NEVADA DIVISION OF
ENVIRONMENTAL PROTECTION

STATE OF NEVADA
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Nevada Bureau of Air Quality Planning Ambient Air Quality Monitoring Guidelines

The Ambient Air Quality Monitoring Guidelines are prepared by the Bureau of Air Quality Planning (BAQP) to define what constitutes acceptable criteria pollutant and meteorological monitoring practices for facilities required to conduct (pre- and post-construction) 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.

Revised November 2016

Contents

1. References and Quality Assurance Project Plans (QAPP)

To ensure data of sufficiently high quality, all sampling and continuous monitoring for Prevention of Significant Deterioration (PSD) permitting (pre- or post-construction) shall be conducted in accordance with these guidelines and U.S. Environmental Protection Agency (EPA) regulations and, generally, EPA guidance. Exceptions include the quality control check tolerances designed for use with trace gas monitors (see subsection 5.3, Gaseous Monitoring) and inconsistent EPA pollutant and meteorological monitoring guidance.

As the Bureau of Air Quality Planning (BAQP) does not submit source monitoring data into the national database for comparison with the National Ambient Air Quality Standards, source monitoring Quality Assurance Project Plan (QAPP) submittals are required only for monitoring under federal jurisdiction—that is, PSD pre-construction monitoring and post-construction monitoring for a significant PSD permitting action such as a major modification. Non-PSD monitoring and State-required post-construction monitoring for PSD sources do not require a QAPP submittal. However, a brief protocol submittal of the project siting including topographic and other relief maps as well as pictures in the four cardinal directions, meteorological tower height, meteorological sensors and pollutant measurement methods (analyzers/samplers and methodology, e.g., Section 2.11 for high-volume PM_{10} sampling), quality control checks and frequency, auditing schedule, and data validation considerations is advisable. Submit QAPPs and protocols in both hard copy and electronic versions. Sampling and continuous monitoring for non-PSD permitting use, or as the result of a State permit condition to monitor, shall be conducted according to these guidelines and EPA regulations and, generally, EPA guidance for State and Local Air Monitoring Stations (SLAMS) with exceptions including quality control check tolerances designed for use with trace gas monitors (see subsection 5.3, Gaseous Monitoring) and inconsistent EPA pollutant and meteorological monitoring guidance, or according to EPA regulations and, generally, guidance for Prevention of Significant Deterioration (PSD) monitoring, with exceptions including quality control check tolerances designed for use with trace gas monitors (see subsection 5.3, Gaseous Monitoring) and inconsistent EPA pollutant and meteorological monitoring guidance. Thus, after one year of preconstruction PSD monitoring, the facility conducting State-required post-construction monitoring as a PSD permit condition may conduct SLAMS, rather than PSD, monitoring. However, only PSD monitoring will support PSD applications for new construction and major modifications. 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) and the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV, Meteorological Measurements, Version 2.0 (Final)* (2008), including recommended system accuracies and resolutions and recommended response characteristics for meteorological sensors.

Several EPA documents follow which 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://www.ecfr.gov/cgi-bin/text-idx?SID=ca67d97a0ed8a8d8ff351fd11320efca&node=pt40.6.58&rgn=div5.

- ***Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)* (1987)**, 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/region7/air/nsr/nsrmemos/monguide.pdf.

- **2012 PSD ambient monitoring guidance Q &A update "Technical Note –PSD Monitoring Quality Assurance Issues,"** Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711. This document may be available at Internet address http://www.epa.gov/ttn/amtic/files/policy/PSDAppAQATechNote14dec12.pdf.

- ***Meteorological Monitoring Guidance for Regulatory Modeling Applications* (2000)**, EPA-454/R-99-005, may be available at Internet address http://www.epa.gov/scram001/guidance/guide/mmgrma.pdf. A copy of this document is also available for purchase from the National Technical Information Service (NTIS), stock number PB 2001103606, telephone (800) 553-6847. This document is an updated version of the *On-Site Meteorological Program Guidance for Regulatory Modeling Applications* (1987, revised 02/93).

- ***Quality Assurance Handbook for Air Pollution Measurement Systems, Volume I, a Field Guide to Environmental Quality Assurance* (1994)**, EPA-600/R-94/038a, US EPA Office of Research and Development (ORD), Washington, DC 20460. This document may 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, Ambient Air Specific Methods (Interim Edition)* (1994)**, EPA-600/R-94/038b, ORD, Washington, DC 20460. The section of Volume II of greatest interest to many 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)." An electronic copy of the January 1990 version of this document is available from the BAQP Technical Services Branch upon request. This document may also be available at Internet address http://www.epa.gov/ttnamti1/files/ambient/qaqc/m211.pdf.
  A 1997 incorrect 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 (rather than standard) 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, as it calculates PM_{10} concentrations in micrograms per actual, rather than standard, cubic meter. An early version of this 1997 document contained other calculation errors since corrected. This 1997 guidance document was removed from the EPA AMTIC online references in late 2014 and replaced with the 1990 version of Section 2.11 guidance.

- ***Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Part 1, Ambient Air Quality Monitoring Program Quality System Development* (1998)**, 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://nepis.epa.gov/Exe/ZyNET.exe/2000QNC4.TXT?ZyActionD=ZyDocument&Client=EP

A&Index=1995+Thru+1999&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C95thru99%5CTxt%5C00000017%5C2000QNC4.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=p%7Cf&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL

- ***Quality Assurance Guidance Document 2.12, Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference or Class I Equivalent Methods*** **(Nov. 1998)**. This document may be available at Internet address http://www.epa.gov/ttn/amtic/files/ambient/pm25/qa/m212covd.pdf.

- A more recent version of the December 2008 EPA ***Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Quality Monitoring Program*** was published in **May 2013**; an address at which this document may be found is http://www.epa.gov/ttn/amtic/files/ambient/pm25/qa/QA-Handbook-Vol-II.pdf. *This 2013 version of Volume II of the Quality Assurance Handbook does not include the Section 2.11 PM_{10} sampling guidance document associated with early versions of the Handbook.*
  In July 2014 EPA made changes to Appendix D, Measurement Quality Objectives and Validation Templates (AMTIC Version) of the 2013 Quality Assurance Handbook, Volume II relating to gaseous monitoring zero drift and other changes. The 2014 version of Appendix D may be available at Internet address http://www.epa.gov/ttnamti1/files/ambient/pm25/qa/appd_validation_template_amtic.pdf.

- ***Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV, Meteorological Measurements, Version 2.0 (Final)*** **(2008)**. This document may be available at Internet address http://www.epa.gov/ttn/amtic/files/ambient/met/Volume%20IV_Meteorological_Measurements.pdf.

2. Highlights

The NDEP-BAQP monitoring requirements specifically include the following:

1) To be usable, all required 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. Additionally, wind speed, wind direction, temperature difference, and solar radiation for AERMOD shall have a **joint** recovery of at least 90% on an annual basis. For regulatory modeling applications, the 90% recovery rate, including joint recovery, should be met on a quarterly basis and must be met on an annual 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) The EPA *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements, Version 2.0 (Final)* (2008) says in Table 10-1, DAS Screening Techniques (with regard to the number of instantaneous readings in the averaging period), "Most data should be valid 75% of the time." The *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (2000), Section 6.1, Averaging and Sampling Strategies says, "If the hourly average is to be based on shorter period averages, then it is recommended that 15-minute intervals be used. At least two valid 15-minute periods are required to represent the hourly period."

4) For gaseous pollutant monitoring data, at least 45 minutes of valid observations are required to represent an hourly average. In general, 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.

5) The EPA specification for the high-volume particulate sampling run time is 24 hours $\pm$ one hour (1440 minutes $\pm$ 60 minutes), from midnight to midnight, local standard time.

6) 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 (**flow not corrected to standard conditions**).

7) 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). **For calculating PM_{10} concentrations, the volume of air sampled must be calculated in standard conditions according to the EPA Quality Assurance Handbook's Section 2.11**, the "Reference Method for the Determination of Particulate Matter as PM_{10} in the Atmosphere (High-Volume PM_{10} Sampler Method)" (see the link to the 1990 Section 2.11 guidance in the References and Quality Assurance Project Plans (QAPP) section of these Guidelines).

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

9) Wind measurements should be taken at heights within the rise of the plume. For tall stacks, this may require use of a (maximum) 100-meter meteorological tower or use of meteorological remote sensing such as acoustic sounding, or SODAR, in conjunction with a meteorological tower at least 10 meters high. 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). Another applicable EPA reference is Section 8, Ground-Based Remote Sensing Devices, of the *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV, Meteorological Measurements, Version 2.0 (Final) (2008)*.

10) Coordinates in Universal Transverse Mercator projection (UTM - NAD 1983, where UTM zone 11 North includes the entire state of Nevada) and elevation shall be provided for each meteorological and pollutant monitoring site.

With the exception of preconstruction PSD monitoring and up to the first year of PSD post-construction monitoring, all required ambient air quality and meteorological monitoring data shall be submitted to the Bureau on a calendar quarter basis within 60 days after the end of the applicable quarter. The initial PSD monitoring may be submitted on a monitoring quarter basis instead of a calendar quarter basis, within 60 days after the end of the monitoring quarter. Monitoring quarterly reports and audit reports, if not included in the quarterly reports, shall be submitted in hardcopy and electronic format. 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, if applicable, the facility may be subject to noncompliance penalties for violations of its air quality permit conditions.

3. Meteorological Monitoring

Site-specific meteorological data can be used for input to dispersion models used for analyzing the potential impacts from the air pollution sources at a facility. For non-PSD meteorological monitoring, representative National Weather Service (NWS) data may be used instead of site-specific data for input to dispersion models. 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 also 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. When deciding whether to use site-specific versus NWS data, the representativeness of such meteorological data with respect to the modeled emission sources should be carefully weighed. Especially in complex terrains, the distance between the meteorological station and the emission sources, as well as property boundaries, may not be of primary importance compared to topography. "[A]cquisition of adequately representative site specific data does not preclude collection of data from a location off property. Conversely, collection of meteorological data on a source's property does not of itself guarantee adequate representativeness" (40 CFR 51, Appendix W, Section 8.3.3.1).

The valid hourly averages of meteorological parameters are to be reported to the Bureau; if 15-minute averages are collected, they may be reported in addition to the 1-hour averages. The one-hour averages should be computed by the data logger due to the complexity of computing hourly average wind directions from sub-hourly intervals. For most meteorological considerations, including siting, obstructions and sensor placement, refer to the *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (February 2000) and the *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final)* (2008). As Appendix W to 40 CFR 51 is of prime importance in modeling source impacts, and as Appendix W relies on the EPA *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (MMGRMA, 2000) through numerous citations, **the Bureau requires the MMGRMA's 6-month meteorological audit schedule for modeling**, rather than the 2008 *Quality Assurance Handbook's* annual meteorological audit schedule for non-PSD monitoring (Section 0, Table 0-6) and for modeling (Section 0, Table 0-10).

3.1 Wind Speed

Wind speed is generally measured with a cup or propeller anemometer for ease of auditing, as sonic instruments require collocated auditing of wind measurements. In addition, NDEP recommends the measurement of the standard deviation of the vertical wind speed (σ_w), at least at one height and, if possible, within the plume layer.

3.1.1 Calibration and accuracy tolerance for horizontal and vertical wind speed

The March 2008 EPA *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final)*, Section 0, Table 0-8 PSD Calibration and Accuracy criteria specifies a tolerance of ±0.2 m/s for horizontal and vertical wind speed calibrations and audits. As pointed out also by the author of this section, once directly contacted by the Bureau, this is a typographical error. **The correct tolerance should be ±(0.2 m/s + 5% of observed wind speed) for both vertical and horizontal wind speed**. The same tolerance must be applied to measurements of horizontal and vertical wind speed for modeling applications (Table 0-10 of the same section, which also erroneously lists ±0.2 m/s as the tolerance for calibrations and audits). The correct formula of the tolerance, which is dependent on the magnitude of the measurement itself, is more consistent with other applications in the same document (e.g., SLAMS/SPM – Table 0-6, NCore – Table 0-4) and previous EPA guidance documents (e.g., EPA *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (2000) and the 1987 PSD guidance).
The same incorrect tolerance of ±0.2 m/s also appears in Appendix C of Volume IV, the Critical Criteria Table—Meteorological Measurement Methods.

3.2 Wind Direction

In accordance with the *Quality Assurance Handbook, Vol. IV, Meteorological Measurements, Version 2.0 (Final)* (2008), NDEP strongly recommends the use of the unit vector calculation to estimate mean wind direction. This approach has been deemed more reliable than the original single-pass procedure developed by Mitsuta, which is described in the *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (2000) (MMGRMA). The *Quality Assurance Handbook*, *Vol. IV* (2008) analyzes a meteorological data set with one 360-degree wind direction rotation injected in the middle of the profile and concludes that "the **scalar calculation** produced erroneous results for the data set while the **unit vector calculation** produced a reasonable average[....]". If the unit vector calculation is used, the MMGRMA recommends a sampling rate of one to five seconds.

Bureau investigation into the algorithms used to calculate unit vector wind direction averages indicates the algorithms provided in both of the above EPA reference documents fail to yield valid wind direction averages for all four quadrants of the circle. The problem in the *Quality Assurance Handbook, Vol. IV* (2008) is in the use of ArcTan rather than ArcTan2, while in the *MMGRMA*, the problem is in the algorithm's flows. Investigation into the algorithms in two commonly used types of data loggers indicates the data loggers are programmed correctly, even though the data logger manual may be in error as to the use of ArcTan versus ArcTan2.

If the single-pass procedure developed by Mitsuta is used to compute the scalar mean wind direction (not recommended by NDEP), the MMGRMA and the *Quality Assurance Handbook, Vol IV, Meteorological Measurements* (2008) recommend a sampling rate of at least once per second to ensure that consecutive values do not differ by more than 180 degrees.

NDEP recommends the measurement of the standard deviation of the horizontal wind direction, sigma theta (σ_Θ), at least at one height and, if possible, within the plume layer.

3.3 Vertical Temperature Gradient

Appendix W[1] 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." AERMOD modeling with AERMET processing will generally involve temperature measurements at heights of 2 meters and 10 meters. Due to the 0.1° C system accuracy tolerance for the temperature difference (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. This document and other EPA guidance also call for these temperature sensors to be aspirated (a fan motor continuously draws ambient air across the temperature sensor).

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, for tall tower measurements:

> A tower measurement of temperature difference can be used as a representation of the temperature profile. The 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).

3.4 Solar Radiation

Both the EPA *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (February 2000) and the EPA *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final)* (2008) specify a spectral response of 285-2800 nm for solar radiation measurements. Yet both guidance documents appear to allow the use of photovoltaic pyranometers, which have a spectral response of only 400-1158 nm. The 2008 guidance features a picture of a photovoltaic pyranometer in Figure 6.4, saying it is "…a popular thermopile radiometer with a silicon photovoltaic detector mounted in a fully cosine-corrected head. The current output is directly proportional to solar radiation." The 2000 guidance says, "If the solar radiation data are to be used in procedures for estimating stability (Section 6.4) then second class (photovoltaic) pyranometers are acceptable." However, the specified regulatory dispersion model when the 2000

[1]All references to 40 CFR Part 51 and its Appendix W across this document refer to the November 9, 2005 version. EPA recently released a proposal for the revision of its guidelines. Changes in the BAQP guidance (this document) may occur after the final version of the EPA guidelines is released.

guidance was promulgated (ISC) used Pasquill-Gifford stability categories for estimating boundary layer stability, while the current dispersion model AERMOD uses the Monin-Obukhov similarity theory. This may affect the suitability of photovoltaic pyranometers (spectral range 400-1158 nm versus 285-2800 nm for full spectral response pyranometers) for AERMOD dispersion modeling. The EPA replaced the ISC dispersion model with AERMOD in November 2006.

3.5 Wind Gust

Facilities required to conduct both meteorological monitoring and particulate monitoring may find it desirable to record the highest gust wind speed or other EPA-specified short-term average wind speed each hour. This information may be useful in documenting Exceptional Events for high winds (dust storms).

3.6 Sampling Frequency

If the unit vector method is used to calculate mean wind direction, the recommended sampling frequency is between one and five seconds. The *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (2000) (MMGRMA) and the *Quality Assurance Handbook, Vol IV, Meteorological Measurements, Version 2.0 (Final)* (2008) *state that* if single-pass (i.e., the Mitsuta method) processing is used to compute the mean scalar wind direction, the output from the wind-direction sensor (wind vane) should be sampled at least once per second to ensure that consecutive values do not differ by more than 180 degrees. Therefore, the Bureau reserves the right to reject wind direction measurements obtained using the Mitsuta method with a sampling interval greater than one second. The data sampling frequency shall be reported in the quarterly monitoring report.

3.7 Standard Deviation of Horizontal Wind Direction

The AERMOD dispersion model uses the standard deviation of the horizontal wind direction, or sigma theta, commonly already being collected. 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 of the *Meteorological Monitoring Guidance for Regulatory Modeling Applications*.

The following formulas are employed by the Yamartino method:

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

where

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

and Θ_i is defined as the horizontal wind direction, measured clockwise from north with values restricted from 001 to 360 degrees, inclusive (please be aware that applying trigonometric functions may require angles to be expressed in either radians or degrees). 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:

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

3.8 Reporting Meteorological Data

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 for use in AERMOD shall be reported for each parameter as follows:

> Year, Month, Day, Hour Ending, Wind Speed (m/s), Wind Direction (degrees clockwise from true north), Upper Level Temperature (K or C) for Delta-T, Lower Level Temperature (K or C) for Delta-T, Delta-T (C), Solar Radiation (W/m^2).

Reporting additional parameters which may affect the modeling outcome (see table below) is optional.

The upper and lower tower levels (in meters) used for Delta-T shall be identified. For tall towers, only one elevated Delta-T need be reported in addition to the 10m - 2m Delta-T. This should be the highest suitable (preferably 50m separation) Delta-T (e.g., for a 100m tower, 100m - 50m, rather than 50m - 10m, where 100m - 10m and 50m - 10m with Delta-T accuracy could be used as backups for 100m - 50m Delta-T).

An Excel spreadsheet with column headings clearly identifying the meteorological parameters shown above and the units of measure is also acceptable reporting as long as substantial further processing is not necessary prior to use in modeling. For example, the sequence of spreadsheet columns must remain consistent throughout the (yearly) modeling timeframe. Electronic data reported in spreadsheets should not be broken into months, but should cover the entire quarter. Submittal of an annual spreadsheet with the fourth quarter submittal would be helpful for modeling. Inclusion of optional meteorological parameters (e.g., sigma theta, sigma w, barometric pressure, relative humidity, net radiation) is encouraged, as it may produce a more accurate modeling outcome. If a relative humidity sensor also collects “ambient temperature” at an accuracy not suitable for modeling, these temperature data will be usable only as substitutions for missing data after the 90% 2m temperature data recovery has been met. The number of decimal digits presented in the table below is the minimum required (using the scientific rounding) ; the use of additional decimal digits is acceptable.

VARIABLE	DECIMAL DIGITS (at least)
Wind speed (m/s)	1
Wind direction (degrees)	0
Sigma theta (degrees)	1
Temperature (C or K)	1
Delta-temperature (C)	2
Solar radiation (W/m^2)	0
Vertical wind speed (m/s)	2
Standard deviation of vertical wind speed (Sigma w, m/s)	2
Relative humidity (%)	0
Barometric pressure (mb or mm Hg)	0
Precipitation (inches or mm)	3 for inches, 1 for mm
Dew point temperature (C or F)	2

For questions about other meteorological variables, please contact the Bureau's Technical Services Branch.

In addition to hardcopy data submittals, meteorological data shall be recorded to an electronic medium approved by the Bureau (Windows-compatible format), such as CD's, DVD's and USB memory devices, and, if not already shown (e.g., on a spreadsheet), be accompanied by a "Read Me" text file explaining the order of meteorological data entries and definitions of units for data entries. In the electronic files, a missing or invalid meteorological datum value shall be identified consistently with the same alphanumeric code across all parameters, for example, as "-9999" or "NA" or "NAN" or "invalid," but not as a combination of different qualifiers, such as "tower," "calib" and "audit" when used for modeling. However, such combinations of qualifiers are acceptable in quarterly reports as opposed to modeling datasets.

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

The data recovery for each meteorological parameter, and for the joint recovery of wind speed, wind direction, temperature difference (Delta-T) and solar radiation, shall be identified in the hardcopy quarterly report.

4. Pollutant Monitoring

4.1 Reporting Pollutant Data

A designated Federal Reference Method or Federal Equivalent Method may be used to collect air pollutant concentration data (http://www.epa.gov/ttn/amtic/files/ambient/criteria/reference-equivalent-methods-list.pdf). Pollutant data shall be reported in a format suitable for comparison with the State ambient air quality standards. This includes reporting running averages, as applicable.

4.2 Gaseous Monitoring Sampling Frequency and Data Recovery

For gaseous 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 gaseous analyzers simultaneously with meteorological instrumentation, where sampling should be once per second. The data sampling frequency shall be reported in the quarterly report. For gaseous monitoring, data recovery shall be based on the total number of hours in the reporting period, rather than the number of hours possible less time used for quality control, upset conditions, etc., and the data recovery shall be reported in the quarterly reports.

4.3 Particulate Samplers and Monitors

4.3.1 $PM_{2.5}$ Monitoring

Guidance for $PM_{2.5}$ monitoring includes the EPA Quality Assurance Guidance Document 2.12, Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference or Class I Equivalent Methods, November 1998 (http://www.epa.gov/ttn/amtic/files/ambient/pm25/qa/m212covd.pdf). This reference and other $PM_{2.5}$ monitoring references are listed in the May 2013 EPA *Quality Assurance Handbook* *for Air Pollution Measurement Systems, Volume II, Ambient Air Quality Monitoring Program*, Appendix D Information/Action column. Other Appendix D references include 40 CFR 58, Appendices A and E; 40 CFR 50, Appendices L and N; and various equipment manufacturers' manuals' standard operating procedures.

4.3.2 PM_{10} Monitoring

The EPA *Quality Assurance Handbook, Volume II*, Appendix D (July 2014) Continuous PM_{10} STP Conditions Validation Template says the number of continuous Federal Equivalent Method PM_{10} monitors have "measurement or sampling attributes that cannot be identified in this validation template. Monitoring organizations should review specific instrument operating manuals[…]. In general, 40 CFR Part 58 App A and 40 CFR Part 50 App J requirements apply to Continuous PM_{10}. Since a guidance document was never developed for continuous PM_{10}, many of the requirements reflect a combination of manual and continuous $PM_{2.5}$ requirements and are therefore considered recommendations." The Appendix D PM_{10} Low Volume STP Filter-Based Local Conditions Validation Template says, "…it is suggested that the validation criteria for this method follow the method requirements for the $PM_{2.5}$ which is Appendix L."

Since use of high-volume PM_{10} samplers, the original reference method for PM_{10} monitoring, has been widespread in Nevada, this method and the Bureau's requirements for its use are discussed in greater detail below and on following pages. If this method is selected, the Bureau requires compliance with Section 2.11 guidance in the EPA *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II* (see References and Quality Assurance Project Plans (QAPP) section of these Guidelines).

4.3.3 High-Volume PM_{10} 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 to the EPA national every-sixth-day PM_{10} sampling schedule. The 2015 electronic link to the EPA particulate sampling schedule is http://www.epa.gov/ttnamti1/files/ambient/pm25/calendar_2015.pdf. 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 standard 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 **in standard conditions**. 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.

For high-volume PM_{10} sampling, 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 $\mu g/m^3$ (40 CFR 50, Appendix J, Section 4.1).

The accuracy of high-volume PM_{10} samplers is assessed by auditing the actual flow rate of each sampler with an orifice transfer standard. First the sampler flow rate is compared to the audit flow rate; 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.

4.3.3.1 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)" (see the References and Quality Assurance Project Plans (QAPP) section of these Guidelines). 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 are not acceptable.

5. Quality Control and Quality Assurance

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." 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., using high volume sampler on-site flow calibrations for concentration calculations but lookup tables for flow audits is not acceptable).

When some meteorological sensors (e.g., pyranometers) are replaced, the sensor-specific multipliers (/offsets, if applicable) used in the data acquisition system programming may need to be updated unless the sensor has been factory-calibrated with variable electrical resistance to yield a consistent multiplier(/offset). The applicability of resistors used with a sensor must also be examined when sensors are replaced.

The results of particulate, gaseous and meteorological performance audits called for in the References and Quality Assurance Project Plans (QAPP) section of these Guidelines shall be reported to the Bureau with the monitoring report for the quarter in which the audits were conducted. For meteorological monitoring, a performance audit for each parameter is required twice yearly at each site, every other quarter. Startup and shutdown meteorological audits may also be appropriate. 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.

5.1 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)* (see References and Quality Assurance Project Plans

(QAPP) section of these Guidelines). 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 document. 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 document, 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 document, 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, which was removed in late 2014 and replaced with the January 1990 version of Section 2.11.
Sample audit sheets in the 1990 Section 2.11 guidance 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 in Item 7 of the Highlights section of these Guidelines. Therefore the 1997 Section 2.11 guidance should be replaced with the 1990 Section 2.11 guidance, as indicated in the References and Quality Assurance Project Plans (QAPP) section of these Guidelines.

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 15°C and 30°C, with a variability of not more than ±3°C. 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 weighs for agreement within ±0.5 mg by weighing two working mass reference standards with weights between 1g and 5 g. The balance shall be zero-checked at least every 10 weighs 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. Reweighed unexposed filters should be within ±2.8 mg of original values. If reweighed exposed filters differ by more than 5.0 mg from original values, the laboratory supervisor should investigate why. 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-weighs.

5.2 Continuous Particulate Monitoring

Please refer to the comments under subsections 4.3.1, PM2.5 Monitoring and 4.3.2, PM10 Monitoring. Of particular interest are the guidance elements of the EPA *Quality Assurance Handbook, Volume II*, Appendix D (July 2014 or later) as well as the monitoring instrument manufacturer's manual. For continuous PM_{10} monitors (as opposed to manual PM_{10} methods), there is no co-location requirement.

5.3 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 (traditionally, ±80% of full scale, or lower concentrations for lower measurement ranges), and precision checks ("one-point QC 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 or audit check is a difference, or drift from true, which varies with EPA guidance updates and may be pollutant specific. As Federal Reference Method and Federal Equivalent Method standard analyzers are sufficient for source monitoring, quality control check tolerances designed for trace gas monitors will not be used for standard analyzer data validation purposes or other comparisons, and the Bureau may then default to earlier (e.g., 2008) EPA guidance tolerances suitable for standard analyzers. When such a quality control check is suspect, it may be supplemented 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.

The shelter temperature or instrument rack temperature shall be monitored and reported quarterly as hourly averages, with the analyzer model and EPA-designated temperature range for that analyzer to be operated as a Federal Reference or Equivalent Method. 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.

5.3.1 Ozone Monitoring

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.

5.3.2 Nitrogen Dioxide Monitoring

The following guidance is for traditional nitrogen dioxide (NO_2) analyzers measuring NO_2 indirectly and utilizing gas phase titration (GPT) with ozone to generate test NO_2 concentrations. This guidance is not for EPA-designated Reference or Equivalent Methods utilizing new technology to measure NO_2 concentrations directly.

For traditional 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.

As discussed in the 40 CFR 58, Appendix A regulations, NO_2 audit gas must contain at least 0.08 ppm NO (excess NO) to assure the reaction of NO with O_3 to produce audit NO_2 concentrations goes to completion. Due to inevitable minor channel imbalance, however, NO_2 audit concentrations may lead to evaluation errors in chemiluminescence analyzers at the lower concentration audit points unless the high GPT audit point NO_x concentration is reduced for each of the lower GPT audit points (to at least 0.08 ppm above each audit NO_2 concentration). For example, if the high audit point is run first and generates 370 ppb NO_2 in 450 ppb NO_x (with 80 ppb excess NO), the NO_x concentration for a 100 ppb NO_2 audit point could be 180 ppb (with 80 ppb excess NO) instead of the original (high audit point) 450 ppb NO_x. Thus reducing the NO_2 audit NO_x concentrations for the lower NO_2 audit points will reduce the magnitude of errors introduced by channel imbalance.

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.

5.3.3 Gaseous Monitoring Audits

As the EPA gaseous monitoring guidance (i.e., the Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Appendix D audit tolerances) is geared toward urban pollution levels, toward average concentrations (as opposed to peak concentrations), which are meaningless in rural or remote locations, and toward the use of trace gas analyzers, which are not required, the Bureau does not use the EPA guidance accuracy tolerances of 15% per audit point for higher concentrations or in the case of very low audit concentrations, per point accuracy of 15% or a specified trace gas range concentration, whichever is higher. Instead, the Bureau relies on a linear regression analysis of the audit points as follows.

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). This approach provides a fairly robust way to evaluate the gas analyzer's performance because it uses an ensemble analysis of the audit points (i.e., a check on the intercept and slope, rather than single-point checks), while ensuring a strong linearity in the sensor response with the check on the correlation coefficient. These audit linear regression tolerances (obtained using the standard least squares method) are:

O_3

Slope: 0.90 ≤ slope ≤ 1.10 = satisfactory
Intercept: -10 ppb ≤ intercept ≤ +10 ppb = satisfactory
Correlation Coefficient: corr. ≥ 0.9950 (to 1.0000) = satisfactory

NO_2, SO_2 and CO

Slope: 0.85 ≤ slope ≤ 1.15 = satisfactory
Intercept: -10 ppb (-1.0 ppm CO) ≤ intercept ≤ +10 ppb (+1.0 ppm CO) = satisfactory
Correlation Coefficient: corr. ≥ 0.9950 (to 1.0000) = satisfactory.

These linear regression slope tolerances borrow from the 2008 EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, App. D, Operational Criteria, Federal Audits (NPAP) tolerances, which use a mean absolute percent difference tolerance for the audit points of 10% for ozone and 15% for NO_2, SO_2 and CO. The linear regression intercept tolerances borrow from the 2008 EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, App. D, Critical Criteria, zero drift tolerances of 2% of full scale (10 ppb and 1.0 ppm for standard analyzers) for O_3 and CO, respectively, and tighten the 2008 zero drift tolerance of 3% of full scale for NO_2 and SO_2 to 2% of full scale (10 ppb). The Correlation Coefficient tolerance is taken from the EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II: Part 1, Ambient Air Quality Monitoring Program Quality System Development (Aug., 1998), Appendix 15, Table A.11, Linear Regression Criteria.

Because a linear regression analysis is being used, the Bureau also recommends use of the regulatory optional fourth audit point: "An additional 4th level is encouraged for those PSD organizations that would like to confirm the monitor's linearity at the higher end of the operational range" (Part 58, Appendix B). Also recommended is the selection of required audit points at the high end of each audit level concentration range to make the audit points more suitable for standard gas analyzers as opposed to trace gas or lower range analyzers.

5.3.4 Gaseous Monitoring Quality Control Checks

The EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Appendix D, Measurement Quality Objectives and Validation Templates (May 2013) criteria pollutant monitoring guidance radically changed the acceptable gaseous criteria pollutant zero drift tolerances for checks every 14 days (biweekly checks) from the EPA 2008 Appendix D tolerances. For NO_2 and SO_2, the zero drift data validation tolerance was changed from 15 ppb to 1.5 ppb, for O_3 from 10 ppb to 1.5 ppb, and for CO from 1 ppm to 0.03 ppm. The 0.03 ppm tolerance was later identified by EPA as a typographical error that should have been 0.3 ppm. These are all trace gas analyzer tolerances, where trace gas analyzers are not required and standard analyzers are in widespread, if not exclusive, use in Nevada source monitoring.

The EPA subsequently acknowledged these 2013 zero drift tolerances for 14-day intervals were taken in error from the 12- and 24-hour zero drift tolerances for analyzer designation by EPA as a Federal Reference or Equivalent Method. Therefore, in July 2014 EPA revised the gaseous criteria pollutant biweekly zero check tolerances, based on its statistical analysis, from 1.5 ppb for O_3, NO_2 and SO_2 to 5.0 ppb and the CO zero check tolerance from 0.03 ppm (a typographical error for 0.3 ppm) to 0.6 ppm. The Bureau finds the EPA statistical analysis on which these changes were made does not support these small increases in zero drift tolerances for biweekly quality control checks, which must be suitable for standard analyzers. Therefore the Bureau adopts, with consideration of the EPA 2008 Appendix D zero drift tolerances, the following zero drift tolerances: for O_3, the EPA 2008 tolerance of 10 ppb; for CO, the EPA 2008 tolerance of 1.0 ppm; for NO_2 and SO_2, the EPA 2008 tolerance of 15 ppb is reduced to 10 ppb.

The Bureau also does not adopt the EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Appendix D, Measurement Quality Objectives and Validation Templates (2013/2014) criteria pollutant monitoring guidance tolerance for biweekly ozone precision ("one point QC check") and span checks. With concurrence from the EPA Region 9 Quality Assurance Office in 2009 for use of a 10% precision and span check tolerance to achieve the 7% ozone data quality objectives, based on available monitoring data at that time, the Bureau uses a 10% tolerance for ozone precision and span checks, rather than a 7% tolerance. As the regulatory precision check concentration range has been lowered, the absolute magnitude of this 10% tolerance has decreased. This 10% precision and span drift tolerance can also be compared to the 2014 EPA Appendix D per audit point tolerance of 15% for annual performance evaluations.

The Bureau supports the 2014 EPA Appendix D precision and span check tolerances of 15% and 10%, respectively, for NO_2 and 10% for SO_2 and CO.

The following table summarizes these quality control check tolerances.

QC checks	SO_2	NO_2	CO	O_3
Zero drift	10 ppb	10 ppb	1.0 ppm	10 ppb
Span drift	10%	10%	10%	10%
Precision (1-point QC)	10%	15%	10%	10%

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.