# Technical Criteria Document
# For
# Determination of Natural and Exceptional Events


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**Air Quality Division**
**Air Assessment Section**

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# NATURAL AND 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 ($PM_{10}$)* (2000 TCD). 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.

In February 2005, ADEQ issued a supplement to the original TCD to address Regional Natural Exceptional Events (RNEE) entitled *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* (2005 Supplement). A Regional Natural Exceptional Event 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 Best Available Control Measures (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 wind velocity; and/or,
- Emissions resulting from violent storms that generate emissions over a broad geographic area and create blowing dust from both natural and anthropogenic sources.

In March 2004, ADEQ initiated a stakeholder process to review the 2000 TCD and 2005 Supplement and other related information and policy issues. During that review it was determined that a revised TCD was needed to address weaknesses in the 2000 TCD and 2005 Supplement and address pollutants other than $PM_{10}$. This document reflects changes precipitated by the review process.

The 2000 TCD and 2005 Supplement address some aspects of the natural and exceptional events, but fall short in two specific areas:

- They do not address analytical requirements for pollutants other than $PM_{10}$;
- They do not address exceptional anthropogenic events (e.g., large structure fires); and,
- The qualifying criteria for events resulting from local emission sources rely on 24-hour average meteorological criteria rather than short-term meteorological criteria that can overwhelm BACM controls and result in elevated $PM_{10}$ emissions.

The net result of the review was a need to streamline and focus the Technical Criteria Document on a pollutant independent general framework for analysis, coupled with pollutant specific or source type specific suggested analysis components where appropriate.

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[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.

## Categories of Events

The fundamental principle behind flagging air quality data as being caused by natural or exceptional events is the need to exclude from air quality planning consideration those air quality measurements that are beyond the ability of the air quality planning agency to effectively control through the implementation of rules and regulations. These events are generally infrequent and are a result of the following categories of sources or transport:

- Emissions from nearby anthropogenic or natural emission sources that are exceptional (caused by unforeseen and non-recurring sources of emissions), or from meteorological conditions that overwhelm the control measures implemented to protect the National Ambient Air Quality Standards (NAAQS) in an area;
- Emissions from Regional Natural and Exceptional Events (RNEE) that involve transport or regional emissions (such as long-range transport of smoke from wildfires, long-range transport of dust from soils, usually without high wind velocity; and/or, emissions resulting from violent storms that generate emissions over a broad geographic area and create blowing dust from both natural and anthropogenic sources); or,
- Emissions from international sources.

EPA established an Exceptional Events Policy (EEP), Natural Events Policy (NEP), and Fire Policies to provide guidance in this area. The typical application of this analysis is to flag events when the air quality monitoring measurement exceeds the NAAQS. However, it is also applicable when an air quality monitoring measurement is below the NAAQS, but exceeds the eligibility limits for areas in which Limited Maintenance Plans are in place or could be submitted.

## Analytical Framework

The analytical framework for all these categories of events are the same and involve developing sufficient documentation to show a clear causal relationship between the qualifying event and the air quality monitor reading that is to be flagged. The framework used is a weight of evidence approach to the analysis. To the extent necessary, it should be developed using the following steps:

Step 1. Properly qualify and validate the air quality measurement to be flagged.
In this step, information about the measurements, the monitoring site(s), the area around the site(s), the sampler(s), quality control, and quality assurance must be documented. A summary for each monitoring site must be included containing the location description, operational history, and relevant data including the values to be flagged. In addition, a description of emissions sources and their activity levels in the area should be included when those sources are contributing to the elevated ambient concentration.

Step 2. Review suspected contributing sources.
In this step, an initial examination should be performed for local, regional, and international sources and/or meteorological conditions that may have contributed to the source. If sufficient evidence is found that the event may qualify to be flagged, then the nature of the suspected cause of the event should be documented and the analysis proceed to the next step.

Step 3. Examine all air quality monitoring information. In this step, all relevant monitoring data from the network should be collected and examined. This should include information from both reference method monitors for the pollutant of concern and other monitors that can shed light on the nature of the event (e.g., optical particulate monitors and photographic images). If it appears the event impacts more than a single monitoring location, then potential impacts from a regional phenomenon should be examined. 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.

Step 4. Examine the meteorological conditions before and during the event.
In this step, synoptic and local meteorological data should be collected and examined to determine the potential source of emissions contributing to the elevated concentrations. This may include data and information from non-EPA reference method monitors when assembling information for the weight of evidence analysis. Visual and infrared satellite images of the area and weather radar images should be collected and reviewed for potential long-range transport events or those driven by high winds. For examination of high-wind driven emissions, collection and examination of short-term (e.g., 5-minute) average wind speeds and/or information on maximum wind gust speeds during the hour will be helpful to understand the highest wind speeds during the hour when estimating emission of dust. Meso-scale meteorological data for an area may be needed for more complex analyses, such as examination of ozone in an area.

Step 5. Perform a qualitative attribution to emission source(s).
In this step, the meteorological and air quality data should be examined together to characterize the nature of the phenomenon 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). In cases where a natural source can be shown to be the overwhelming contributor to an elevated value through the data collected and analyzed in steps 3 and 4, the detailed modeling described in the next step may not be necessary. Photographic records of emissions from sources or source areas can be helpful in reducing the need for the detailed modeling, and/or documenting contributions from wildfires and international sources (such as fires or emissions from anthropogenic activities in Mexico).

Step 6. Estimation of Contribution from Sources
In this step, which may or may not be needed depending on the results from Step 5, the relative contribution from sources eligible for treatment under EEP, NEP and/or Federal Fire Policies 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 measured just before and

just after the event. In some cases refined air quality modeling will be needed in order to develop the evidence that the contribution from natural sources was a significant contributor to the air quality reading being flagged.

Step 7. Determination that a Natural or Exceptional Event Contributed To an 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, NEP and/or Federal Fire Policies, then a finding should be made that the event so qualifies for treatment and the procedure described in the policy should be followed.

**Special Considerations – Particulate Matter**

For wind-blown dust, it will be necessary to demonstrate that the winds were high enough to exceed the threshold friction velocity for the local area, if local sources are suspected to be contributing, and that anthropogenic sources were in compliance with applicable requirements at the time of the event. The Western Regional Air Partnership, of which Arizona is a member, developed a comprehensive review of dust emissions and control strategies. Emissions from open areas are a particular concern for areas in Arizona.

Key variables used to characterize emissions from open areas include the friction velocity (defined by the wind speed in the atmosphere), and the threshold friction velocity, which is the velocity below which emission of dusts will not be initiated. The threshold friction velocity related to the soil type, residual soil moisture, and ground cover. A challenge in the analysis and characterization of emissions of dust from open areas is that the actual wind speed varies considerably during an hour, and hourly average wind speeds may not be representative of the friction velocity that can cause emissions. As an example in an area where the threshold friction velocity is 3 meters per second and the hourly average friction velocity is 2.9 meters per second, an erroneous conclusion may be drawn that no emissions are expected from the area. Actual emissions will occur because the short term wind speed will exceed the average approximately half the time. It is therefore important to use direct measurements of wind gust speed, or estimates from nearby stations when characterizing emissions from dust sources. The WRAP Fugitive Dust Handbook initially published in November 2004 is a useful reference for dust sources and control measures. This can be found on the WRAP website at http://www.wrapair.org/dejf. Other WRAP work products provide additional insight on the mechanics and physics of the dust emissions phenomenon.

Emissions from seismic or volcanic activity can also contribute to elevated PM concentrations and should be considered when examining an event.

An alternative framework for analysis defined in the original Technical Criteria Document (May 2000) may be used to characterize events from extremely rare climatological conditions.

**Special Considerations – Ozone**

Wildfires may contribute to exceedances of the ozone NAAQS if plumes are transported into an area with elevated ozone from other sources. Air quality modeling may be necessary in order to develop a weight of evidence case that the ozone exceedance was a result of emission contributions from wildfire.

## Special Considerations – 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 wind velocity; and/or,
- Emissions resulting from violent storms that generate emissions over a broad geographic area create blowing dust from both natural and anthropogenic sources.

Long-range 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 a monitored area, $PM_{10}$ concentrations would be expected to be elevated across the entire monitoring network. 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.

Long-range transport of dust from soils. 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 Arizona. On May 15, 2003, elevated $PM_{10}$ concentrations were observed across the entire monitoring network in Maricopa County. 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.

Emissions resulting from violent storms. 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. Hail stones striking the ground can significantly impact any undisturbed soils with surface crusts allowing for rapid release dust. 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. Examination of the hourly average TEOM and optical particulate monitor data was required to develop an understanding of the causes of the exceedances.