating the Emission Inventory Source Name and Emission Point Number (EPN) with the Source Number in the Modeling Output**

- Include a table that cross-references the source identification numbers used in the modeling if they are different from the EPNs in the Table 1(a) or from any additional list of sources.

### **Stack Parameter Justification**

- Include the basis for using the listed stack parameters (flow rates, temperatures, stack heights, velocities). This should include the calculations used to determine the parameters.
- If the production or load levels could be less than 100 percent, demonstrate how the modeled emission rates and stack parameters were obtained to produce the worst-case impacts (in certain cases lower production levels may result in higher predicted impacts).
- Include at least 25 percent, 50 percent, 75 percent, and 100 percent production or load levels analyses, if the source could be operated at these reduced levels.

### **Scaling Factors**

- Discuss how emission scalars were developed and used in the modeling demonstration. In addition, identify those scalars that should be included in an enforceable permit provision, such as restricted hours of operation.

### **Models Proposed and Modeling Techniques**

- Include a detailed discussion of the models that were used, model version numbers, and the model entry data options such as the regulatory default option and the period option.
- Discuss any specialized modeling techniques such as screening, collocating sources, and ratiointg.
- Include assumptions and sample calculations.

### **Selection of Dispersion Option**

- Base the selection of urban or rural dispersion coefficients on the Auer land-use analysis.

- Include a detailed discussion and sufficient technical justification to support the selection of the dispersion option.

## **Building Wake Effects (Downwash)**

- Discuss how downwash structures were determined and include applicable information required to use the EPA's BPIP-PRIME. Submit all input files and files generated by the BPIP-PRIME program, and any computer-assisted drawing files.
- Provide a table of structure heights and associated building IDs used in the downwash analysis.

## **Receptor Grid**

- Discuss how the receptor grids were determined for each type of analysis.
- Include the datum of your coordinates.
- Discuss if terrain was applicable. If so, discuss how terrain for individual receptors was determined.

## **Meteorological Data**

- Indicate the surface station, surface station anemometer height, surface station profile base elevation, upper-air station, and period of record, as applicable.
- Include the meteorological data files used for all demonstrations.
- Discuss how meteorological data were determined or replaced. Include Air Dispersion Modeling Team (ADMT) approval of replacement data.
- In addition, submit all the supplementary data used to develop the specific input meteorological parameters required by the meteorological pre-processor programs.

## **Modeling Results**

- Summarize and compare the modeling results relative to all applicable de minimis values, standards, guidelines, or reference air concentrations. Tabulated results are preferred.
- For the Health Effects Review, present the maximum concentrations predicted for non-industrial receptors separately and include the location of the receptor. Provide the predicted frequency of exceedance if applicable.
- For the Additional Impacts Analysis (for PSD Analyses), include the results of the additional impacts analysis for growth, visibility, and soils and vegetation.
- For the Class I Area Impacts Analysis (for PSD Analyses), include the results of the Class I area impacts analysis, as applicable.

## **Electronic Information (Model Input/Output and Associated Computer or Electronic Files)**

- Include:
  - All input and output files for each air dispersion model run, including data, grid and plot files.
  - All files produced by a software entry program.
  - All automated downwash program input and output files and any computer-assisted drawing files.
  - All meteorological data files in ASCII format.
  - All boundary files, including computer-assisted drawing files, specifying coordinates for property lines.
  - For PSD Analyses, all boundary files, including computer-assisted drawing files, specifying coordinates for fence lines.
  - Include all spreadsheet files used for comparison of predicted concentrations with standards or guidelines. This includes, but is not limited to, spreadsheet files used for ratio techniques.

## Appendix Q - Conducting an Ambient Ozone Impacts Analysis

For a Prevention of Significant Deterioration (PSD) application, if a project will emit 100 tons per year (tpy) or more of volatile organic compounds (VOCs) or nitrogen oxides (NO<sub>x</sub>) emissions, an ozone impact analysis to demonstrate predicted compliance with the 8-hour ozone standard is required, including the gathering of ambient air quality data. The person conducting the analysis should follow the basic procedure described in the following paragraphs:

**Step 1.** Determine whether site-specific monitoring data or representative monitoring data will be used to obtain an ozone background concentration.

- A site-specific monitoring program must last a minimum of at least four to six months up to twelve months during the ozone season (an ozone season can vary based on the location being evaluated). Use the fourth-highest daily maximum 8-hour average ozone concentration monitored during a single ozone season or up to a three-year average of the annual fourth-highest daily maximum 8-hour ozone concentrations if data are available.
- Representative monitoring data may be available from the ozone network in Texas. Refer to Appendix D for additional guidance on determining a representative ozone background concentration.

If the background concentration equals or exceeds 70 parts per billion (ppb), Step 2 cannot be used and approaches such as the applicant providing emissions offsets or reducing proposed VOC or NO<sub>x</sub> emissions for the project below 100 tpy would be considered.

**Step 2.** Determine the potential impacts on ozone levels associated with the proposed project emissions.

As part of the revisions made to the Guideline on Air Quality Models (January 17, 2017), the Environmental Protection Agency (EPA) promulgated a two-tiered demonstration approach for addressing single-source impacts on ozone. The first tier involves the use of technically credible relationships between precursor emissions and a source's impact (that may be published in literature; developed from modeling that was previously conducted for an area by a source, a governmental agency, or some other entity that is deemed sufficient; or generated by a reduced form model) in combination with other supportive information and analysis for the purpose of estimating secondary impacts from a particular source. The second tier involves application of more sophisticated case-specific chemical transport models (e.g., photochemical grid models). The appropriate tier for a given application should be selected in consultation with the Air Dispersion Modeling Team (ADMT) and be consistent with applicable EPA guidance.

## Tier 1

The EPA developed a tier 1 demonstration tool for ozone precursor emissions called Modeled Emission Rates for Precursors (MERPs). The development of the tool and related guidance is summarized in a memorandum from EPA dated April 30, 2019, with a subject, "Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and PM<sub>2.5</sub> under the PSD Permitting Program." The basic idea behind the MERPs is to use technically credible air quality modeling to relate precursor emissions and peak secondary pollutant impacts from specific or hypothetical sources. To derive a MERP value, the model predicted relationship between precursor emissions from hypothetical sources and their downwind maximum impacts can be combined with a significant impact level (SIL) using the following equation:

$$MERP = SIL * \frac{\text{Modeled emission rate from hypothetical source}}{\text{Modeled air quality impact from hypothetical source}}$$

The ADMT used the air quality modeling results for hypothetical sources summarized in Appendix A of the EPA MERPs memorandum to derive MERPs for the hypothetical sources located in Texas using the EPA recommended SIL for ozone (1 ppb). The EPA is maintaining an Excel spreadsheet of the maximum impacts for daily maximum 8-hour average ozone for the hypothetical sources on their Support Center for Regulatory Atmospheric Modeling website. It is expected that the information in the Excel spreadsheet will be updated over time as newer modeling is done. The worst-case derived MERPs for the hypothetical Texas sources are presented below in Table Q-1:

**Table Q-1. Worst-case MERP Values (in tons per year)**

Precursor	8-hour Ozone
NO <sub>x</sub>	250
VOC	2604

To use the MERP values in Table Q-1 as a tier 1 demonstration, an analysis will need to be provided that shows that the emissions characteristics of the project source and the chemical and physical environment in the vicinity of the project source are adequately represented by the various hypothetical Texas sources modeled by the EPA (and documented in the EPA MERPs memorandum).

For the ozone impacts, VOC and NO<sub>x</sub> are both precursors to ozone formation, and the contributions to ozone formation are considered together. The proposed ozone precursor emissions increase can be expressed as a percent of the lowest MERP for each precursor and then summed. A value less than 100% indicates that the SIL will not be exceeded:

$$\left[ \frac{NO_x \text{ project emissions}}{NO_x \text{ MERP}} + \frac{VOC \text{ project emissions}}{VOC \text{ MERP}} \right] * 100 < 100\%$$

For example, a project with proposed emissions of 200 tpy of NO<sub>x</sub> and 120 tpy of VOC. Since NO<sub>x</sub> and VOC are both precursors to ozone formation, the contributions to 8-hour daily maximum ozone are considered together. The proposed emissions increase can be expressed as a percent of the lowest MERP for each precursor and then summed:

$$\begin{aligned} & \left[ \frac{200 \text{ tpy}}{250 \text{ tpy}} + \frac{120 \text{ tpy}}{2604 \text{ tpy}} \right] * 100 \\ & = [0.8 + 0.046] * 100 \\ & = 84.6\% \end{aligned}$$

Since the value is less than 100%, this example shows the source impact is less than the SIL and a cumulative analysis would not be needed.

If the worst-case MERP values listed in Table Q-1 are too conservative, then MERP values for a specific hypothetical source may be used provided a demonstration is shown that the identified hypothetical source is representative for the project source. Tables Q-2 and Q-3 show the derived MERPs for all of the hypothetical Texas sources for precursors NO<sub>x</sub> and VOC, respectively. The ADMT used the air quality modeling results for hypothetical sources summarized in Appendix A of the EPA MERPs memorandum (also provided in Tables Q-2 and Q-3 as the Max Impact) to derive MERPs for the hypothetical sources located in Texas using the EPA recommended SIL for ozone:

**Table Q-2. NO<sub>x</sub> MERP Values for Hypothetical Texas Sources**

Source	Emissions (tpy)	Height	Max Impact (ppb)	MERP (tpy)
5 (Terry)	500	H	1.168	428
5 (Terry)	500	L	1.199	417
5 (Terry)	1000	H	2.043	489
5 (Terry)	3000	H	4.292	698
19 (Henderson)	500	H	1.93	259
19 (Henderson)	500	L	1.998	250
19 (Henderson)	1000	H	3.462	288
19 (Henderson)	3000	H	8.424	356
20 (Harris)	500	H	0.782	639
20 (Harris)	500	L	0.788	634
20 (Harris)	1000	H	1.352	739
20 (Harris)	3000	H	2.81	1067
24 (Parker)	500	H	1.295	386
24 (Parker)	500	L	0.959	521
24 (Parker)	1000	H	2.311	432
24 (Parker)	3000	H	5.137	583
25 (Guadalupe)	500	H	0.723	691
25 (Guadalupe)	500	L	0.721	693
25 (Guadalupe)	1000	H	1.34	746
25 (Guadalupe)	3000	H	3.059	980

**Table Q-3. VOC MERP Values for Hypothetical Texas Sources**

Source	Emissions (tpy)	Height	Max Impact (ppb)	MERP (tpy)
5 (Terry)	500	H	0.03	16666
5 (Terry)	500	L	0.032	15625
5 (Terry)	1000	H	0.061	16393
5 (Terry)	3000	H	0.313	9584
19 (Henderson)	500	L	0.044	11363
19 (Henderson)	1000	H	0.077	12987
19 (Henderson)	1000	L	0.097	10309
19 (Henderson)	3000	H	0.463	6479
20 (Harris)	500	L	0.124	4032
20 (Harris)	1000	H	0.262	3816
20 (Harris)	1000	L	0.247	4048
20 (Harris)	3000	H	0.943	3181
24 (Parker)	500	L	0.155	3225
24 (Parker)	1000	H	0.304	3289
24 (Parker)	1000	L	0.305	3278
24 (Parker)	3000	H	1.035	2898
25 (Guadalupe)	500	L	0.149	3355
25 (Guadalupe)	1000	H	0.313	3194
25 (Guadalupe)	1000	L	0.334	2994
25 (Guadalupe)	3000	H	1.152	2604

The sources are identified by number and county. The numbers are the same numbers used to identify sources in the EPA MERP memorandum. For source height, a value of H represents an elevated release (90 meters) and a value of L represents a lower release (10 meters).

As an example, a project with proposed emissions of 800 tpy of NO<sub>x</sub> and 310 tpy of VOC is proposed to be located in Caldwell County. Caldwell County is adjacent to Guadalupe County and the MERP values from source 25 (Guadalupe) will be used. An analysis is first conducted to compare the chemical and physical environment in the vicinity of the project source (Caldwell County) relative to the hypothetical source modeled in Guadalupe County. Information used in the analysis may include average and peak temperatures, humidity, terrain, rural/urban nature of the area, regional sources of pollutants (biogenic, industrial, etc.), and ambient concentrations of relevant pollutants.

Based on this analysis, and the proposed emissions associated with the project, the NO<sub>x</sub> MERP value associated with the 1000 tpy source and the VOC MERP value associated with the 500 tpy source will be used. As with the previous example, the proposed emissions increase can be expressed as a percent of the MERP for each precursor and then summed:

$$\begin{aligned} & \left[ \frac{800 \text{ tpy}}{746 \text{ tpy}} + \frac{310 \text{ tpy}}{3355 \text{ tpy}} \right] * 100 \\ & = [1.072 + 0.092] * 100 \\ & = 116.4\% \end{aligned}$$

Given that the value is greater than 100 percent, a cumulative analysis is needed since the source impact is greater than the SIL.

The cumulative analysis for a NAAQS demonstration includes contributions from background concentrations and impacts associated with ozone precursor emissions. The following equation is used:

$$\begin{aligned} & \text{Cumulative concentration} = \text{Background concentration} + \\ & \left[ \frac{\text{NO}_x \text{ project emissions}}{\text{NO}_x \text{ MERP}} + \frac{\text{VOC project emissions}}{\text{VOC MERP}} \right] * \text{SIL} \end{aligned}$$

Continuing with the Caldwell County project example, the 8-hour background concentration for the project area is determined to be 60 ppb. The cumulative concentration would be:

$$\begin{aligned} & = 60 \text{ ppb} + \left[ \frac{800 \text{ tpy}}{746 \text{ tpy}} + \frac{310 \text{ tpy}}{3125 \text{ tpy}} \right] * 1 \text{ ppb} \\ & = 60 \text{ ppb} + 1.164 \text{ ppb} \\ & = 61.164 \text{ ppb} \end{aligned}$$

The cumulative concentration is less than the 8-hour NAAQS (70 ppb) and the demonstration is complete. The contributions to the formation of ozone from off-site sources are generally accounted for through the use of background concentrations. For nearby off-site sources that may have been recently permitted and are not yet operating, their contribution towards ozone formation may need to be determined since background concentrations will not include their contribution.

## **Tier 2**

Tier 2 assessments are intended for impact assessments that are not able to be satisfied with a tier 1 demonstration in that pre-existing information is not available or representative of the situation such that more refined modeling is necessary. For these situations, application of more sophisticated case-specific chemical transport models (e.g., photochemical grid models) should be performed to address single-source impacts.

## Appendix R - Secondary Formation of Particulate Matter (PM<sub>2.5</sub>)

The purpose of this appendix is to provide guidance for addressing the secondary formation of PM<sub>2.5</sub>. Please note that secondary formation of PM<sub>2.5</sub> must be addressed even if the predicted concentration for direct PM<sub>2.5</sub> is less than the significant impact levels (SILs). Furthermore, secondary formation of PM<sub>2.5</sub> must be addressed for projects that trigger minor or federal New Source Review (NSR) for PM<sub>2.5</sub>, including cases where the project emissions of precursor emissions (sulfur dioxide (SO<sub>2</sub>) and nitrogen oxides (NO<sub>x</sub>)) are less than the significant emission rates (SERs).

### Terms

**Direct PM emissions.** Solid particles emitted directly from an air emissions source or activity, or gaseous emissions or liquid droplets from an air emissions source or activity which condense to form particulate matter at ambient temperatures. Direct PM<sub>2.5</sub> emissions include elemental carbon, directly emitted organic carbon, directly emitted sulfate, directly emitted nitrate, and other inorganic particles (including but not limited to crustal materials, metals, and sea salt).

**Secondary PM Emissions.** Those air pollutants other than PM<sub>2.5</sub> direct emissions that contribute to the formation of PM<sub>2.5</sub>. For NSR permitting purposes, PM<sub>2.5</sub> precursors include SO<sub>2</sub> and NO<sub>x</sub>.

### Overview

The complex chemistry of secondarily formed PM<sub>2.5</sub> is well documented and has historically presented significant challenges with the identification and establishment of particular models for assessing the impacts of individual stationary sources on the formation of this air pollutant. For example, the current preferred air dispersion model (i.e. AERMOD) can be used to simulate the dispersion of direct PM<sub>2.5</sub> emissions but does not explicitly account for secondary formation of PM<sub>2.5</sub>. As part of the revisions made to the Guideline on Air Quality Models (January 17, 2017), the EPA promulgated a two-tiered demonstration approach for addressing single-source impacts on secondary PM<sub>2.5</sub>.

A detailed discussion on the tiered approach, including examples, is provided below. Keep in mind that the appropriate methods for assessing PM<sub>2.5</sub> impacts are determined as part of the normal consultation process with the Texas Commission on Environmental Quality (TCEQ).

## Two-tiered Approach

As noted above, the EPA promulgated a two-tiered demonstration approach for addressing single-source impacts on secondary PM<sub>2.5</sub>. The first tier involves the use of technically credible relationships between precursor emissions and a source's impact (that may be published in literature; developed from modeling that was previously conducted for an area by a source, a governmental agency, or some other entity that is deemed sufficient; or generated by a reduced form model) in combination with other supportive information and analysis for the purpose of estimating secondary impacts from a particular source. The second tier involves application of more sophisticated case-specific chemical transport models (e.g., photochemical grid models). The appropriate tier for a given application should be selected in consultation with the Air Dispersion Modeling Team (ADMT) and be consistent with applicable EPA guidance.

### Tier 1

The EPA developed a tier 1 demonstration tool for secondary PM<sub>2.5</sub> precursor emissions called Modeled Emission Rates for Precursors (MERPs). The development of the tool and related guidance is summarized in a memorandum from EPA dated April 30, 2019, with a subject, "Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and PM<sub>2.5</sub> under the PSD Permitting Program." The basic idea behind the MERPs is to use technically credible air quality modeling to relate precursor emissions and peak secondary pollutant impacts from specific or hypothetical sources. To derive a MERP value, the model predicted relationship between precursor emissions from hypothetical sources and their downwind maximum impacts can be combined with a significant impact level using the following equation:

$$MERP = SIL * \frac{\text{Modeled emission rate from hypothetical source}}{\text{Modeled air quality impact from hypothetical source}}$$

The ADMT used the air quality modeling results for hypothetical sources summarized in Appendix A of the EPA MERPs memorandum to derive MERPs for the hypothetical sources located in Texas using the EPA recommended SILs for PM<sub>2.5</sub> (1.2 µg/m<sup>3</sup> for the 24-hour averaging time and 0.2 µg/m<sup>3</sup> for the annual averaging time). The EPA is maintaining an Excel spreadsheet of the maximum impacts for daily PM<sub>2.5</sub> and annual PM<sub>2.5</sub> for the hypothetical sources on their Support Center for Regulatory Atmospheric Modeling website. It is expected that the information in the Excel spreadsheet will be updated over time as newer modeling is done. The worst-case derived MERPs for the hypothetical Texas sources are presented below in Table R-1:

**Table R-1. Worst-case MERP Values (in tons per year)**

Precursor	24-hour PM <sub>2.5</sub>	Annual PM <sub>2.5</sub>
NO <sub>x</sub>	2649	10397
SO <sub>2</sub>	359	1820

To use the MERP values in Table R-1 as a tier 1 demonstration, an analysis will need to be provided that shows that the emissions characteristics of the project source and the chemical and physical environment in the vicinity of the project source are adequately represented by the various hypothetical Texas sources modeled by the EPA (and documented in the EPA MERPs memorandum).

An evaluation of PM<sub>2.5</sub> includes both direct PM<sub>2.5</sub> emissions and secondary PM<sub>2.5</sub> precursor emissions. For the direct PM<sub>2.5</sub> emissions, modeling is conducted following applicable guidance to determine impacts associated with the direct PM<sub>2.5</sub> emissions. The impacts can be expressed as a percent of the SIL and summed with the secondary PM<sub>2.5</sub> impacts. For the secondary PM<sub>2.5</sub> impacts, NO<sub>x</sub> and SO<sub>2</sub> are both precursors to secondary PM<sub>2.5</sub> formation, and the contributions to secondarily formed PM<sub>2.5</sub> are considered together. The proposed secondary PM<sub>2.5</sub> precursor emissions increase can be expressed as a percent of the lowest MERP for each precursor and then summed. A value less than 100% indicates that the SIL will not be exceeded when considering the combined impacts of the direct and secondary precursor emissions on 24-hour and annual PM<sub>2.5</sub>:

$$\left[ \frac{\text{Modeled value}}{\text{SIL}} + \frac{\text{NO}_x \text{ project emissions}}{\text{NO}_x \text{ MERP}} + \frac{\text{SO}_2 \text{ project emissions}}{\text{SO}_2 \text{ MERP}} \right] * 100 < 100\%$$

For example, a project has proposed emissions of 200 tons per year (tpy) of NO<sub>x</sub> and 80 tpy of SO<sub>2</sub>. The project also has emissions of PM<sub>2.5</sub> and modeling of those emissions gives a 24-hour prediction of 0.4 µg/m<sup>3</sup> and an annual prediction of 0.03 µg/m<sup>3</sup>. Using this information, along with the worst-case MERPs listed in Table R-1 gives:

$$\begin{aligned} \text{24 hour: } & \left[ \frac{0.4 \mu\text{g}/\text{m}^3}{1.2 \mu\text{g}/\text{m}^3} + \frac{200 \text{ tpy}}{2649 \text{ tpy}} + \frac{80 \text{ tpy}}{359 \text{ tpy}} \right] * 100 \\ & = [0.33 + 0.076 + 0.223] * 100 \\ & = 62.9\% \end{aligned}$$

$$\begin{aligned} \text{Annual: } & \left[ \frac{0.03 \mu\text{g}/\text{m}^3}{0.2 \mu\text{g}/\text{m}^3} + \frac{200 \text{ tpy}}{10397 \text{ tpy}} + \frac{80 \text{ tpy}}{1820 \text{ tpy}} \right] * 100 \\ & = [0.15 + 0.0192 + 0.044] * 100 \\ & = 21.3\% \end{aligned}$$

Since the values for both the 24-hour and annual averaging times are less than 100%, this example shows the source impact is less than the SILs and a cumulative analysis would not be needed. Keep in mind that this exercise may need to be performed separately for the NAAQS and increment analyses based on the output metric used with the modeling of the direct PM<sub>2.5</sub> emissions. When modeling PM<sub>2.5</sub>, the maximum predicted concentrations from all receptors are used in the increment analysis for the 24-hour and annual averaging times instead of the five-year averages of the maximum predicted concentrations used in a NAAQS analysis.

The example above follows the same procedure described in the EPA MERPs memorandum. The example is taken a step further in order to quantify the secondary PM<sub>2.5</sub> impacts using the same MERP concept. Quantifying the secondary PM<sub>2.5</sub> impacts in the air quality analysis is necessary in order to determine the total predicted concentration for the increment analysis since public notice requires the degree of increment consumption that is expected from the new source or modification. The estimated concentration from the secondary impacts can be determined from the following equation:

$$\text{Concentration} = \left[ \frac{NO_x \text{ project emissions}}{NO_x \text{ MERP}} + \frac{SO_2 \text{ project emissions}}{SO_2 \text{ MERP}} \right] * SIL$$

Using the project information provided in the example, the worst-case MERPs from Table R-1, and the SILs, the total predicted concentrations can be determined based on the following:

$$\text{Total concentration} = \text{Modeled direct concentrations} + \text{Secondary concentrations}$$

$$24 \text{ hour: } 0.4 \mu\text{g}/\text{m}^3 + \left[ \frac{200 \text{ tpy}}{2649 \text{ tpy}} + \frac{80 \text{ tpy}}{359 \text{ tpy}} \right] * 1.2 \mu\text{g}/\text{m}^3$$

$$= 0.4 \mu\text{g}/\text{m}^3 + 0.358 \mu\text{g}/\text{m}^3$$

$$= 0.758 \mu\text{g}/\text{m}^3$$

$$\text{Annual: } 0.03 \mu\text{g}/\text{m}^3 + \left[ \frac{200 \text{ tpy}}{10397 \text{ tpy}} + \frac{80 \text{ tpy}}{1820 \text{ tpy}} \right] * 0.2 \mu\text{g}/\text{m}^3$$

$$= 0.03 \mu\text{g}/\text{m}^3 + 0.0126 \mu\text{g}/\text{m}^3$$

$$= 0.0426 \mu\text{g}/\text{m}^3$$

If the worst-case MERP values listed in Table R-1 are too conservative, then MERP values for a specific hypothetical source may be used provided a demonstration is shown that the identified hypothetical source is representative for the project source. Tables R-2 and R-3 show the derived 24-hour and annual MERPs, respectively, for the hypothetical Texas sources for precursor NO<sub>x</sub>. Tables R-4 and R-5 show the derived 24-hour and annual MERPs, respectively, for the hypothetical Texas sources for precursor SO<sub>2</sub>. The ADMT used the air quality modeling results for hypothetical sources summarized in Appendix A of the EPA MERPs memorandum (also provided in Tables R-2 thru R-5 as the Max Impact) to derive MERPs for the hypothetical sources located in Texas using the EPA recommended SILs for PM<sub>2.5</sub>:

**Table R-2. NO<sub>x</sub> 24-hour MERP Values for Hypothetical Texas Sources**

Source	Emissions (tpy)	Height	Max Impact (µg/m <sup>3</sup> )	MERP (tpy)
5 (Terry)	500	H	0.038	15789
5 (Terry)	500	L	0.082	7317
5 (Terry)	1000	H	0.072	16666
5 (Terry)	3000	H	0.205	17560
19 (Henderson)	500	H	0.033	18181
19 (Henderson)	500	L	0.109	5504
19 (Henderson)	1000	H	0.07	17142
19 (Henderson)	1000	L	0.212	5660
19 (Henderson)	3000	H	0.236	15254
20 (Harris)	500	H	0.039	15384
20 (Harris)	500	L	0.114	5263
20 (Harris)	1000	H	0.083	14457
20 (Harris)	1000	L	0.215	5581
20 (Harris)	3000	H	0.31	11612
24 (Parker)	500	H	0.078	7692
24 (Parker)	500	L	0.198	3030
24 (Parker)	1000	H	0.164	7317
24 (Parker)	1000	L	0.453	2649
24 (Parker)	3000	H	0.586	6143
25 (Guadalupe)	500	H	0.05	12000
25 (Guadalupe)	500	L	0.103	5825
25 (Guadalupe)	1000	H	0.111	10810
25 (Guadalupe)	1000	L	0.224	5357
25 (Guadalupe)	3000	H	0.383	9399

**Table R-3. NO<sub>x</sub> Annual MERP Values for Hypothetical Texas Sources**

Source	Emissions (tpy)	Height	Max Impact (µg/m <sup>3</sup> )	MERP (tpy)
5 (Terry)	500	H	0.0011429	87496
5 (Terry)	500	L	0.00373408	26780
5 (Terry)	1000	H	0.00214904	93064
5 (Terry)	3000	H	0.00561334	106888
19 (Henderson)	500	H	0.00116918	85530
19 (Henderson)	500	L	0.00514512	19435
19 (Henderson)	1000	H	0.00284077	70403
19 (Henderson)	1000	L	0.01168501	17115
19 (Henderson)	3000	H	0.0121492	49385
20 (Harris)	500	H	0.00209254	47788
20 (Harris)	500	L	0.00930842	10742
20 (Harris)	1000	H	0.00441016	45349
20 (Harris)	1000	L	0.01923452	10397
20 (Harris)	3000	H	0.01515664	39586
24 (Parker)	500	H	0.00139691	71586
24 (Parker)	500	L	0.00424063	23581
24 (Parker)	1000	H	0.00329347	60726
24 (Parker)	1000	L	0.0093796	21322
24 (Parker)	3000	H	0.01297507	46242
25 (Guadalupe)	500	H	0.00146152	68421
25 (Guadalupe)	500	L	0.00512243	19521
25 (Guadalupe)	1000	H	0.0034135	58590
25 (Guadalupe)	1000	L	0.0116476	17170
25 (Guadalupe)	3000	H	0.01355757	44255

**Table R-4. SO<sub>2</sub> 24-hour MERP Values for Hypothetical Texas Sources**

Source	Emissions (tpy)	Height	Max Impact (µg/m <sup>3</sup> )	MERP (tpy)
5 (Terry)	500	H	0.068	8823
5 (Terry)	500	L	0.277	2166
5 (Terry)	1000	H	0.122	9836
5 (Terry)	3000	H	0.356	10112
19 (Henderson)	500	H	0.163	3680
19 (Henderson)	500	L	0.383	1566
19 (Henderson)	1000	H	0.55	2181
19 (Henderson)	1000	L	1.087	1103
19 (Henderson)	3000	H	2.116	1701
20 (Harris)	500	H	0.402	1492
20 (Harris)	500	L	1.562	384
20 (Harris)	1000	H	0.833	1440
20 (Harris)	1000	L	3.341	359
20 (Harris)	3000	H	2.643	1362
24 (Parker)	500	H	0.309	1941
24 (Parker)	500	L	0.526	1140
24 (Parker)	1000	H	0.821	1461
24 (Parker)	1000	L	1.999	600
24 (Parker)	3000	H	3.459	1040
25 (Guadalupe)	500	H	0.209	2870
25 (Guadalupe)	500	L	0.512	1171
25 (Guadalupe)	1000	H	0.64	1875
25 (Guadalupe)	1000	L	1.282	936
25 (Guadalupe)	3000	H	2.416	1490

**Table R-5. SO<sub>2</sub> Annual MERP Values for Hypothetical Texas Sources**

Source	Emissions (tpy)	Height	Max Impact (µg/m <sup>3</sup> )	MERP (tpy)
5 (Terry)	500	H	0.00188606	53020
5 (Terry)	500	L	0.00385673	25928
5 (Terry)	1000	H	0.00365867	54664
5 (Terry)	3000	H	0.0102369	58611
19 (Henderson)	500	H	0.00270821	36924
19 (Henderson)	500	L	0.00637221	15693
19 (Henderson)	1000	H	0.00748003	26737
19 (Henderson)	1000	L	0.01979857	10101
19 (Henderson)	3000	H	0.0429117	13982
20 (Harris)	500	H	0.00962696	10387
20 (Harris)	500	L	0.03860893	2590
20 (Harris)	1000	H	0.02180936	9170
20 (Harris)	1000	L	0.10987971	1820
20 (Harris)	3000	H	0.10310254	5819
24 (Parker)	500	H	0.00300141	33317
24 (Parker)	500	L	0.00796769	12550
24 (Parker)	1000	H	0.00906999	22050
24 (Parker)	1000	L	0.026133	7653
24 (Parker)	3000	H	0.04585198	13085
25 (Guadalupe)	500	H	0.00617332	16198
25 (Guadalupe)	500	L	0.01313179	7615
25 (Guadalupe)	1000	H	0.01392273	14364
25 (Guadalupe)	1000	L	0.04064511	4920
25 (Guadalupe)	3000	H	0.07068093	8488

The sources are identified by number and county. The numbers are the same numbers used to identify sources in the EPA MERP memorandum. For source height, a value of H represents an elevated release (90 meters) and a value of L represents a lower release (10 meters).

As an example, a project with emissions of 800 tpy of NO<sub>x</sub> and 150 tpy of SO<sub>2</sub> is proposed to be located in Hood County. The project also has emissions of PM<sub>2.5</sub> and modeling of those emissions gives a 24-hour prediction of 1.1 µg/m<sup>3</sup> and an annual

prediction of  $0.1 \mu\text{g}/\text{m}^3$ . Hood County is adjacent to Parker County and the MERP values from source 24 (Parker) will be used. An analysis is first conducted to compare the chemical and physical environment in the vicinity of the project source (Hood County) relative to the hypothetical source modeled in Parker County. Information used in the analysis may include average and peak temperatures, humidity, terrain, rural/urban nature of the area, regional sources of pollutants (biogenic, industrial, etc.), and ambient concentrations of relevant pollutants. Based on this analysis, and the proposed emissions associated with the project, the 1000 tpy  $\text{NO}_x$  MERP values (low height) and the 500 tpy  $\text{SO}_2$  MERP values (low height) from source 24 (Parker) will be used. As with the previous example, the impacts associated with the direct  $\text{PM}_{2.5}$  emissions can be expressed as a percent of the SIL and summed with the secondary  $\text{PM}_{2.5}$  impacts, which are based on expressing the proposed emissions increase as a percent of the MERP for each precursor and then summed. A value less than 100% indicates that the SIL will not be exceeded when considering the combined impacts of the direct and secondary precursor emissions on 24-hour and annual  $\text{PM}_{2.5}$ :

$$\begin{aligned}
 \text{24 hour: } & \left[ \frac{1.1 \mu\text{g}/\text{m}^3}{1.2 \mu\text{g}/\text{m}^3} + \frac{800 \text{ tpy}}{2649 \text{ tpy}} + \frac{150 \text{ tpy}}{1140 \text{ tpy}} \right] * 100 \\
 & = [0.92 + 0.302 + 0.132] * 100 \\
 & = 135.4\%
 \end{aligned}$$

$$\begin{aligned}
 \text{Annual: } & \left[ \frac{0.1 \mu\text{g}/\text{m}^3}{0.2 \mu\text{g}/\text{m}^3} + \frac{800 \text{ tpy}}{21322 \text{ tpy}} + \frac{150 \text{ tpy}}{12550 \text{ tpy}} \right] * 100 \\
 & = [0.5 + 0.038 + 0.012] * 100 \\
 & = 55\%
 \end{aligned}$$

Since the value for the annual averaging time is less than 100%, this shows the source impact is less than the SIL and a cumulative analysis would not be needed. For reporting purposes in the air quality analysis, the total annual predicted concentration would be determined following the steps in the previous example (total annual predicted concentration of  $0.11 \mu\text{g}/\text{m}^3$ ). Given that the value for the 24-hour averaging time is greater than 100 percent, a cumulative analysis is needed since the source impact is greater than the SIL.

When determining significant receptors to include in the cumulative analysis, add the contributions associated with the secondary  $\text{PM}_{2.5}$  impacts to the modeling results associated with the direct  $\text{PM}_{2.5}$  emissions on a receptor-by-receptor basis. Then identify receptors with total predictions greater than or equal to the SIL and use these receptors in the cumulative modeling analyses.

The cumulative analysis for a NAAQS demonstration includes contributions from background concentrations, modeling of direct  $\text{PM}_{2.5}$  emissions (from the project source

and nearby off-site sources), and impacts associated with secondary PM<sub>2.5</sub> precursor emissions. The following equation is used:

*Cumulative concentration = Background concentration + Modeled value +*

$$\left[ \frac{NO_x \text{ project emissions}}{NO_x \text{ MERP}} + \frac{SO_2 \text{ project emissions}}{SO_2 \text{ MERP}} \right] * SIL$$

Continuing with the Hood County project example, the 24-hour background concentration for the project area is determined to be 24 µg/m<sup>3</sup> and the 24-hour modeled value, which includes the project source and nearby off-site sources, is 4.6 µg/m<sup>3</sup>. The 24-hour cumulative concentration would be:

$$\begin{aligned} &= 24 \mu\text{g}/\text{m}^3 + 4.6 \mu\text{g}/\text{m}^3 + \left[ \frac{800 \text{ tpy}}{2649 \text{ tpy}} + \frac{150 \text{ tpy}}{1140 \text{ tpy}} \right] * 1.2 \mu\text{g}/\text{m}^3 \\ &= 24 \mu\text{g}/\text{m}^3 + 4.6 \mu\text{g}/\text{m}^3 + 0.52 \mu\text{g}/\text{m}^3 \\ &= 29.12 \mu\text{g}/\text{m}^3 \end{aligned}$$

The cumulative concentration is less than the 24-hour NAAQS (35 µg/m<sup>3</sup>) and the demonstration is complete. The contributions to secondarily formed PM<sub>2.5</sub> from off-site sources are generally accounted for through the use of background concentrations. For nearby off-site sources that may have been recently permitted and are not yet operating, their contribution towards secondarily formed PM<sub>2.5</sub> may need to be determined since background concentrations will not include their contribution.

A similar type of demonstration can be performed for the 24-hour PM<sub>2.5</sub> increment analysis. However, background concentrations would not be included, as they are with a NAAQS analysis, and the 24-hour modeled value of the direct emissions would be different as well. The differences in the modeled value are related to using an inventory of increment affecting sources and the form of the model output. For the 24-hour PM<sub>2.5</sub> increment analysis, the model output would be the highest, high-second high 24-hour prediction over a five-year period. For the 24-hour PM<sub>2.5</sub> NAAQS analysis, the model output would be a five-year average of the 98th percentile of the annual distribution of the maximum 24-hour predicted concentrations.

## Tier 2

Tier 2 assessments are intended for impact assessments that are not able to be satisfied with a tier 1 demonstration in that pre-existing information is not available or representative of the situation such that more refined modeling is necessary. For these situations, application of more sophisticated case-specific chemical transport models (e.g., photochemical grid models) should be performed to address single-source impacts.

## **Appendix S – Additional Guidance for evaluating Nitrogen Dioxide and 1-hour Sulfur Dioxide**

The purpose of this appendix is to provide additional guidance for addressing the nitrogen dioxide (NO<sub>2</sub>) and 1-hour sulfur dioxide (SO<sub>2</sub>) National Ambient Air Quality Standards (NAAQS). The Environmental Protection Agency (EPA) issued a memorandum on March 1, 2011, with a subject, “Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO<sub>2</sub> National Ambient Air Quality Standard.” This memorandum is meant to supplement the memorandum issued by the EPA on June 29, 2010, with a subject, “Guidance Concerning the Implementation of the 1-hour NO<sub>2</sub> NAAQS for the Prevention of Significant Deterioration Program.” The March 1 memorandum provides further clarification and guidance on the application of Appendix W guidance for the 1-hour NO<sub>2</sub> standard.

While the discussion of nitrogen oxides (NO<sub>x</sub>) chemistry options in the March 1 memorandum is exclusive to the 1-hour NO<sub>2</sub> standard, the discussion of other topics in the memorandum should apply equally to the 1-hour SO<sub>2</sub> standard, accounting for the differences in the form of the two standards. The memorandum does not apply to the other averaging periods of NO<sub>2</sub> and SO<sub>2</sub>, nor does it apply to other pollutants with a standard based on a multiyear average.

The EPA also issued a memorandum on September 30, 2014, with a subject, “Clarification on the Use of AERMOD Dispersion Modeling for Demonstrating Compliance with the NO<sub>2</sub> National Ambient Air Quality Standard.” This memorandum is meant to supplement the memoranda issued by the EPA on June 29, 2010, and March 1, 2011. The September 30 memorandum discusses the Ambient Ratio Method 2 (ARM2) as a tier 2 screening approach. ARM2 is based on hourly measurements of the NO<sub>2</sub> to NO<sub>x</sub> ratios and provides more detailed estimates of this ratio based on the total NO<sub>x</sub> present. The memorandum also discusses the Ozone Limiting Method (OLM) and Plume Volume Molar Ratio Method (PVMRM) tier 3 screening approaches and the associated in-stack NO<sub>2</sub>/NO<sub>x</sub> ratios used in the tier 3 applications.

### **Approval and Application of a Tiering Approach for NO<sub>2</sub>**

There are different approaches to demonstrate compliance with the NO<sub>2</sub> NAAQS:

1. Tier 1 – 100 percent conversion of NO<sub>x</sub> to NO<sub>2</sub>.
2. Tier 2 – multiply the tier 1 results by the ARM2, which provides estimates of representative equilibrium ratios of NO<sub>2</sub>/NO<sub>x</sub> values based on ambient levels of NO<sub>2</sub> and NO<sub>x</sub> derived from national data from the EPA’s Air Quality System. The national default for ARM2 will include a minimum NO<sub>2</sub>/NO<sub>x</sub> ratio of 0.5 and a maximum ratio of 0.9. Alternative default minimum NO<sub>2</sub>/NO<sub>x</sub> values may be established based on the source’s in-stack emissions ratio, with alternative minimum values reflecting the source’s in-stack NO<sub>2</sub>/NO<sub>x</sub> ratios. These should be based on source-specific data, which satisfies all quality assurance procedures that ensure data accuracy for both NO<sub>2</sub> and NO<sub>x</sub> within the typical range of measured values. However, manufacturer test data, state or local agency guidance, peer-reviewed literature, or the EPA’s

NO<sub>2</sub>/NO<sub>x</sub> ratio database may be used as sources of data. If another minimum value is used, sufficient justification and documentation will need to be provided prior to submitting the Air Quality Analysis.

Note that the source code for AERMOD has been edited to include the ARM2 method; therefore, AERMOD will internally compute the ambient ratios using the ARM2 equation when modeling with applicable NO<sub>x</sub> emission rates and using the ARM2 model option keyword. For model platforms that do not have the ARM2 method coded or when conducting modeling using generic emission rates (e.g., 1 pound per hour or 1 gram per second), use an ambient ratio of 0.9 for simplicity since 0.9 is the maximum ambient ratio used with ARM2.

3. Tier 3 – use of the regulatory OLM and PVMRM options within AERMOD to determine the amount of conversion of NO<sub>x</sub> to NO<sub>2</sub>. The key input variables for these model options are in-stack NO<sub>2</sub>/NO<sub>x</sub> ratios and background ozone concentrations.
  - In-stack NO<sub>2</sub>/NO<sub>x</sub> ratios:
    - The EPA established a general acceptance of 0.50 as a default in-stack ratio of NO<sub>2</sub>/NO<sub>x</sub> for input to the OLM and PVMRM model options within AERMOD. When conducting a cumulative modeling analysis, a default in-stack NO<sub>2</sub>/NO<sub>x</sub> ratio of 0.2 can be used for more distant sources (sources located greater than three kilometers from the primary source).
    - If proposing an in-stack NO<sub>2</sub>/NO<sub>x</sub> ratio other than the default, sufficient justification and documentation will need to be provided to support the source-specific data on the in-stack NO<sub>2</sub>/NO<sub>x</sub> ratio.
  - Background ozone concentrations:
    - There are many options for utilizing the background ozone data in the OLM and PVMRM model options. Be sure to provide sufficient justification and documentation to support the use of the ozone data (representativeness of the monitor, filling in missing data, etc.).

Even though the OLM and PVMRM tier 3 screening techniques are considered part of the regulatory version of AERMOD, prior approval (submitting modeling protocols to Air Permits Division (APD) and the EPA) is required for any applicant proposing to use a tier 3 approach given the additional input data requirements and complexities associated with the tier 3 screening options. Sufficient documentation and justification must be provided when developing the modeling protocol.

## Treatment of Intermittent Emissions for 1-hour NO<sub>2</sub> and 1-hour SO<sub>2</sub> NAAQS

An assumption of continuous operation for intermittent emissions using the maximum allowable emissions may be an overly conservative assumption and could result in them becoming the controlling emission scenario for determining compliance with the 1-hour NO<sub>2</sub> and 1-hour SO<sub>2</sub> standards. To account for this, the March 1 memorandum discusses different approaches for evaluating intermittent emissions:

- Excluding certain types of intermittent emissions from the compliance demonstrations for the 1-hour NO<sub>2</sub> and 1-hour SO<sub>2</sub> standards. The most appropriate data to use for compliance demonstrations for the 1-hour NO<sub>2</sub> and 1-hour SO<sub>2</sub> NAAQS are those based on emissions scenarios that are continuous enough or frequent enough to contribute significantly to the annual distribution of daily maximum 1-hour concentrations.
- Using model scalars to limit the hours modeled to account for meteorological conditions that are more representative of actual operations. A permit condition can be used to restrict operation to certain hours of the day.
- Modeling the impacts from intermittent emissions based on an average hourly rate, rather than the maximum hourly emission rate.

The March 1 memorandum is limited to what intermittent emissions are related to. An emergency generator is provided as an example of an intermittent emissions unit, and startup/shutdown operations are provided as examples of intermittent emissions scenarios. The memorandum does not have a discussion regarding a specific duration on the number of hours of operation per year that constitutes intermittent or infrequent. Furthermore, there is no discussion on the frequency of intermittent emissions needed to be considered to contribute significantly to the annual distribution of daily maximum 1-hour concentrations. Also important for determining and evaluating intermittent emissions is the distinction between intermittent emissions that can be scheduled with some degree of flexibility and intermittent emissions that cannot be scheduled.

The recommendation is that compliance demonstrations for the 1-hour NO<sub>2</sub> and 1-hour SO<sub>2</sub> NAAQS be based on emission scenarios that can logically be assumed to be relatively continuous or which occur frequently enough to contribute significantly to the annual distribution of daily maximum 1-hour concentrations. There are unique case-by-case factors, as it relates to determining whether or not emissions are intermittent, which can affect the application of the guidance in the March 1 memorandum. The proposed operation of the unit or operating scenarios will need to be fully explained and documented in order to determine the appropriateness of following the guidance in the memorandum. The ADMT recommends providing sufficient justification and documentation for intermittent use prior to submitting the Air Quality Analysis. For example:

- How many units are there;
- How often will the unit operate per year;

- What is the duration of operation once the unit is operating;
- Will the unit be operated on a known schedule or will it operate randomly;
- What is the magnitude of the emissions for the source(s);
- Does the unit operate simultaneously with other sources?