Technical Criteria Document
For
Determination of Natural Exceptional Events For Particulate Matter Equal to or Less Than Ten Microns In Aerodynamic Diameter (PM_{10})

Supplement To Address
Regional Natural Exceptional Events

Arizona Department of Environmental Quality
Air Quality Division
Air Assessment Section
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REGIONAL NATURAL EXCEPTIONAL EVENTS

BACKGROUND

In May 2000, The Arizona Department of Environmental Quality (ADEQ) issued the *Technical Criteria Document for Determination of Natural Exceptional Events For Particulate Matter Equal to or Less Than Ten Microns in Aerodynamic Diameter (PM_{10}).* These criteria were established based on an analysis of meteorological and air quality data performed by the Department of Geography and Regional Development at the University of Arizona (U of A)[1]. These criteria focused on extreme values of meteorological parameters which could contribute to elevated PM_{10} concentrations, specifically, high wind conditions and low soil moisture content.

These criteria have been used since May 2000 to examine several air quality episodes to determine whether the elevated PM_{10} concentrations should be considered a result of natural exceptional events. Also during the past few years, additional air quality and meteorological data has been collected and reviewed to determine the adequacy of the criteria issued in May 2000.

On August 13, 2004, an unusual series of storms affected the air quality in the greater Phoenix metropolitan area. The analysis performed by ADEQ based on the May 2000 Technical Criteria Document indicated that the event should not be classified as a natural exceptional event. This precipitated a thorough review of the May 2000 Technical Criteria Document, underlying study performed by the U of A, as well as EPA guidance. It was found that the criteria established in May 2000 were adequate to identify events caused by nearby sources due to unusual meteorological events. These meteorological events could cause exceedances of the National Ambient Air Quality Standards (NAAQS) in spite of the application of Best Available Control Measures (BACM). However, the criteria did not properly characterize regional natural exceptional events (i.e., events that affect broad geographic areas) resulting from long-range transport of emissions from distant sources, or emissions resulting from short-term violent meteorological events. This supplement to the Technical Criteria Document addresses these regional natural exceptional events (RNEEs.)

REGIONAL NATURAL EXCEPTIONAL EVENTS

For the purpose of this document, a RNEE is defined as an adverse air quality event over a broad geographic area resulting from natural sources or caused by meteorological conditions that overwhelm control strategies (including BACM) for anthropogenic sources. These are generally characterized by one of the following:

- Long-range transport of smoke from wildfires;
- Long-range transport of dust from soils, usually without high transport winds; and/or,
- Emissions resulting from violent storms that generate emissions over a broad geographic area create blowing dust from both natural and anthropogenic sources.

[1] Comrie, A.C., et al. *Climatological Analysis for PM10 Natural Exceptional Events in Arizona*. Final Report to the Arizona Department of Environmental Quality, June 2001.

LIMITATIONS OF CRITERIA IN MAY 2000 TECHNICAL CRITERIA DOCUMENT

The May 2000 Technical Criteria Document includes criteria which do not recognize RNEEs. Specifically:

- The minimum 24-hour average wind speed and 3-hour sustained wind speed criteria are not relevant when emissions from blowing dust or wild fires from distant source are being transported into the area because the transport winds can be significantly lower than the threshold speeds designed to characterize high local emissions;
- The minimum 24-hour average wind speed and 3-hour sustained wind speed criteria are not relevant for emissions resulting from violent short term wind events associated with thunderstorm activities because the violent down drafts and winds over a short time period can generate significant blowing dust which affects the area; and,
- The minimum precipitation criteria do not recognize the seasonal dependence of the link between precipitation and residual soil moisture.

REVIEW OF AMBIENT PM_{10} DATA COLLECTED IN MARICOPA COUNTY

Numerous PM_{10} monitors are operated in Maricopa County. Data from all monitoring stations reported in the EPA AQS data base from 1998 through the third quarter 2004 were extracted for analysis. Only days corresponding with the routine one-in-six day monitoring schedule were retained. These data were examined to identify characteristics associated with RNEEs.

REGIONAL TRANSPORT OF SMOKE FROM WILDFIRES

Large wildfires can generate significant quantities of PM_{10} emissions. Because of the intense heat, these emissions can be carried high into the atmosphere and transported over very long distances. When emissions from distant wildfires arrive in Maricopa County, PM_{10} concentrations would be expected to be elevated across the entire monitoring network.

On July 14, 2003, smoke from the Kinishba Fire burning near the town of Whiteriver on Fort Apache Indian Reservation was transported into Maricopa County. This resulted in an increase in PM_{10} concentrations across the entire monitoring network. Of the 17 monitors reporting PM_{10} data for that day, the lowest concentration was 133 micrograms per cubic meter or 89% of the NAAQS. In addition to the contribution from the wildfire, a major thunderstorm created significant blowing dust that affected many of the monitors. The network-wide average concentration for the day was 172 micrograms per cubic meter, with one monitor reporting a concentration of 240 micrograms per cubic meter. In this situation, the addition of the smoke from the fire, coupled with the contribution from blowing dust from the storm, caused the NAAQS to be exceeded.

Similar long-range transport events of smoke have been observed for the California wildfires in 2003 that contributed to elevated PM_{10} concentrations in Kingman, Yuma and Maricopa County, and the wildfires in Mexico and Central America in 1998 that contributed to elevated PM_{10} concentrations in Maricopa County.

REGIONAL TRANSPORT OF DUST

When emissions from distant sources of blowing dust arrive in Maricopa County, PM_{10} concentrations would be expected to be elevated across the entire monitoring network. This pattern would also be expected in the unlikely event that volcanic dusts were to impact Maricopa County.

On May 15, 2003, elevated PM_{10} concentrations were observed across the entire monitoring network in Maricopa County. Of the 17 monitors reporting PM_{10} data for that day, the lowest concentration was 103 micrograms per cubic meter or 69% of the NAAQS. The network-wide average concentration for the day was 126 micrograms per cubic meter, with one monitor reporting a concentration of 151[2] micrograms per cubic meter. These elevated concentrations were associated with the transport of PM_{10} from west and southwest of Maricopa County. This transport of PM_{10} was the result of a cold front that moved east across the Phoenix area shortly after midnight bringing with it a significant amount of suspended dust.

THUNDERSTORM EVENTS

The criteria in the May 2000 Technical Criteria Document focused on two metrics for wind speed: the 24-hour average wind speed, and the requirement for 3 consecutive hours with hourly average wind speed greater than 16 miles per hour (mph). Neither of these criteria would necessarily occur with winds generated by a large thunderstorm.

Winds generated from a thunderstorm generally start out with flow from the base of the cloud down to the ground. When the downdraft reaches the ground it changes to horizontal flow outward from the center of the thunderstorm cell. The thunderstorm cells tend to migrate and can move very rapidly. The high horizontal winds generate blowing dust which can be transported over long distances. The high winds will not persist at one location, and generally will migrate. When the thunderstorm cells migrate, the leading edge wall of winds pick up additional dust until sufficient precipitation occurs to suppress the generation of dust.

On August 13, 2004, elevated PM_{10} concentrations were observed at most of the monitors in Maricopa County. A detailed examination of this event was prepared by ADEQ[3]. A strong thunderstorm cell formed southwest of the Phoenix area and began moving to the northeast. At noon, the winds in Phoenix were light and variable but by 2:00 p.m. winds were from the west at 29 mph with blowing dust reducing visibility to less than 5 miles. By 5:00 p.m. the winds in Phoenix were from the northwest at 20 mph with gusts to 32 mph. Another much larger thunderstorm cell began developing south of Tucson in the early afternoon hours. This thunderstorm cell moved rapidly to the north arriving at the south eastern edge of Maricopa County at approximately 7:00 p.m. This is evident from the satellite sequence and visibility photographs contained in the report. At 7:40 p.m., visibility in Phoenix was reduced to one mile

[2] Under EPA's reporting procedures a value of 151 is reported as 150 for the purpose of determining compliance with the NAAQS.

[3] *Summary of High Particulate (PM_{10}) Concentrations in the Phoenix Area on August 12, 2004*. Report Prepared by ADEQ Air Quality Division Air Assessment Section. October 7, 2004

with winds from the southeast with wind gusts to 53 mph. Other stations around the Phoenix area reported similar wind and visibility conditions. The optical particulate monitors and TEOM monitors all showed a significant PM event throughout the valley.

The two thunderstorm cells that affected the Valley on August 13, 2004, created elevated PM_{10} levels in different areas of the region. Because of the nature of the flow, the monitors on the southern periphery of Phoenix along the Salt River floodplain were most significantly affected by the first storm, and monitors on the south and east were more significantly impacted by the second storm. In this event, the 24-hour average PM_{10} measurements are less revealing of the cause and effect relationship of sources contributing to the exceedances than were the hourly average data from the TEOM and optical monitors. Examination of the hourly average TEOM and optical particulate monitor data was required to develop an understanding of the causes of the exceedances.

PROCEDURE AND CRITERIA FOR THE IDENTIFICATION OF REGIONAL NATURAL EXCEPTIONAL EVENTS

Identification of RNEEs is not well suited to the use of simple meteorological threshold parameters like those established in the May 2000 Technical Criteria Document. It requires a much more robust understanding of the meteorological driving forces, transport characteristics, and potential sources of the emissions resulting in elevated PM_{10} concentrations. The discussions in the preceding sections discuss specific attributes of events eligible for treatment under this Supplement, but not specific criteria for identifying RNEEs.

A general procedure follows for identification of RNEEs that should be used when examining an air quality event to determine if it is a candidate for treatment under the ADEQ Air Quality Exceptional and Natural Events Policy. This procedure may be applied to air quality events that result in exceedances of the 24-hour NAAQS, or that exceed 50% of the 24-hour NAAQS for monitors that operate on the one-in-six day sampling cycle where the annual average concentration could be significantly impacted by one event.

PERFORM ANALYSIS UNDER MAY 2000 TECHNICAL CRITERIA DOCUMENT – The necessary data and analysis outlined under the May 2000 Technical Criteria Document should be performed to determine if the event qualifies for treatment. If the event meets these criteria, a finding of potential eligibility for EEP or NEP should be based on these criteria.

EXAMINATION OF PM_{10} INFORMATION – All monitoring data from the network, including the 24-hour filter based data and the hourly TEOM and optical particulate monitor data should be collected and examined. If it appears the event impacts more than a single monitoring location, then the analysis should proceed. As a general guideline, the monitoring data from monitors throughout the area would be expected to be elevated for regional transport episodes of smoke or dust transported over long distances. Thunderstorm events will usually have elevated concentrations at multiple monitoring sites. In cases where there is not a dense network of monitors, unlike the case in Maricopa County, the examination of other meteorological information should be performed.

EXAMINATION OF METEOROLOGY – Synoptic and local meteorological data should be collected and examined to determine the potential source of emissions contributing to the elevated concentrations.

ATTRIBUTION TO EMISSION SOURCE – The meteorological and air quality data should be used to characterize the nature of the sources contributing to the event. In some cases specific sources may be identifiable (e.g., smoke from a specific wildfire). In others, it may not be possible to know the specific source, but the nature of the source can be inferred (e.g., blowing dust from a major thunderstorm cell over a large region).

ESTIMATION OF CONTRIBUTION FROM REGIONAL NATURAL SOURCE(S) – The relative contribution from sources eligible for treatment under EEP or NEP should be estimated based on information that is available. For long-range transport, this may be the difference between the network-wide lowest monitor reading and the highest monitor reading, adjusted for an expected contribution from local sources. For thunderstorm events, use of hourly or sub-hourly average particulate measurements can be used to estimate the "net" contribution of the event compared to the background concentrations measures just before and just after the event.

DETERMINATION IF REGIONAL NATURAL EXCEPTIONAL EVENT CONTRIBUTED TO PM_{10} EXCEEDANCE OR NEAR EXCEEDANCE – If the examination shows that an exceedance of the NAAQS would not have occurred but for the contribution from sources eligible for treatment under the EEP or NEP, then a finding should be made that the event so qualifies for treatment and the procedure described in the policy should be followed.