Introduction to October 2006 Ambient Air Quality Monitoring Guidelines

The Bureau of Air Quality Planning's (BAQP) ambient air quality and meteorological monitoring guideline document has been revised from the June 2003 version. Some air quality permits require ambient air quality and (or) meteorological monitoring to be conducted as a permit condition. Those air quality permits reference the version of the Bureau of Air Quality Planning's Ambient Air Quality Monitoring Guidelines in effect at the time of the issuance of the permit, stating that monitoring must be conducted in accordance with that version of the Guidelines. The Bureau Guidelines have now been revised in major part to accommodate changes in US EPA modeling requirements. These revisions result in the need to install additional equipment on meteorological towers collecting data for new permitting purposes. No additional equipment installation is required to establish compliance with air quality permits which reference a previous (June 2003 or older) version of the Guidelines.

The Bureau has revised the Guidelines primarily in response to the US EPA's promulgation in the Federal Register on November 9, 2005 of its changes and additions to its *Guideline on Air Quality Models*—more specifically, EPA's recommendation to replace the Industrial Source Complex (ISCST3) dispersion model with the dispersion model AERMOD no later than November 9, 2006. AERMOD model meteorological inputs include two new parameters to be collected at meteorological towers, solar radiation and temperature difference, in support of AERMOD's use of the Bulk Richardson scheme. Public notice of changes to the federal Appendix W Guideline was provided at the federal and state levels through the Federal Register announcement and the related amendment of the applicable Nevada Administrative Code. The ISCST3 model is no longer contained in the federal Guideline.

After November 9, 2006 proposed and existing sources submitting air quality modeling analyses in support of new air quality permits, permit renewals or permit modifications may be required to provide appropriate meteorological input data for use in AERMOD modeling analyses. Existing sources already conducting meteorological monitoring for ISCST3 (sigma theta) modeling analyses, which did not convert to AERMOD (SRDT) meteorological monitoring, will have one year, until November 9, 2007, during which five years of representative National Weather Service (NWS) data may be substituted for one year of on-site meteorological data for use in AERMOD. The appropriate

NWS station may not always be the closest one to the project site, and the selection of a NWS station for such AERMOD modeling data substitution is subject to Bureau approval.

The Bureau's ambient monitoring guidelines have also been revised to help facilities identify and correct certain deficiencies which may invalidate or compromise the monitoring data collected. The new version of the Guidelines will be referenced in future air quality permits which contain ambient monitoring conditions. The Bureau's Guidelines must also be adhered to when necessary to support Air Quality Permits To Construct, Air Quality Operating Permits, permit renewals and permit modifications. What constitutes valid ambient monitoring is defined by the Bureau's Guidelines in conjunction with the various US EPA guidance documents referenced in the Bureau Guidelines.

The draft revised Guidelines were presented for comments at a Stakeholders' Meeting on October 18, 2006. Those comments were addressed in the final Guidelines. The final October 2006 Guidelines follow this introduction. Copies are also available from the Bureau upon request to (775) 687-9354.

Nevada Bureau of Air Quality Planning and Bureau of Air Pollution Control
Ambient Air Quality Monitoring Guidelines

The Nevada Bureau of Air Quality Planning Ambient Air Quality Monitoring Guidelines are prepared in general to define what constitutes acceptable criteria pollutant and meteorological monitoring for pre-construction dispersion modeling and for post-construction monitoring by facilities required by air quality permit condition to conduct ambient air quality monitoring. These Guidelines are provided in the interest of obtaining valid, consistent, usable data from ambient monitoring operations within the Division of Environmental Protection's jurisdiction, which excludes Clark and Washoe Counties except for regulation of certain power plants. Fossil fuel-fired steam generating plants are under the Division's jurisdiction statewide. Deviations from or alternatives to the Guidelines procedures or requirements shall be submitted to the Bureau of Air Quality Planning prior to their use for review and approval.

References

To ensure data of sufficiently high quality, all sampling and continuous monitoring for Prevention of Significant Deterioration (PSD) permitting use, or as the result of a PSD permit condition to monitor, shall be conducted in accordance with these guidelines and the applicable guidance and procedures published by the U.S. Environmental Protection Agency (EPA). Sampling and continuous monitoring for non-PSD permitting use, or as the result of a non-PSD permit condition to monitor, shall be conducted according to these guidelines and published EPA guidance and procedures for State and Local Air Monitoring Stations (SLAMS). After one year of PSD monitoring conducted subsequent to the commencement of operation of a PSD facility, the PSD facility required to monitor as a PSD permit condition may conduct SLAMS, rather than PSD, monitoring, if continued monitoring is required. However, only PSD monitoring will be sufficient to support applications for new and revised PSD permits. Modeling applications may require meteorological data collected in accordance with the "Meteorological Monitoring Guidance for Regulatory Modeling Applications" (formerly, the "On-Site Meteorological Program Guidance for Regulatory Modeling Applications"), including recommended system accuracies and resolutions and recommended response characteristics for meteorological sensors.

Several EPA documents follow that contain information to be adhered to in the operation of such monitoring networks. These documents and their titles may be revised at times.

> "Code of Federal Regulations," Title 40, Chapter I, Subchapter C, Part 58, Ambient Air Quality Surveillance. This reference is available for purchase from the Superintendent of Documents, Attn: New Orders, P.O. Box 371954, Pittsburgh, PA 15250-7954, telephone (202) 512-1800. It may also be available at Internet address http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=ebccfc3fec4560934f342cb67341f438&tpl=/ecfrbrowse/Title40/40cfr58_main_02.tpl

"Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)," EPA-450/4-87-007, US EPA Office of Air Quality Planning and Standards (OAQPS), Research Triangle Park (RTP), NC 27711. A copy of this document is available for purchase from the National Technical Information Service (NTIS), stock number PB 90-168030, telephone (800) 553-6847. It may also be available at Internet address http://www.epa.gov/ttn/amtic/files/ambient/criteria/reldocs/4-87-007.pdf.

"On-Site Meteorological Program Guidance for Regulatory Modeling Applications," EPA-450/4-87-013, OAQPS, RTP, NC 27711. This meteorological guidance document is available for purchase from the NTIS, stock number PB 87-227542, telephone (800) 553-6847. An updated version entitled "Meteorological Monitoring Guidance for Regulatory Modeling Applications," EPA-454/R-99-005, may be available at Internet address http://www.epa.gov/scram001/guidance/guide/mmgrma.pdf.

"Quality Assurance Handbook for Air Pollution Measurement Systems, Volume I, a Field Guide to Environmental Quality Assurance," EPA-600/R-94/038a, US EPA Office of Research and Development (ORD), Washington, DC 20460. See the ordering information below for the EPA-600-series documents. It may also be available at Internet address http://www.epa.gov/ttn/amtic/files/ambient/qaqc/r94-038a.pdf.

"Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Part 1," EPA-454/R-98/004, OAQPS, Research Triangle Park, NC 27711. This document is available for purchase from the NTIS, stock number PB 99-129876, telephone (800) 553-6847. It may also be available at Internet address http://www.epa.gov/ttn/amtic/files/ambient/qaqc/redbook.pdf.

"Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Specific Methods (Interim Edition)," EPA-600/R-94/038b, ORD, Washington, DC 20460. See the ordering information below for the EPA-600-series documents. The section of Volume II of greatest interest to most operators is Section 2.11, the "Reference Method for the Determination of Particulate Matter as PM_{10} in the Atmosphere (High-Volume PM_{10} Sampler Method)." A more recent (1997) version of this document is known as the "Quality Assurance Guidance Document 2.11, Monitoring PM_{10} in Ambient Air Using a High-Volume Sampler Method**."** This 1997 PM_{10} guidance document was intended to implement the 1997 99^{th}-percentile, actual concentration-based PM_{10} standard, which was vacated by the courts. Consequently, Section 5.1.2 of this document, Calculation of PM_{10} Concentrations, is not applicable. This document may only be available on the Internet. An address at which this document may be found is http://www.epa.gov/ttn/amtic/files/ambient/qaqc/2-11meth.pdf.

"Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV, Meteorological Measurements," EPA-600/R-94/038d, ORD, Washington, DC 20460. See the ordering information below for the EPA-600-series documents. A more recent version of this document (EPA-600/R95/050) is available for purchase from the NTIS, stock number PB 95-199782, telephone (800) 553-6847. An updated version is available at Internet address http://www.epa.gov/ttn/amtic/met.html.

The EPA-600-series documents, Volumes I, II and IV of the Quality Assurance Handbook for Air Pollution Measurement Systems, may be available at no cost from the US EPA National Service Center for Environmental Publications (NSCEP), telephone (800) 490-9198 or (513) 569-7562.

Discussion

The Bureau of Air Quality Planning monitoring requirements specifically include the following:

1) All meteorological data collected shall be recovered at a minimum rate of 90% of the total data possible on an annual basis for each variable being measured and for the joint recovery of wind direction, wind speed and measurements for stability determinations (e.g., temperature difference and solar radiation). For regulatory modeling applications, the 90% recovery rate, including joint recovery, should be met on a quarterly basis.
2) All ambient monitoring data for pollutants (including data from continuous analyzers and manual samplers) shall be recovered at a minimum rate of 80% of the total data possible per continuous analyzer or manual sampler per calendar quarter for PSD monitoring, or at a minimum rate of 75% of the total data possible per continuous analyzer or manual sampler per calendar quarter for non-PSD (SLAMS) monitoring.
3) For meteorological monitoring data, at least 30 minutes of valid observations are required to represent an hourly average. If 15-minute averages are used for compiling meteorological data, then at least two valid 15-minute periods are required for an hourly average. For continuous ambient air quality monitoring data, at least 45 minutes of valid observations are required to represent an hourly average. Running averages of more than one hour shall require valid observations for at least 75 percent of the hours in the averaging period. All invalid data observations shall be excluded from the average.
4) The EPA specification for the high-volume particulate sampling run time is 24 hours ± one hour (1440 minutes ± 60 minutes), from midnight to midnight, local time.
5) The EPA specification for the PM_{10} high-volume particulate sampling flow rate is 1.02 to 1.24 actual cubic meters per minute, or 36 to 44 actual cubic feet per minute (not corrected to standard conditions).
6) Because the 1997 99^{th}-percentile, actual concentration-based PM_{10} standard was vacated by the courts (D.C. Circuit, May 14, 1999) without an appeal by the EPA, and because only the

original PM_{10} standard is in effect, the PM_{10} concentration calculations section of the 1997 "Quality Assurance Guidance Document 2.11, Monitoring PM_{10} in Ambient Air Using a High-Volume Sampler Method" does not apply. Section 5.1.2 of the Quality Assurance Guidance Document 2.11 calculates the volume of air sampled in actual conditions (while incorrectly identifying the conditions as standard conditions). The volume of air sampled must be calculated in standard conditions, which results in a higher PM_{10} concentration for elevations above sea level. Comparisons with the PM_{10} standards utilize 40 CFR Part 50, Appendix K, not 40 CFR Part 50, Appendix M. In Appendix K, the 24-hour standard is based on the average number of exceedances, while in Appendix M, it is based on the average 99^{th}-percentile concentration.

7) For gaseous analyzers, the results of zero, span and precision checks shall be reported quarterly. Hourly instrument panel or instrument rack temperature shall be reported for gaseous analyzers. When an analyzer is operated outside the temperature range for which the analyzer is certified by the EPA, it may be necessary to invalidate the data, as described in the Quality Control and Quality Assurance section of these guidelines.

8) Meteorological upper-air monitoring (e.g., SODAR) shall be conducted in accordance with the guidance provided in Chapter 9, Upper-Air Monitoring, of the EPA's "Meteorological Monitoring Guidance for Regulatory Modeling Applications" (February 2000).

All required ambient air quality and meteorological monitoring data shall be submitted to the Bureau on a calendar quarter basis no later than 60 days after the end of the applicable quarter. Should any of the requirements for a monitoring program not be maintained at the requisite levels, part or all of the data recovered may be deemed incomplete and may not be usable to support the environmental evaluation, ambient concentration assessment, or meteorological assumptions necessary for new or modified air quality permits, and the facility may be subject to noncompliance penalties for violations of its air quality permit conditions.

Gaseous Analyzers

The limit at which continuous gaseous data shall be invalidated is the greater of 15 percent span drift or 15 ppb (1.5 ppm for carbon monoxide) zero drift.

For continuous analyzers, the recommended data sampling frequency of at least 360 samples per averaging period is met by electronically sampling the instrument output at least once every 10 seconds for hourly averages or at least once every 2.5 seconds for 15-minute averages. More frequent sampling may be necessary when sampling continuous analyzers simultaneously with meteorological instrumentation. One method for computing horizontal wind direction requires sampling at least once per second. Therefore, a sampling frequency of at least once per second is recommended. The data sampling frequency shall be reported in the quarterly report. Data recovery shall be based on the total number of hours in the reporting period, not the number of hours possible less time used for quality control, upset conditions, etc.

Data shall be reported in a format suitable for comparison with the State ambient air quality standards. This includes reporting running averages, as applicable. Data recovery shall be based on one-hour averages.

Particulate Samplers

The data reported for high-volume particulate samplers shall include:

- sampler identification
- run date
- filter serial number
- elapsed run time (minutes)
- actual flow rate (m^3/min)
- standard flow rate (m^3/min)
- net weight (g)
- particulate concentration ($\mu g/m^3$).

For co-located particulate samplers, the particulate data for both samplers shall be reported in order to provide a precision check of the samplers. Sampling shall conform with the EPA national every-sixth-day particulate sampling schedule. A copy of the schedule is available from the Bureau upon request. Each sampler shall be operated at least every designated sixth day throughout the year. Any deviations from these scheduled run days require justification and written approval from the Bureau.

The most common type of sampler is the high-volume PM_{10} sampler; therefore, this guidance is directed toward high-volume PM_{10} samplers. PM_{10} may be measured by drawing a known volume of ambient air at a specified flow rate through a size-selective inlet and through a quartz fiber filter. Particles in the PM_{10} size range are collected on the filter during a 24-hour sampling period from midnight to midnight, local time. After a period of equilibration for temperature and humidity, filters are weighed prior to and after collection of the sample to determine the net mass of the collected sample. The concentration of PM_{10} in the ambient air is computed as the total mass of the collected particles divided by the volume of air sampled. The original reference method for PM_{10} sampling is given in 40 CFR Part 50, Appendix J and implemented in the "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II," Section 2.11. Comparisons with the PM_{10} standards are done according to 40 CFR Part 50, Appendix K. In response to the 1997 PM_{10} standard later vacated by the courts, the 1997 reference method for PM_{10} sampling is given in 40 CFR Part 50, Appendix M and implemented in the "Quality Assurance Guidance Document 2.11, Monitoring PM_{10} in Ambient Air Using a High-Volume Sampler Method." Appendix M to 40 CFR Part 50 is not used for comparisons to the PM_{10} standards, because the 1997 PM_{10} standards were vacated.

Co-located PM_{10} samplers are required on one or more sites in each facility's PM_{10} monitoring network, depending on the size of the network, in order that the precision of the samples from the network may be determined relative to EPA and Bureau requirements. The co-located samplers must be of the same type with the same inlet type and use the same method of flow control. The two samplers must be located within four meters of each other, but at least two meters apart to preclude any air flow interference. The vertical placement of the samplers must be such that the inlets are no lower than two meters and no higher than fifteen meters above ground elevation. If the sampler is to be located on a roof or near any structures, there must be a minimum clearance of two meters from surrounding walls or obstacles. Adjacent buildings or obstacles should be avoided so that the distance between an obstacle and the sampler is at least twice the height that the obstacle protrudes above the sampler. Also, there must be a minimum of a 270-degree arc of unrestricted airflow around each sampler. The predominant wind direction for the season of greatest pollutant concentration potential from the facility must be included in the 270-degree arc. Calibration, sampling and analysis must be the same for both co-located samplers and any other samplers in the sampling network to which the co-located samplers apply. One of the two co-located samplers must be designated as the primary or official sampler and the second designated as the secondary or duplicate sampler. The official sampler shall be used to report the air quality for the monitoring site and the duplicate sampler shall be used to determine the precision of the measurement. In the event of a failure of the official sampler, the duplicate sampler may be used to report the air quality for the monitoring site.

The measured concentrations from both co-located samplers shall be reported, as well as the percentage difference in concentrations between the two samplers for concentrations above 80 $\mu g/m^3$. For the purpose of this precision check of co-located high-volume samplers, negative concentrations shall be reported without changing the negative concentration to zero. With proper PM_{10} sampling and analysis, co-located samplers should generally be capable of precision of not more than seven percent difference for concentrations above 80 $\mu g/m^3$ and not more than five $\mu g/m^3$ difference for concentrations below 80 $\mu g/m^3$.

The accuracy of high-volume PM_{10} samplers is assessed by auditing the flow rate of each sampler with an orifice transfer standard. Then the corrected sampler flow rate without an orifice transfer standard is compared to the design flow rate.

The monitoring site location shall be representative of the point of maximum PM_{10} concentration from the proposed and existing facilities at the limit of public access. This shall be determined based on the combined effect of existing facilities and the proposed new facility or modification. The maximum concentration at the point of public access may be determined through the use of an EPA-approved model. In the case where a model may not be applicable, the initial monitoring site location, supported by detailed maps, may be proposed by the applicant, and shall be based on atmospheric drainage and prevailing wind direction in the area where the facility is to be located. Sampler locations shall also satisfy the requirement to sample ambient air. Ambient air is defined in 40 CFR Part 50.1 (e) as "that portion of the atmosphere, external to buildings, to which the general public has access," and in the Nevada Administrative Code (NAC) 445B.018 as "that portion of the atmosphere which is external to buildings, structures, facilities, or installations to which the general public has access." Each monitoring site location shall be approved by Bureau staff.

Calculations for High-Volume PM_{10} Sampling

High-volume PM_{10} sampling calculations, methodology and units of measurement shall conform to Section 2.11 of the "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Specific Methods (Interim Edition)" or, excluding PM_{10} concentration calculations, the "Quality Assurance Guidance Document 2.11, Monitoring PM_{10} in Ambient Air Using a High-Volume Sampler Method." The method utilizes sampler and orifice calibration relationships based on linear regressions involving the actual flow rate in the independent variable and the adjusted flow rate indicator reading in the dependent variable. Since the multiplier and exponent from a power-fit orifice certification ($y=ax^b$) are not usable in the specified PM_{10} calculations, power-fit orifice certifications shall be converted to linear-fit orifice certifications (y=mx+b) as shown in Section 2.11.2 of the Section 2.11 guidance documents.

Meteorological Data

Current on-site meteorological data are required for input to dispersion models used for analyzing the potential impacts from the air pollution sources at a facility. Dispersion modeling may be used to determine impacts from proposed facilities, proposed modifications to facilities, and for compliance determinations in the event of an exceedance. Meteorological data may be used to aid the Bureau in determining the source of a pollutant that has caused an exceedance of the standards and to aid a facility in correcting a problem.

Although only hourly averages of meteorological parameters are required to be reported to the Bureau, it may be advisable to collect and archive meteorological data in 15-minute averages, while reporting hourly averages. For example, dispersion models developed by the EPA for evaluating air quality impacts may require the use of 15-minute averages.

For most meteorological considerations, including siting, obstructions and sensor placement, refer to the "Meteorological Monitoring Guidance for Regulatory Modeling Applications" (February 2000). In the November 9, 2005 Federal Register Vol. 70, No. 216, the EPA announced, "As proposed, beginning November 9, 2006, the new model—AERMOD--*should* be used for appropriate application as replacement for ISC3. During the one-year period following this promulgation, protocols for modeling analyses based on ISC3 which are submitted in a timely manner *may be* approved at the discretion of the appropriate Reviewing Authority." Appendix W to 40 CFR Part 51, the Guideline on Air Quality Models, Section 4.2.2 b states, "For a wide range of regulatory applications in all types of terrain, the recommended model is AERMOD."

To accommodate the change from ISCST3 to AERMOD, it will be necessary to add meteorological tower monitoring for solar radiation/delta-T (SRDT). The SRDT method will generally involve temperature measurements at heights of 2 meters and 10 meters. Due to the 0.1º C system accuracy tolerance for Delta-T, the use of temperature sensors matched by the manufacturer for Delta-T measurements is referenced in Appendix W as follows: "Temperature difference (ΔT) measurements should be obtained using matched thermometers or a reliable thermocouple system to achieve adequate accuracy." Appendix W adds that the guidance provided in the EPA's "Meteorological Monitoring Guidance for Regulatory Modeling Applications" (February 2000) should be followed.

Sources collecting meteorological data suitable for ISCST3 (sigma theta) modeling analyses as a result of an existing air quality permit condition may continue to collect those data for compliance purposes, with the understanding that those data may not be sufficient to support future permit applications, renewals and modifications. Proposed and existing PSD sources in increment-triggered basins will be required through the permitting process to collect AERMOD-quality (SRDT) data for AERMOD modeling analyses. After November 9, 2006 proposed and existing sources submitting air quality modeling analyses in support of new air quality permits, permit renewals or permit modifications may be required to provide AERMOD modeling analyses with appropriate meteorological input data. Existing sources already conducting meteorological monitoring for ISCST3 (sigma theta) modeling analyses, which did not convert to AERMOD (SRDT) meteorological monitoring, will have one year, until November 9, 2007, during which five years of representative National Weather Service (NWS) data may be substituted for one year of on-site meteorological data for use in AERMOD. The appropriate NWS station may not always be the closest one to the project site, and the selection of a NWS station for such AERMOD modeling data substitution is subject to Bureau approval.

The ISCST3 model is no longer contained in the federal Guideline and may not be usable for regulatory modeling applications after November 9, 2006. The Bureaus of Air Quality Planning and Air Pollution Control recommend adding SRDT capability to existing meteorological data collection systems. ISCST3 modeling analyses submitted during the transition period November 9, 2005 to November 9, 2006 must justify the use of ISCST3 instead of AERMOD.

Facilities required to conduct both meteorological monitoring and PM_{10} monitoring may find it desirable to record the highest gust (instantaneous) wind speed each hour. This information may be useful in documenting exceptional events or natural events for high winds (dust storms).

The minimum meteorological data sampling frequency for determining standard deviation, 360 samples per averaging period, is met by electronically sampling equipment output at least once every 10 seconds for hourly averages or at least once every 2.5 seconds for 15-minute averages. A sampling frequency of at least once every 2.5 seconds is required for data loggers that utilize 15-minute averages to calculate sigma theta according to the Yamartino method, as discussed below. More frequent sampling may be necessary for other meteorological computations. One method for computing horizontal wind direction requires sampling at least once per second. Therefore, a sampling frequency of at least once per second is recommended. The data sampling frequency shall be reported in the quarterly report.

Data recovery shall be based on the total number of hours in the reporting period, not the number of hours possible less time used for quality control, upset conditions, etc. To conform to common modeling requirements, hourly meteorological data shall be reported for the period ending at the hour (i.e., the data between midnight and one o'clock shall be reported for hour "one"). The hourly average values derived from standard 10-meter meteorological towers for use in AERMOD shall be stored and reported for each parameter as follows:

> Year/Month/Day, Julian Day, Hour, Wind Speed (m/s), Wind Direction (degrees clockwise from true north), Upper (10m) Temperature (K or C), Lower (2m) Temperature (K or C), Solar Radiation (W/m^2), or,
>
> YY (or YYYY)/MM/DD JJJ HH SS.SS DDD.D UUU.U LLL.L RRR.

The hourly average values derived from meteorological tall towers (60m or taller) for use in AERMOD shall be stored and reported for each level above 10 meters as follows:

> Year/Month/Day, Julian Day, Hour, Wind Speed (m/s), Wind Direction (degrees clockwise from true north), Temperature (K or C), Tower Level (m), or,
>
> YY (or YYYY)/MM/DD JJJ HH SS.SS DDD.D TTT.T LLL.

The "Meteorological Monitoring Guidance for Regulatory Modeling Applications" states in Section 6.3.2, Vertical Temperature Gradient,

> Recommended heights for temperature gradient measurements in the surface layer are 2m and 10m. For use in estimating plume rise in stable conditions, the vertical temperature gradient should be determined using measurements across the plume rise layer; a minimum height separation of 50 m is recommended for this application.

The same Guidance states in Section 3.3.3, Temperature Difference,

> The [temperature difference] measurement should be taken between two elevated levels on the tower (e.g. 50 and 100 meters)…. A separation of 50 m between the two sensors is preferred.

Therefore, it is recommended that the temperature difference derived from elevated levels of tall towers maximize the height of the lower temperature within these constraints (i.e., 100m-50m or 60m-10m, rather than 100m-2m or 60m-2m).

For SODAR monitoring, the data reporting format varies with the size definition of the levels, or bins, and the heights monitored.

Meteorological data shall be recorded to an electronic medium, approved by the Bureau, in the formats indicated above (space-delineated or comma-delineated string, ASCII file) and be accompanied by a "Read Me" text file explaining the order of meteorological data entries and definitions of units for data entries. The Bureau currently prefers compact disks (CD's) in MS Windows-compatible format. The meteorological data are to be processed such that the fields for all parameters are right-justified. A missing or invalid meteorological datum value shall be identified as a field of nines (9's).

The data recovery for each meteorological parameter shall be identified in the hardcopy quarterly report. It is not necessary to report hourly meteorological data in hardcopy.

The AERMOD dispersion model can accommodate, as optional inputs for refining the output, the standard deviation of the horizontal wind direction and the standard deviation of the vertical wind speed. The preferred method for calculating sigma theta (σ_Θ), the standard deviation of the horizontal wind direction, is the Yamartino method described in Section 6, Meteorological Data Processing, of the "On-Site Meteorological Program Guidance for Regulatory Modeling Applications" or the "Meteorological Monitoring Guidance for Regulatory Modeling Applications."

The following formulas are employed by the Yamartino method:

$$\sigma_\Theta = \arcsin(\varepsilon)\,[1 + 0.1547\,\varepsilon^3],$$

$$\varepsilon = \sqrt{1 - \{[\overline{\sin(\Theta_i)}]^2 + [\overline{\cos(\Theta_i)}]^2\}}$$

where

and Θ_i is defined as the horizontal wind direction, measured clockwise from north with values restricted from 001 to 360 degrees, inclusive. To minimize the effects of meander under light wind speed conditions on σ_Θ for the hour, it is recommended that four 15-minute values be computed and averaged as follows:

$$\sigma_\Theta(1\text{-}hr) = \sqrt{(\sigma_{\Theta_{15}}{}^2 + \sigma_{\Theta_{30}}{}^2 + \sigma_{\Theta_{45}}{}^2 + \sigma_{\Theta_{60}}{}^2)/4}.$$

<u>Quality Control and Quality Assurance</u>

The "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Part 1" (8/98) notes in Section 3 of Appendix 15, "The performance audit is used to validate and document the accuracy of the data generated by a measurement system." Therefore, an audit should be used to evaluate the performance of the instrument or sensor over time and should not be used only to check a newly-installed sensor or newly-calibrated instrument. For the same reason, an instrument or sensor output may be adjusted only after the audit determines its accuracy in the calibration/configuration in which it was collecting data over a period of time before the audit. Audit results must be compared with instrument or sensor outputs, as recorded by the data acquisition system, that are derived from the same calibration used to calculate the data values (e.g., use of high volume sampler on-site calibrations for concentration calculations but lookup tables for audits is not acceptable).

When meteorological sensors are replaced, the sensor-specific multipliers (/intercepts) used in the data acquisition system programming must be updated. The applicability of resistors used with a sensor must also be examined when sensors are replaced (e.g., pyranometers).

The results of particulate, gaseous and meteorological performance audits called for in the References section above shall be reported to the Bureau with the monitoring report for the calendar quarter in which the audits were conducted. For tower-based meteorological monitoring, a performance audit for each parameter is required twice yearly at each site, every other quarter. A performance audit for each ambient air quality (pollutant) automated analyzer and manual sampler is required to be conducted quarterly for PSD monitoring and for non-PSD monitoring with not more than one automated analyzer or manual sampler for a pollutant. The minimum audit schedule for non-PSD monitoring with more than one automated analyzer or manual sampler for a pollutant is the same as for SLAMS monitoring, as presented in 40 CFR Part 58, Appendix A, Section 3.

Particulate Sampling

High-volume PM_{10} sampling calculations, methodology and units of measurement shall conform to Section 2.11 of the "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Specific Methods (Interim Edition)" or, excluding PM_{10} concentration calculations, the "Quality Assurance Guidance Document 2.11, Monitoring PM_{10} in Ambient Air Using a High-Volume Sampler Method." Copies shall be submitted each calendar quarter of the most recent orifice transfer standard certifications for both calibration and audit orifices, with the slope, intercept and correlation coefficient for each orifice transfer standard calculated according to Section 2.11.2 of the Section 2.11 guidance documents. Copies shall also be submitted each calendar quarter of the audit sheets and sampler calibration sheets applicable to the report quarter, calculated according to Sections 2.11.7 and 2.11.2 of the Section 2.11 guidance documents, showing the following:

- ambient temperature
- uncorrected station atmospheric pressure
- orifice pressure drop
- sampler pressure or sampler pressure indicator reading
- sampler calibration slope, intercept and correlation coefficient.

Sample calibration sheets are shown in the Section 2.11 guidance documents, Figure 2.3 and Figure 2.5, respectively, for mass-flow-controlled (MFC) and volumetric-flow-controlled (VFC) high-volume samplers. Some versions of Section 2.11 guidance documents (e.g., the 1987 version and second draft September 1997 version) may contain an error on the MFC Sampler Calibration Data Sheet, Figure 2.3. There the formula for the subsequent calculation of the sampler flow rate with a flow recorder using a square root scale, such as a Dickson recorder with square root chart paper (the concentric circles become more widely spaced away from the center of the circular chart), may be in error. This formula should have "mean I" moved outside (to the left of) the left square root bracket, so that the square root applies only to $(T_{av} + 30)/P_{av}$ and not to "mean I." The correct formula is then:

$$\text{Ave. } Q_a = \{\text{mean I } [(T_{av} + 30)/P_{av}]^{1/2} - b\}\{1/m\}.$$

This error was corrected on the Internet copy of the September 1997 version.
Sample audit sheets are found in Figure 7.1 and Figure 7.3 for MFC and VFC samplers, respectively. In the EPA 1997 Section 2.11 guidance document, another error occurs in the calculation of PM_{10} concentrations, as explained above in Discussion Item 6 on page 3.

The filters shall be handled with care to minimize breakage and loss of sample. Unexposed and exposed filters shall be equilibrated in an environment with controlled temperature and humidity for at least 24 hours before weighing. The mean temperature shall be between 15ºC and 30ºC, with a variability of not more than ±3ºC. The mean relative humidity shall be between 20 and 45 percent, with a variability of not more than ±5 percent. If filters must be weighed outside the conditioning chamber, begin the weighing within 30 seconds of removal of the filters. Filters shall be weighed on an analytical balance with a minimum resolution of 0.1 mg and a precision of 0.5 mg that is calibrated at least annually. Before a batch of filters is weighed, the balance shall be zeroed according to the manufacturer's recommendations. The balance shall be checked at least daily during weighings for agreement within ±0.5 mg by weighing a pair of working mass reference standards with weights between 1g and 5 g. The balance shall be zero-checked at least every 10 weighings for agreement within ±0.5 mg of true zero. Each day of weighing, at least five exposed and unexposed filters per balance shall be reweighed. Each calendar quarter, a copy shall be submitted of the most recent balance calibration certification and the balance minimum resolution. Each calendar quarter, copies shall also be submitted of the records for each day of filter weighing, showing the equilibration temperature and relative humidity, results of zero checks and weight checks with working mass reference standards, and results of exposed and unexposed filter re-weighings.

Gaseous Monitoring

As applicable, for the quality control (station reference) and audit calibrators and gas cylinders, submit copies each calendar quarter of the most recent certifications of the ozone generator calibrations, photometer calibrations, mass flow-controller calibrations, and gaseous standard concentrations with cylinder expiration dates.

Quality control for gaseous pollutant analyzers requires zero, span (80% of full scale), and precision (80-100 ppb, or 8-10 ppm for carbon monoxide) checks at least every two weeks. The results of these checks shall be included in the quarterly report in the form of the known (calibrator or cylinder) input concentration and the analyzer response data logger concentration for the zero, span and precision points. The accuracy tolerance for validating the data collected since the last satisfactory quality control check is a difference, or drift from true, of 15 percent of the concentration or 15 ppb (1.5 ppm for carbon monoxide), whichever is greater. When such a quality control check is suspect, it may be replaced with a multipoint calibration.

A recommended zero air circuit consists of the following scrubbers in the following order: first, a desiccant, such as silica gel; then, a carbon monoxide scrubber (if applicable), such as hopcalite; then an oxidant, such as Purafil (potassium permanganate); and last, a suitable grade of activated carbon. The desiccant should be first in the sequence so that dry air is delivered to the remaining scrubbers. The oxidant must precede the activated carbon, since it oxidizes nitric oxide to nitrogen dioxide, which is captured by the activated carbon. Otherwise, ambient nitric oxide may interfere with quality control and quality assurance for nitrogen dioxide and ozone monitoring.

The panel temperature, which is representative of the instrument rack air temperature, shall be monitored and reported quarterly as hourly averages, with the analyzer model and EPA-certified temperature range. Data collected outside the temperature range specified in the analyzer's EPA certification as a reference or equivalent method shall be evaluated in conjunction with other relevant information, such as the results of zero, span and precision checks conducted at similar panel temperature, and validated accordingly.

Since instrument ozone outputs are elevation-dependent, test concentrations that rely on an ozone generator calibration, rather than a photometer concentration adjusted with pressure and temperature sensors, shall be derived from an ozone generator calibration done at the monitoring site elevation or mathematically corrected for the monitoring site elevation. Ozone generation shall be done at the same flow rate used to calibrate the ozone generator.

For nitrogen dioxide (NO_2) monitoring, required quality control checks and quality assurance audits shall use gas phase titration (GPT) or a permeation tube and record the NO_2 channel data logger responses. Quality control checks of the nitric oxide (NO) and oxides of nitrogen (NO_x) channels alone are insufficient. Audit NO_2 concentrations using GPT shall be calculated from the drop in the true NO concentration with GPT. For the purpose of calculating NO_2 audit concentrations with GPT, the NO channel responses shall be adjusted to true NO concentrations by applying the NO channel audit linear regression slope and intercept to the NO channel readings before and after GPT. The subtraction difference between the adjusted NO concentrations before and after GPT is the true NO_2 audit concentration.

The NO_2 converter efficiency in percent is 100 times the slope of the linear regression, where the independent variable (x-value) is the drop in NO (adjusted to true concentration as described above) with gas phase titration, and the dependent variable (y-value) is the independent variable (x-value) less the drop in NO_x (adjusted to true concentration with the NO_x slope and intercept) with gas phase titration.

For this agency, gaseous multipoint audit results shall be evaluated by a linear regression analysis between the audit concentrations (x-axis independent variable) and the analyzer response data logger concentrations (y-axis dependent variable). Satisfactory audit results will exhibit a slope between 0.85 and 1.15, an intercept between -15 ppb and +15 ppb (between -1.5 ppm and +1.5 ppm for carbon monoxide), and a correlation coefficient between 0.9950 and 1.0000.

Certification

A statement shall accompany the ambient air monitoring results submitted to the Bureau that the information contained in the report is true and correct to the best of the knowledge of the responsible official, as defined in NAC 445B.156, signing and dating the statement.