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Criteria For Assessing Whether an Ozone Nonattainment Area is Affected by Overwhelming Transport

1.0 Introduction

Section 172(a)(1) of the Clean Air Act provides that EPA has the discretion to classify ozone nonattainment areas that are not subject to other classification provisions of the Act (e.g., section 182(a)(1)). In the Final Rule to Implement the 8-hour Ozone National Ambient Air Quality Standard (NAAQS) - Phase 1 (Phase 1 Rule), EPA provided that it would not classify subpart 1 areas, with one exception. EPA created an overwhelming transport classification for rural nonattainment areas that are not subject to classification under subpart 2 (i.e., subpart 1 ozone areas) and whose ozone problem is the result of transport of ozone and ozone precursors. We limited the availability of the classification to certain rural areas that demonstrate that transport of ozone and/or precursors into the area is so overwhelming that the contribution of local emissions to observed 8-hour ozone concentration above the level of the NAAQS is relatively minor and that emissions within the area do not significantly contribute to ozone concentrations measured in other areas (40 CFR 51.904).

It should be noted that EPA is aware that transport of ozone and ozone precursors has contributed, and is contributing, to ozone nonattainment in many areas. Recent assessments of regional ozone control approaches[1, 2] have concluded that a nitrogen oxides (NO_x) control strategy would be most effective for reducing regional scale ozone and ozone transport. To that end, EPA has promulgated several rules (e.g., NO_x SIP Call[3], Tier-2/Low Sulfur Gasoline Vehicle[4], Heavy Duty Diesel Engine[5], the Clean Air NonRoad Diesel rule[6], and the Clean Air

[1] OTAG Final Report; Ozone Transport Assessment Group, 1997.

[2] An Assessment of Tropospheric Ozone Pollution - A North American Perspective; NARSTO, July 2000.

[3] Finding of Significant Contribution and Rulemaking for Certain States in the Ozone Transport Assessment Group Region for Purposes of Reducing Regional Transport of Ozone; Rule; USEPA, October 1998.

[4] Control of Air Pollution From New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements; Final Rule; USEPA, February 2000.

[5] Control of Emissions of Air Pollution from 2004 and Later Model Year Heavy-duty Highway Engines and Vehicles; Final Rule; USEPA, October 2000.

[6] Control of Emissions of Air Pollution From Nonroad Diesel Engines and Fuel; Final Rule, USEPA, May 2004.

Interstate Rule[7]) over the past decade, that are designed, in part, to lower regional emissions of NO_x. Over time, these rules are expected to reduce the magnitude and the geographic extent of the nation's 8-hour ozone problem. There is already some evidence[8] that improvements in ozone air quality over the eastern United States since the mid-1990s have coincided with continued decreases of regional NO_x emissions, in conjunction with local VOC control programs.

It is expected that there will be subpart 1 ozone areas affected by transport that will not be eligible for the overwhelming transport area (OTA) classification because they do not meet the definition of a rural area in 40 CFR 51.904(a)(1).[9] However, EPA restricted the OTA classification to rural areas because these areas will generally not have significant sources of emissions to control and therefore are not likely to contribute much to their own nonattainment problem. Areas that are not rural, even if they are affected to a significant degree by transport, can generally be shown to contribute to their own and to other areas' nonattainment problems.

Upon request by the State, EPA would conduct notice-and-comment rulemaking to classify an area as an OTA. The EPA will propose that an area will be classified as an OTA if it is rural, demonstrates that the nonattainment problem in the area is due to overwhelming transport, and shows the area does not significantly contribute to ozone in other areas. This guidance document outlines EPA's recommended approach for demonstrating overwhelming transport and lack of significant contribution.

The purpose of this document is to provide guidance to EPA Regional, State, and Tribal air quality management authorities and the general public with respect to 40 CFR 51.904(a)(2) and (3). The guidance may not apply to a particular situation, depending upon the circumstances. Any decisions by EPA regarding a particular overwhelming transport demonstration will only be made following notice and opportunity for public review and comment. Therefore, interested parties are free to raise questions and objections about the appropriateness of the application of this guidance to a particular situation; EPA will consider whether or not the guidelines set forth in this document are appropriate in that situation. This guidance is a living document and may be revised periodically without public notice. The EPA welcomes public comments on this document at any time and will consider those comments in any future revisions of this guidance document. Readers of this document are cautioned not to regard statements recommending the use of certain procedures or defaults as either precluding other procedures or information or providing guarantees that using these procedures or defaults

[7] Clean Air Interstate Rule, Final Rule March 10, 2005, USEPA.

[8] The Ozone Report: Measuring Progress through 2003; USEPA, April 2004.

[9] Paragraph (a)(1) indicates an OTA must meet the criteria as specified for rural transport areas under section 182(h) of the CAA; however, EPA is proposing to revise this to allow for an area that meets the section 182(h) criteria--except it is adjacent to a county or counties in an adjacent C/MSA, where the adjacent county/counties is/are designated attainment.

will result in actions that are fully approvable.

2.0 Criteria for assessing overwhelming transport

Assuming a subpart 1 ozone area meets the requirement of section 51.904(a)(1) demonstrating that it is rural, there are two additional criteria that must be met under 51.904(a)(2) and (3) for the area to be classified as an OTA:

51.904(a)(2): transport of ozone and/or precursors into the area is so overwhelming that the contribution of local emissions to observed 8-hour ozone concentrations above the level of the NAAQS in the area is relatively minor; and

51.904(a)(3): emissions within the area must not make a significant contribution to the ozone concentrations in other downwind areas.

The first of these criteria concerns whether an area is being affected by overwhelming transport and the second whether the area is significantly contributing to another nonattainment area. Analyses for both of these criteria will involve assembling emissions, air quality, meteorological, and/or photochemical grid modeling data; and making an informed decision regarding contribution based on the results of the composite set of analyses. This aggregation of data is generally referred to as "weight of evidence"[10] and is discussed in detail in EPA modeling guidance on 8-hour ozone attainment demonstrations.[11] The end product of this "weight of evidence" determination is a document which describes analyses performed, data bases used, key assumptions and outcomes of each analysis, and why a State believes that the evidence, viewed as a whole, supports a conclusion that the area is overwhelmingly affected by transport and does not significantly contribute to downwind problems.

The following types of analyses are examples of elements of possible weight of evidence determinations supporting whether an area should receive an OTA classification. It is expected

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[10] The term "weight of evidence" has a specific meaning in the context of an attainment demonstration. In terms of an attainment demonstration, a weight of evidence demonstration is a set of analyses that show an area can be expected to attain the standard in the future, despite a modeling projection that may not demonstrate that all monitors in an area will be monitoring attainment. In the context of the overwhelming transport guidance we are using the term "weight of evidence" in its more generic sense, that is, a series of technical analyses that when aggregated tend to support a particular air quality conclusion. Because in many cases, the same types of ambient analyses can support both goals – attainment demonstrations and overwhelming transport determinations – we cross-reference our modeling guidance for more information on performing a weight of evidence analysis.

[11] Guidance on the Use of Models and Other Analyses in Attainment Demonstrations for the 8-Hour Ozone NAAQS (Draft Final); USEPA, February 2004, http://www.epa.gov/scram001/guidance/guide/draft-final-o3.pdf .

that an area petitioning for an OTA classification would complete, and submit to EPA, a full analysis consisting of evidence from multiple forms of weight of evidence analyses as described within this guidance. For an area to be classified as an OTA, the large majority of the tests would have to demonstrate the area meets the criteria in 51.904(a)(2) and (3).

2.1 Ambient Data / Meteorological Analyses

There are numerous types of ambient data analyses that can be completed that show whether an area is being overwhelmingly influenced by ozone generated outside of the local area and whether local emissions make a significant contribution to high downwind ozone concentrations. The following are a subset of possible analyses that States should use in analyzing whether an overwhelming transport classification is appropriate for an area.

2.1.1 Trajectory analyses and wind roses: One useful analysis to assess the extent of transport into a given nonattainment region is compiling back trajectories for those days upon which the ambient NAAQS is exceeded in an area and determining the origin and transport path of the air masses that result in violations. If a large percentage of days with ozone violations is associated with air parcel trajectories from areas outside of the area in question, then it may be concluded that transport is a significant contributor to a large percentage of the violations. Shorter-path trajectories (i.e., those that originate in or near the area in question) may indicate a greater role from local/nearby sources, however long-path trajectories (i.e., those that originate long distances away from the potential OTA) by themselves are not sufficient evidence for an overwhelming transport classification. One possible tool for use in calculating back trajectories for days on which exceedance-level ozone was observed locally is the HYSPLIT[12] (HYbrid Single-Particle Lagrangian Integrated Trajectory) model. It is recommended that 24-, 48-, and 72-hour backward trajectories be calculated for any days within the past three years in which observed 8-hour ozone concentrations were greater than 85 ppb. Another way to look for overwhelming transport would involve the use of pollution wind roses. These combine wind speed and wind direction with observed ozone concentrations. The ambient data can be stratified by concentration levels and used with regional emissions analyses, discussed in the next section, to assess transport effects.

To assess the 51.904(a)(3) criteria, States should identify potential downwind areas that may be affected by the local area in question and perform similar analyses from the perspective of the downwind area.

It should be noted that there are some limitations associated with the use of trajectories and wind roses. In particular, it is not possible to apportion contribution to an area's ozone

[12] Draxler, R.R. and Rolph, G.D., 2003. HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) Model access via NOAA ARL READY Website (http://www.arl.noaa.gov/ready/hysplit4.html). NOAA Air Resources Laboratory, Silver Spring, MD.

problem from other regions solely through the use of trajectories.[13] However, if other analyses confirm the importance of upwind emissions, trajectories can be useful in determining which upwind areas, in particular, are contributing to the ozone problem in the OTA.

2.1.2 Ozone and Ozone Precursor Data: At the simplest level, depending on data availability, it may be possible in some cases to observe exceedance-levels of 8-hour ozone being transported into the region of interest. Animations of observed ozone over specific regions (e.g., as shown on the EPA AIRNow site) may indicate plumes of ozone being generated in urban areas, then advecting in steady-state over rural areas. It may also be possible to use animations from fully-evaluated photochemical grid models to detect transport into a particular region. A more data-intensive approach would be to demonstrate transport by compiling recent aircraft observations along an upwind boundary. Ozone transport predominantly takes place not at the surface, but within the entire planetary boundary layer (PBL) during the daytime, and in the residual layer that exists at night when the surface winds become decoupled from aloft winds due to the formation of a nocturnal temperature inversion. If aircraft data are available along the upwind boundaries of an area thought to be affected by significant transport, and those data show that incoming ozone is equivalent to, or higher than, ozone observed at the surface on days with exceedances of the NAAQS, that could be construed as evidence of transport. Additionally, field study analyses such as those completed by the Texas Council of Environmental Quality (TCEQ) in Houston[14] and by the Lake Michigan Air Directors Consortium (LADCO) in the Lake Michigan region[15] can provide the necessary data to quantify the influences of transport on an area. Finally, it may also be possible through detailed analyses of ozone precursor data to make some determination about the chemistry of a given airmass that indicates whether the ozone was formed locally or elsewhere and then advected to the local area. Several studies[16,17] have

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[13] Backward trajectories estimate the route that an air parcel took to get to the location in which high ozone was observed. These trajectories use gridded meteorological data to determine the parcel's trajectory. Because of the difficulty in representing atmospheric variables, which are continuous in space and time, by discrete gridded data points, these trajectories should be viewed as uncertain. This uncertainty is difficult to quantify, but 24-72 hour backward trajectories have potential errors in the hundreds of kilometers. Further, just because an trajectory passed over a populated area, does not necessarily mean that emissions from that area were loaded into the eventual high-ozone parcel. The height of the trajectory along the path as it relates to the mixed layer can help indicate whether upwind emissions loading takes place.

[14] http://www.tceq.state.tx.us/policy/ta/am/TexAQS_II.html

[15] http://www.ladco.org/index.html

[16] Blanchard, C.L.; Lurmann, F.W.; Roth, P.M.; Jeffries, H.E.; Korc, M. 1999. The use of ambient data to corroborate analyses of ozone control strategies. *Atmos. Environ. 33*, 369-381.

[17] Trainer M., Parrish D.D., Buhr M.P., Norton R.B., Fehsenfeld F.C., Anlauf K.G., Bottenheim J.W., Tang Y.Z., Wiebe H.A., Roberts J.M., Tanner R.L., Newman L., Bowersox V.C., Meagher J.F., Olszyna K.J., Rodgers M.O., Wang T., Berresheim H., Demerjian K.L., and Roychowdhury U.K. (1993) Correlation of ozone with

demonstrated cases where ozone exceedances were correlated with air masses in which most of the chemistry has already taken place, perhaps supporting, in conjunction with other factors, a determination of overwhelming transport.

2.1.3 Satellite analyses: Recent advances in satellite imagery have made it possible to track total aerosol in the atmosphere on a periodic basis. For those ozone events that are shown to be contemporaneous with elevated levels of fine particulate matter, it may be possible to track the evolution of an ozone event back to a particular source region. In the future, it may be possible to extract "surface" level ozone from the satellite measurements directly.

2.2 Emissions Analyses

The Phase 1 Rule makes it clear that the local emissions in the area are a key consideration in determining if an overwhelming transport classification is warranted. If the NO_x and VOC inventories for a particular area are much less than those for other areas for which there is evidence demonstrating contribution to the ozone nonattainment problem, this provides support that the transport component is overwhelming the local component of ozone formation.

One approach to assessing the potential importance of local emissions is to compile county-level emissions inventory estimates for each county over a broad region around the area being considered. The regional emissions analyses should include 1) the areas affecting the potential OTA and 2) areas being affected by the potential OTA. These results should be paired with the information gleaned from the analyses described in Section 2.1. If the emissions from contributing upwind counties are much larger than what is being emitted locally, this provides support that the impact of the local emissions may not be significant. EPA recommends that these emissions inventories should be built using the most current, accurate, and practical methods available. Several references are available for guidance on building emission inventories. The first is the "Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter NAAQS and Regional Haze Regulations" (USEPA, 2005). Additionally, modelers may also want to consider EPA's approaches for developing the 2002 National Emissions Inventory (NEI) to guide the development of the emissions data.

2.3 Photochemical Grid Modeling Analyses

Photochemical grid models (PGMs) are powerful tools to assess the impacts of emissions on air quality over a particular domain of interest. However, in many cases PGM-based analyses can be resource-intensive to establish and complete. Thus, in light of other available analyses to

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NOy in photochemically aged air. *J. Geophys. Res.* **98**, 2917-2925.

confirm whether an area is affected by transport, EPA does not believe such modeling would be necessary to support all such petitions. However, EPA is encouraging the use of modeling as an element of the weight of evidence to support an OTA petition, where such use is feasible and/or necessary.

2.3.1 Source apportionment: One modeling tool that can be used to evaluate the downwind contributions of emissions in upwind States is source apportionment. The source apportionment technique was developed to provide a means of estimating the contributions of many different source areas/categories to ozone formation in a single model run. This is achieved by using multiple tracer species to track the fate of ozone precursor emissions (VOC and NO_x) and the ozone formation caused by these emissions within a simulation. The methodology is designed so that all ozone and precursor concentrations are attributed to the selected source areas/categories at all time steps. Thus, for all receptor locations and times, the ozone concentrations predicted by the model are attributed to various source areas/categories selected for analysis. Additional information on the source apportionment technique can be found in the CAMx User's Guide.[18] Results that indicate large contributions from sources outside the local area could support a determination of overwhelming transport.

2.3.2 Sensitivity analyses / Zero out modeling: The zero-out modeling technique provides another technical approach to quantifying the downwind impact of emissions in upwind States. The zero-out modeling provides an estimate of downwind impacts by calculating the difference between the model estimates from a base case run and the estimates from a simulation in which the base case man-made emissions of NO_x and VOC are removed from a specific area. This approach is useful for showing both the effects of transported ozone on a particular area and the effects of the emissions within a local area on ozone locally and downwind. If the response of the model is small (i.e., even with zero local emissions, there is still a local ozone problem due to transport), when emissions from the OTA are removed, it would support a determination that local ozone is strongly influenced by transport.

Additional modeling-based tools beyond those mentioned here may also be used if they can be shown to represent sound approaches to assessing the origin and transport of ozone and its precursors.

3.0 Summary

Most subpart 1 ozone areas are not subject to classification. However, an overwhelming transport classification is available for rural nonattainment areas whose ozone problem is the result of transport of ozone and ozone precursors and which do not have emissions that

[18] ENVIRON, 2002. User's Guide for a Comprehensive Air Quality Model with Extensions (CAMx). ENVIRON Corp, Novato, CA 94945. Also see, http://www.camx.com.

significantly contribute to ozone concentrations in other areas. The EPA will propose that an area will be classified as an overwhelming transport area if:

(1) it meets the definition of a rural area under 40 CFR 51. 904(a)(1),

(2) transport of ozone and/or ozone precursors into the area is so overwhelming that the contribution of local emissions to observed 8-hour ozone concentration above the level of the NAAQS is relatively minor; and

(3) it is determined that emissions within the area do not make a significant contribution to the ozone concentrations measured in the area or in other areas.

In general, EPA believes the rural limitations will restrict the number of areas eligible for such classification. This guidance document outlines the types of analyses available for those subpart 1 areas that meet the location test in 51.904(a)(1) to compile a sufficient body of evidence to demonstrate whether the area meets the other two components of the test for the OTA classification. States requesting this classification for a subpart 1 ozone area are encouraged to conduct the technical analyses discussed in Section 2, as well as any other relevant technical analyses. Documentation which describes each analysis performed (e.g., data bases used, modeling methodology, results, etc.) and explains how strongly it supports a determination of overwhelming transport should be submitted to the appropriate EPA regional office. States/Tribes seeking the OTA classification are encouraged to work closely with the appropriate Regional Office to develop a plan for performing the analyses for such a demonstration. Obtaining early review of approaches being applied can help assure efficient use of resources.