Meteorological Data

The meteorological data utilized in the air quality analysis should consider the proximity of the collection site to the area of interest, the complexity of the terrain in the area surrounding the facility, the exposure of the meteorological sensor and temporal variations in local climate.

Because AERMOD does not accept raw meteorological data, it must be processed through AERMET, the meteorological data pre-processor for the AERMOD modeling system. AERMET extracts and processes meteorological data in order to calculate the boundary layer parameters that are ultimately necessary for the calculation of pollutant concentrations within the atmosphere. AERMET will process site-specific meteorological data and National Weather Service data. In most instances, data from a representative National Weather Service site is utilized because site-specific data is unavailable.

The selection of a representative National Weather Service site should consider local climate conditions and terrain effects. If it is determined that representative National Weather Service data is available, staff from the Department’s Air Pollution Control Program will provide AERMOD ready meteorological data inputs along with an evaluation of the surface characteristics surrounding the facility site compared to the National Weather Service site. In order to process the meteorological data request, the applicant must provide the UTM coordinates for the facility center in the NAD83 datum, UTM Zone 15. 40 CFR Part 51 Appendix W, “The Guideline on Air Quality Models,” recommends the use of a five year data set to ensure that the worst case meteorological conditions have been accounted for in the compliance demonstration.

Site-specific meteorological data must be collected in instances where micrometeorological flows, terrain effects, or unique surface characteristics are evident. The data collection effort must meet the minimum monitoring requirements described in the EPA document entitled “Meteorological Monitoring Guidance for Regulatory Modeling Applications” and should be detailed in a Quality Assurance Project Plan for submittal to the department’s Air Quality Monitoring Unit. If on-site meteorological parameters are going to be collected, the applicant should contact the department’s Air Pollution Control Program during the development stage of the meteorological study in order to ensure that delays in permit issuance do not result.

The following paragraphs provide an overview of the procedures that are followed when processing National Weather Service data and the data elements that must be included if on-site meteorological data is going to be collected. Questions, comments or data requests should be directed to staff of the Department’s Air Pollution Control Program at (573)751-4817.

National Weather Service Data
National Weather Service data are routinely available from the National Climatic Data Center and provide the basic elements that are necessary to characterize the atmospheric conditions that are occurring in the region surrounding the meteorological sensor. Figure 1 entitled, “Surface and Upper Air Reporting Sites,” visually depicts the location of the surface and upper
air National Weather Service Stations that are used in determining representative meteorological data for modeling applications within the State of Missouri.
When National Weather Service data is used in an ambient air quality impact analysis, it should be representative of the facility site. In other words, the meteorological conditions that are occurring at the facility site should be similar to the meteorological conditions that are occurring at the measurement site. Data representativeness is critical and is directly dependent upon spatial proximity, instrument exposure, topography and land use.

Spatial proximity is an important component in airport selection because differences in mesoscale features, such as, frontal boundary position, temperature, pressure and cloud cover, are more likely to occur as the distance between the application site and the National Weather Service site increases. Every effort is made to select meteorological data within the same region as the application site in order to ensure that the application site and the measurement site are experiencing the same weather conditions.

Additionally, because manmade and natural terrain features, such as buildings, valleys, river bottoms, etc. can influence microscale meteorological conditions, it is important to ensure that the meteorological sensors are located in areas that are not unduly influenced by obstacles. The National Weather Service was established to provide weather forecasts and warnings for the United States and its territories. In order to provide accurate up to date forecasts, the placement of instruments must meet minimum exposure criteria as established by the National Oceanic and Atmospheric Administration and should be sufficient to prevent microscale influences.

Lastly, to accurately calculate the boundary layer parameters in AERMET, the meteorological model must have information about the land use that surrounds the meteorological site: surface roughness, albedo and Bowen ratio. In order to provide a consistent method for determining surface characteristics, the Environmental Protection Agency developed a mathematical tool, AERSURFACE, to determine surface roughness, Bowen ratio, and albedo values for input into AERMET. The Department’s Air Pollution Control Program executes AERSURFACE for each data request using the default values described below:

- Bowen ratio
  - Ten kilometer by ten kilometer domain centered on the site.
- Albedo
  - Ten kilometer by ten kilometer domain centered on the site.
- Surface roughness length
  - Default upwind distance of one kilometer centered on the site.
  - Twelve, 30 degree meteorological sectors.

Because these surface characteristics influence the similarity profiles that are utilized by the dispersion model, AERMOD, the user must determine if the surface characteristics at the
meteorological site accurately represent the conditions that are present at the facility site. In order to determine if the differences in surface conditions will significantly impact the AERMOD predictions, a direct comparison between the meteorological site and the facility site is necessary.

The department’s Air Pollution Control Program has developed surface characteristics for multiple airports across the state for each moisture condition: average, dry and wet. The results from the AERSURFACE analysis for each airport have been summarized in an excel template. This template enables staff to input facility surface characteristics from AERSURFACE and compare each airport based upon characteristics of surface roughness, albedo, Bowen ratio, land use classifications, proximity and aerial photography.

The most recent meteorological data that is available will be processed for use in ambient air quality impact analyses that utilize National Weather Service data. If available, data processing will include 1-minute ASOS wind data. The 1-minute ASOS data will be obtained from the National Climatic Data Center and will include the 2-minute average wind speed and direction for each minute within an hour. The use of the 1-minute ASOS data more accurately depicts the average hourly wind flow than the single instantaneous reading of wind speed and direction that is currently used in air quality modeling analyses.

Several advantages to supplementing the one hour wind data are evident. For instance, the frequency of measurements that result in calm or missing data is decreased. The instantaneous reading included in the hourly data file represents the 2-minute average wind speed and direction at a specified time, typically ten minutes before the hour. If the measured value is missing or variable, the data for that hour is reported as a calm value or a missing value. On the other hand, when using 1-minute ASOS data as a supplement, the wind speed and direction are based upon the hourly average of all of the two-minute averages that are collected within that hour at the ASOS station. If the hour has at least two usable non-calm observations during the first half hour or at least one usable non-calm observation in the last half hour, the direction and speed will have a value. Using each minute instead of a predetermined time increases the likelihood that the hour will have a valid value.

Another advantage to supplementing the hourly data with the 1-minute ASOS data is that the wind speed threshold of the anemometer is lower. The reporting requirements for the hourly data state that any wind speed below three knots must be reported as a calm value. If the data is supplemented, the wind speed threshold is less than or equal to two knots. If the ASOS station is a member of the Ice Free Winds Group, the wind speed threshold is effectively zero.

Lastly, the hourly data file reports wind direction to the nearest ten degrees. In order to obtain a wind direction based upon the nearest degree, the EPA developed a procedure to “randomize”
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the reported wind direction using a single-digit random number for each hour of the year. In order to obtain a wind direction based upon the nearest degree, the sum of the wind direction and the random number are subtracted by four. The process of randomizing the wind direction is not necessary when utilizing the 1-minute ASOS data because the wind direction is reported to the nearest degree rather than the nearest ten degrees.

Site-specific Meteorological Data Collection

As previously noted, the use of representative meteorological data plays a crucial role in the air quality model’s ability to accurately predict ambient pollutant concentrations. The accurate depiction of spatial and geographic influences near a facility site is often achieved through the collection of site-specific meteorological data. This is particularly true in regions where National Weather Service data may not be available due to natural features such as complex terrain, forests, river bluffs, etc. Typically, the Environmental Protection Agency prefers the collection of site-specific meteorological data provided the collection criteria established in the document entitled “Meteorological Monitoring Guidance for Regulatory Modeling Applications” are followed.

A minimum of one-year of site-specific data is required for ambient air quality impact assessments. Site-specific measurements must include temperature, wind speed, wind direction, relative humidity, barometric pressure, total solar radiation and precipitation totals. Additional parameters that must be reported include the scalar average wind speed, wind speed standard deviation, scalar average wind direction (or, alternatively, vector average wind direction), wind direction standard deviation (sigma theta) and the temperature difference between two and ten meters.

When siting meteorological instruments, particular attention must be paid to proper placement because a poorly sited instrument can result in biased data that does not accurately characterize local weather conditions. The primary objective of meteorological tower placement is the acquisition of precise atmospheric measurements that are not influenced by natural or man-made obstacles.

The siting, exposure, data acquisition procedures, data processing, data completeness and reporting requirements should be summarized and submitted via a Quality Assurance Project Plan to the Air Quality Monitoring Unit for approval prior to the start of any monitoring study.

In order to prevent delays in permit issuance, applicants that are required to collect on-site meteorological data should allow ample time for site approval. Again, a minimum of one-year of meteorological data is required for on-site air quality assessments without consideration of the review process and the time necessary to review site selection and collection procedures.