

## F O R E W O R D

### AUTHORITY

In accordance with the provisions of Section 35-11-106 of the Wyoming Environmental Quality Act 1973, Standards and Regulations adopted by the Air Resources Council pursuant to Section 5, Wyoming Air Quality Act, Chapter 186, Session Laws of Wyoming 1967 were adopted as Standards and Regulations of the Department effective July 1, 1973.

Rules and Regulations adopted subsequent to July 1, 1973, are adopted under the authority of Sections 35-11-110, 112, 114, and 202 through 212 of the Wyoming Environmental Quality Act, 1993 and in accordance with the provisions of Sections 16-3-101 through 16-3-115 of the Wyoming Administrative Procedures Act.

### APPLICATION

The following table lists the effective dates for specific sections and subsections of **Chapter 2, Ambient Standards**.

<u>Section</u> .....	<u>Effective Date</u>
<b>Section 1 - <u>Introduction to ambient standards</u></b>	
New section.....	October 29, 1999
Revised to describe new Section 12.....	September 7, 2010
<b>Section 2 - <u>Ambient standards for particulate matter</u></b>	
(c) Ambient air definition .....	June 5, 1987
(a) PM <sub>10</sub> standards.....	February 13, 1989
(b) TSP 24-hour retained .....	February 13, 1989
Entire section restructured .....	October 29, 1999
(b) TSP 24-hour removed .....	March 30, 2000
(b) PM <sub>2.5</sub> standards.....	March 30, 2000
(b)(v) Provision to delay PM <sub>2.5</sub> implementation removed.....	January 30, 2006
(a) PM <sub>10</sub> annual standard addressed in new Appendix 1 .....	September 7, 2010
(b) PM <sub>2.5</sub> 24-hr standard 35 µg/m <sup>3</sup> .....	September 7, 2010
(b) Entire subsection added (primary ambient air quality standards for PM <sub>2.5</sub> ) .....	October 13, 2015
Entire section restructured .....	October 13, 2015
<b>Section 3 - <u>Ambient standards for nitrogen oxides</u></b>	
(a) 100 µg/m <sup>3</sup> .....	February 22, 1972
Entire section restructured .....	October 29, 1999
(a) 40 CFR part 50 and 40 CFR part 53.....	March 26, 2002
(a)-(g) update to 53 ppb (annual) and 100 ppb (1-hour) .....	December 19, 2012
<b>Section 4 - <u>Ambient standards for sulfur oxides</u></b>	
(a) 60 µg/m <sup>3</sup> .....	February 10, 1970
(a) 260 µg/m <sup>3</sup> .....	February 22, 1972

(a) 1300 µg/m <sup>3</sup> .....	February 22, 1972
Entire section restructured .....	October 29, 1999
(a) 40 CFR part 50 and 40 CFR part 53.....	March 26, 2002
(a) remove annual and 24-hour standards; update to 75 ppb (1-hour) .....	December 19, 2012
(b) update to 0.5 ppm (3-hour secondary) .....	December 19, 2012
Section 5 - <u>Ambient standards for carbon monoxide</u>	
(a) 10 mg/m <sup>3</sup> .....	February 22, 1972
(a) 40 mg/m <sup>3</sup> .....	February 22, 1972
Entire section restructured .....	October 29, 1999
(a) 40 CFR part 50 and 40 CFR part 53.....	March 26, 2002
Section 6 - <u>Ambient standards for ozone</u>	
New section.....	February 22, 1972
(a) 0.08 ppm, 8hr.....	October 15, 1998
(b) Entire subsection added.....	October 15, 1998
Entire section restructured .....	October 29, 1999
(c) 0.12 ppm, 1hr.....	March 26, 2002
(c) 0.12 ppm, 1hr removed.....	January 30, 2006
(a) 0.075 ppm (8-hour primary) .....	December 19, 2012
(b) 0.075 ppm (8-hour secondary) .....	December 19, 2012
Section 7 - <u>Ambient standards for hydrogen sulfide</u>	
(a) 70 µg/m <sup>3</sup> .....	February 10, 1970
(a) 40 µg/m <sup>3</sup> .....	February 10, 1970
Entire section restructured .....	October 29, 1999
Section 8 - <u>Ambient standards for suspended sulfates</u>	
New section.....	February 22, 1972
Entire section restructured .....	October 29, 1999
Section 9 - <u>Ambient standards for fluorides</u>	
New section.....	April 17, 1986
Entire section restructured .....	October 29, 1999
Section 10 - <u>Ambient standards for lead</u>	
New section.....	August 29, 1984
Entire section restructured .....	October 29, 1999
(a) add reference to 40 CFR part 53.....	January 30, 2006
(a) 0.15 µg/m <sup>3</sup> (3-month mean) .....	September 7, 2010
(b) Entire subsection added.....	September 7, 2010
Section 11 - <u>Ambient standards for odors</u>	
(a) Seven dilutions .....	February 10, 1970
(b) Reduction of animal matter .....	February 10, 1970
(c) Handling of odor producing materials.....	February 10, 1970
(d) Processing animal matter .....	February 10, 1970
(a)(i) Undetectable at seven dilutions .....	October 15, 1998
Entire section restructured .....	October 29, 1999
Section 12- <u>Incorporation by reference</u>	
New section - adoption by reference 7/1/2008 .....	September 7, 2010
Adoption by reference 7/1/2011 .....	December 19, 2012
Adoption by reference 7/1/2014 .....	October 13, 2015

**WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY  
AIR QUALITY DIVISION  
STANDARDS AND REGULATIONS**

**Ambient Standards**

**CHAPTER 2**

**TABLE OF CONTENTS**

Section 1.	Introduction to ambient standards .....	2-1
Section 2.	Ambient standards for particulate matter .....	2-1
Section 3.	Ambient standards for nitrogen oxides .....	2-2
Section 4.	Ambient standards for sulfur oxides .....	2-3
Section 5.	Ambient standards for carbon monoxide .....	2-4
Section 6.	Ambient standards for ozone .....	2-4
Section 7.	Ambient standards for hydrogen sulfide .....	2-4
Section 8.	Ambient standards for suspended sulfates .....	2-5
Section 9.	Ambient standards for fluorides .....	2-5
Section 10.	Ambient standards for lead .....	2-6
Section 11.	Ambient standards for odors .....	2-6
Section 12.	Incorporation by reference .....	2-7
Appendix 1.	Interpretation of the Annual State Ambient Air Quality Standards for PM <sub>10</sub> .....	2-8



**WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY  
AIR QUALITY DIVISION  
STANDARDS AND REGULATIONS**

**Ambient Standards**

**CHAPTER 2**

**Section 1. Introduction to ambient standards.**

(a) This Chapter establishes standards of ambient air quality necessary to protect public health and welfare. Such standards are subject to revision. The term “ambient air” refers to that portion of the atmosphere, external to buildings, to which the general public has access. Section 12 incorporates by reference all Code of Federal Regulations (CFRs) cited in this chapter, including their Appendices.

**Section 2. Ambient standards for particulate matter.**

(a) PM<sub>10</sub>: The ambient air standards for PM<sub>10</sub> particulate matter are:

(i) 150 micrograms per cubic meter — 24-hour average concentration with not more than one expected exceedance per year.

(A) Attainment of the 24-hour standard is determined in accordance with Appendix K of 40 CFR part 50.

(ii) 50 micrograms per cubic meter — annual arithmetic mean.

(A) Attainment of the annual standard is determined in accordance with Appendix 1 of this chapter.

(iii) For the purpose of determining attainment of the standards, particulate matter shall be measured in the ambient air as PM<sub>10</sub> (particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers), by a reference method based on 40 CFR part 50, Appendix J and designated in accordance with 40 CFR part 53 or an equivalent or alternate method designated in accordance with 40 CFR part 53.

(b) PM<sub>2.5</sub>: The primary ambient air quality standards for PM<sub>2.5</sub> particulate matter are:

(i) 12.0 micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ) annual arithmetic mean concentration and 35  $\mu\text{g}/\text{m}^3$  24-hour average concentration measured in the ambient air as PM<sub>2.5</sub> (particles with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers) by either:

(A) A reference method based on 40 CFR part 50, Appendix L, and designated in accordance with 40 CFR part 53; or

(B) An equivalent method designated in accordance with 40 CFR part 53.

(ii) The primary annual PM<sub>2.5</sub> standard is met when the annual arithmetic mean concentration, as determined in accordance with 40 CFR part 50, Appendix N, is less than or equal to 12.0 µg/m<sup>3</sup>.

(iii) The primary 24-hour PM<sub>2.5</sub> standard is met when the 98th percentile 24-hour concentration, as determined in accordance with 40 CFR part 50, Appendix N, is less than or equal to 35 µg/m<sup>3</sup>.

(c) PM<sub>2.5</sub>: The secondary ambient air quality standards for PM<sub>2.5</sub> particulate matter are:

(i) 15 micrograms per cubic meter (µg/m<sup>3</sup>) annual arithmetic mean concentration and;

(ii) 35 micrograms per cubic meter (µg/m<sup>3</sup>) — 98th percentile 24-hour average concentration.

(iii) Attainment of the annual and 24-hour standards is determined in accordance with Appendix N of 40 CFR part 50.

(iv) For the purpose of determining attainment of the standards, particulate matter shall be measured in the ambient air as PM<sub>2.5</sub> (particles with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers), by a reference method based on 40 CFR part 50, Appendix L and designated in accordance with 40 CFR part 53, or an equivalent or alternate method designated in accordance with 40 CFR part 53.

(d) Ambient air, for the area bounded by Townships 40 through 52 North, and Ranges 69 through 73 West, inclusive, of the Sixth Principal Meridian, Campbell and Converse Counties, in the Powder River Coal Basin, is defined as that portion of the atmosphere, external to buildings, to which the general public has access. For surface mining operations, the application of this definition will be limited to only those lands that are necessary to conduct mining operations as determined by the Administrator of the Wyoming Air Quality Division.

### Section 3. **Ambient standards for nitrogen oxides.**

(a) The level of the primary annual ambient air quality standard for oxides of nitrogen is 53 parts per billion (ppb, which is 1 part in 1,000,000,000), annual average concentration, measured in the ambient air as nitrogen dioxide.

(b) The level of the primary 1-hour ambient air quality standard for oxides of nitrogen is 100 ppb, 1-hour average concentration, measured in the ambient air as nitrogen dioxide.

(c) The level of the secondary ambient air quality standard for nitrogen dioxide is 0.053 parts per million (ppm, which is 1 part in 1,000,000), annual arithmetic mean concentration.

(d) The levels of the standards shall be measured by:

(i) A reference method based on 40 CFR part 50, Appendix F; or

(ii) A Federal equivalent method (FEM) designated in accordance with 40 CFR part 53.

(e) The annual primary standard is met when the annual average concentration in a calendar year is less than or equal to 53 ppb, as determined in accordance with Appendix S of 40 CFR part 50 for the annual standard.

(f) The 1-hour primary standard is met when the three-year average of the annual 98th percentile of the daily maximum 1-hour average concentration is less than or equal to 100 ppb, as determined in accordance with Appendix S of 40 CFR part 50 for the 1-hour standard.

(g) The secondary standard is attained when the annual arithmetic mean concentration in a calendar year is less than or equal to 0.053 ppm, rounded to three decimal places (fractional parts equal to or greater than 0.0005 ppm must be rounded up). To demonstrate attainment, an annual mean must be based upon hourly data that are at least 75 percent complete or upon data derived from manual methods that are at least 75 percent complete for the scheduled sampling days in each calendar quarter.

#### Section 4. **Ambient standards for sulfur oxides.**

(a) The level of the primary 1-hour annual ambient air quality standard for oxides of sulfur is 75 parts per billion (ppb, which is 1 part in 1,000,000,000), measured in the ambient air as sulfur dioxide (SO<sub>2</sub>).

(i) The 1-hour primary standard is met at an ambient air quality monitoring site when the three-year average of the annual (99th percentile) of the daily maximum 1-hour average concentrations is less than or equal to 75 ppb, as determined in accordance with Appendix T of 40 CFR part 50.

(ii) The level of the standard shall be measured by a reference method based on 40 CFR part 50, Appendix A or A-1, or by a Federal Equivalent Method (FEM) designated in accordance with 40 CFR part 53.

(b) The level of the secondary 3-hour ambient air quality standard for oxides of sulfur is 0.5 parts per million (ppm, which is 1 part in 1,000,000), not to be exceeded more than once per calendar year. The 3-hour averages shall be determined from successive nonoverlapping 3-hour blocks starting at midnight each calendar day and shall be rounded to 1 decimal place (fractional parts equal to or greater than 0.05 ppm shall be rounded up).

(i) Sulfur oxides shall be measured in the ambient air as sulfur dioxide by the reference method described in Appendix A of 40 CFR part 50 or by an equivalent method

designated in accordance with 40 CFR part 53.

(ii) To demonstrate attainment, the second-highest 3-hour average must be based upon hourly data that are at least 75 percent complete in each calendar quarter. A 3-hour block average shall be considered valid only if all three hourly averages for the 3-hour period are available. If only one or two hourly averages are available, but the 3-hour average would exceed the level of the standard when zeros are substituted for the missing values, subject to the rounding rule of paragraph (b) of this section, then this shall be considered a valid 3-hour average. In all cases, the 3-hour block average shall be computed as the sum of the hourly averages divided by 3.

#### **Section 5. Ambient standards for carbon monoxide.**

(a) The ambient air standard for carbon monoxide, measured by nondispersive infrared spectrometry, as described in 40 CFR part 50, Appendix C, or by an equivalent method designated in accordance with 40 CFR part 53, is:

(i) 10 milligrams per cubic meter (9 ppm) — maximum 8-hour concentration not to be exceeded more than once per year;

(ii) 40 milligrams per cubic meter (35 ppm) — maximum 1-hour concentration not to be exceeded more than once per year.

#### **Section 6. Ambient standards for ozone.**

(a) The level of the 8-hour primary and secondary ambient air quality standards for ozone (O<sub>3</sub>) is 0.075 parts per million (ppm, which is 1 part in 1,000,000), daily maximum 8-hour average, measured by a reference method based on Appendix D to 40 CFR part 50 and designated in accordance with 40 CFR part 53 or an equivalent method designated in accordance with 40 CFR part 53.

(b) The 8-hour primary and secondary standard ozone ambient air quality standards are met at an ambient air quality monitoring site when the 3-year average of the annual fourth-highest daily maximum 8-hour average ozone concentration is less than or equal to 0.075 ppm, as determined in accordance with 40 CFR part 50, Appendix P.

#### **Section 7. Ambient standards for hydrogen sulfide.**

(a) The ambient air standards for hydrogen sulfide, measured by the mercuric chloride method, methylene blue method, or by an equivalent method are:

(i) 70 micrograms H<sub>2</sub>S per cubic meter, ½-hour average not to be exceeded more than 2 times per year;

(ii) 40 micrograms H<sub>2</sub>S per cubic meter, ½-hour average not to be exceeded more than 2 times in any five consecutive days.

**Section 8. Ambient standards for suspended sulfates.**

(a) The ambient air standards for suspended sulfate measured as a sulfation rate by the lead peroxide method are:

(i) 0.25 milligrams SO<sub>3</sub> per 100 square centimeters per day, maximum annual average;

(ii) 0.50 milligrams SO<sub>3</sub> per 100 square centimeters per day, maximum 30-day value.

**Section 9. Ambient standards for fluorides.**

(a) The ambient air standards for fluorides, measured as hydrogen fluoride through methods approved by the Administrator are:

(i) Statewide Standard:

Averaging Time	Maximum Allowable Concentration for Averaging Time
12 hours	3.0 µg/m <sup>3</sup>
24 hours	1.8 µg/m <sup>3</sup>
7 days	0.5 µg/m <sup>3</sup>
30 days	0.4 µg/m <sup>3</sup>

(ii) Regional Standard:

Averaging Time	Maximum Allowable Concentration for Averaging Time
12 hours	10.0 µg/m <sup>3</sup>
24 hours	4.0 µg/m <sup>3</sup>
7 days	1.8 µg/m <sup>3</sup>
30 days	1.2 µg/m <sup>3</sup>

The Regional Standard applies to the area encompassing the following lands in Sweetwater County, Wyoming:

T19N R104W, E1/2 Section 31 & Sections 32, 33, 34, 35, 36;

T19N R103W, Section 31;

T18N R105W, S1/2 Section 1 & Sections 12, 13, 24, 25, 35, 36;

T18N R104W, All Sections 1 through 36;

T18N R103W, Sections 6, 7, 18, 19, 30, 31, 32, 33;

T17N R105W, Sections 1, 2, 11, 12, 13, 14, 23, 24, 25, 26;  
T17N R104W, Sections 1 through 30;  
T17N R103W, Sections 4, 5, 6, 7, 8, 9, 16, 17, 18, 19, 20, 21, 28, 29, 30

(b) The standards for fluoride in forage for animal consumption measured as fluorine, dry weight basis, are:

Averaging Time	Maximum Allowable Concentration for Averaging Time
One year	30 ppm
60 days	60 ppm
30 days	80 ppm

The concentration of fluoride in forage shall be determined through sampling and analysis methods approved by the Administrator.

**Section 10. Ambient standards for lead.**

(a) The primary and secondary ambient air quality standards for lead (Pb) and its compounds are 0.15 micrograms per cubic meter, arithmetic mean concentration over a 3-month period, measured in the ambient air as Pb either by:

(i) A reference method based on 40 CFR part 50, Appendix G (Reference Method for the Determination of Lead in Suspended Particulate Matter Collected From Ambient Air), and designated in accordance with 40 CFR part 53 or;

(ii) An equivalent method designated in accordance with 40 CFR part 53.

(b) The primary and secondary ambient air quality standards for Pb are met when the maximum arithmetic 3-month mean concentration for a 3-year period, as determined in accordance with Appendix R (Interpretation of the National Ambient Air Quality Standards for Lead) of 40 CFR part 50, is less than or equal to 0.15 micrograms per cubic meter.

**Section 11. Ambient standards for odors.**

(a) The ambient air standard for odors from any source shall be limited to:

(i) An odor emission at the property line which is undetectable at seven dilutions with odor free air as determined by a scintometer as manufactured by the Barnebey-Cheney Company or any other instrument, device, or technique designated by the Division as producing equivalent results. The occurrence of odors shall be measured so that at least two measurements can be made within a period of one hour, these determinations being separated by at least 15 minutes.

(b) No person shall operate or use any device, machine, equipment, or other contrivance

for the reduction of animal matter unless all gases, vapors and gas entrained effluents from such facility are incinerated at a temperature of not less than 1200 degrees Fahrenheit for a period not less than 0.3 second, or processed by condensation or such manner as determined by the Division to be equally or more effective for the purpose of controlling such emissions.

(i) A person incinerating or processing gases, vapors, or gas entrained effluents pursuant to this rule shall provide, properly install, and maintain in good working order and in operation, devices as specified by the Division for indicating temperature, pressure, or other operating conditions.

(ii) Effective odor control devices, systems, or measures shall be installed and operated such that no vent, exhaust pipe, blowoff pipe, or opening of any kind shall discharge into the outdoor air any odorous matter, vapors, gases, or dusts, or any combination thereof, which create odors in areas adjacent to the plant in excess of the limits described in Chapter 2, Section 11(a)(i) of this regulation.

(c) Odor producing materials shall be stored, transported, and handled in a manner that:

(i) Odors produced from such materials are confined and that accumulation of such materials resulting from spillage or other escape is prevented.

(d) Whenever dust, fumes, gases, mist, odorous matter, vapors, or any combination thereof escape from a building used for processing animal matter in such manner and amount as to cause a violation of Subsection (a)(i) of this regulation, the Division may require that the building or buildings in which processing, handling, and storage are done be tightly closed and ventilated in such a manner that all airborne effluent materials leaving the building be treated by an effective means for removal or destruction of odorous matter before release to the open air.

## Section 12. **Incorporation by reference.**

(a) Code of Federal Regulations (CFR). All Code of Federal Regulations (CFRs) cited in this chapter, including their Appendices, revised and published as of July 1, 2014, not including any later amendments, are incorporated by reference. Copies of the Code of Federal Regulations are available for public inspection and can be obtained at cost from the Department of Environmental Quality, Division of Air Quality, Cheyenne Office. Contact information for the Cheyenne Office can be obtained at: <http://deq.wyoming.gov>. Copies of the CFRs can also be obtained at cost from Government Institutes, 15200 NBN Way, Building B, Blue Ridge Summit, PA 17214, or online at: <http://www.gpo.gov/fdsys/browse/collectionCfr.action?collectionCode=CFR>.

APPENDIX 1  
INTERPRETATION OF THE ANNUAL STATE  
AMBIENT AIR QUALITY STANDARD FOR PM<sub>10</sub>

1.0 *General.*

(a) This appendix explains the computations necessary for analyzing particulate matter data to determine attainment of the annual standard. For the primary standard, particulate matter is measured in the ambient air as PM<sub>10</sub> (particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers) by a reference method based on 40 CFR part 50, Appendix J, and designated in accordance with 40 CFR part 53, or by an equivalent method designated in accordance with 40 CFR part 53. The required frequency of measurements is specified in 40 CFR part 58.

(b) The terms used in this appendix are defined as follows:

*Average* refers to an arithmetic mean. The particulate matter standard is expressed in terms of the annual arithmetic mean.

*Daily value* for PM<sub>10</sub> refers to the 24-hour average concentration of PM<sub>10</sub> calculated or measured from midnight to midnight (local time).

*Expected annual value* is the number approached when the annual values from an increasing number of years are averaged, in the absence of long-term trends in emissions or meteorological conditions.

*Year* refers to a calendar year.

(c) Although the discussion in this appendix focuses on monitored data, the same principles apply to modeling data, subject to EPA modeling guidelines.

2.0 *Attainment Determinations.*

2.1 *Annual Primary Standard.*

The annual primary standard is attained when the expected annual arithmetic mean PM<sub>10</sub> concentration is less than or equal to the level of the standard. In the simplest case, the expected annual arithmetic mean is determined by averaging the annual arithmetic mean PM<sub>10</sub> concentrations for the past 3 calendar years. Because of the potential for incomplete data and the possible seasonality in PM<sub>10</sub> concentrations, the annual mean shall be calculated by averaging the four quarterly means of PM<sub>10</sub> concentrations within the calendar year. The equations for calculating the annual arithmetic mean are given in Section 3.0 of this appendix. Situations in which 3 years of data are not available and possible adjustments for unusual events or trends are discussed in Sections 2.2 and 2.3 of this appendix. The expected annual arithmetic mean is rounded to the nearest 1 µg/m<sup>3</sup> before comparison with the annual standard (fractional values equal to or greater than 0.5 are to be rounded up).

2.2 *Data Requirements.*

(a) A minimum of 75 percent of the scheduled PM<sub>10</sub> samples per quarter are required.

(b) To demonstrate attainment of the annual standard at a monitoring site, the monitor must provide sufficient data to perform the required calculations of Section 3.0 of this appendix. The amount of data required varies with the sampling frequency, data capture rate and the number of years of record. In all cases, 3 years of representative monitoring data that meet the 75 percent criterion of the previous paragraph should be utilized, if available, and would suffice. More than 3 years may be considered, if all additional representative years of data meeting the 75 percent criterion are utilized. Data not meeting these criteria may also suffice to show attainment;

however, such exceptions will have to be approved by the Air Quality Division Administrator.

(c) There are less stringent data requirements for showing that a monitor has failed an attainment test and thus has recorded a violation of the particulate matter standard. Although it is generally necessary to meet the minimum 75 percent data capture requirement per quarter to use the computational equations described in Section 3.0 of this appendix, this criterion does not apply when less data is sufficient to unambiguously establish nonattainment. The following examples illustrate how nonattainment can be demonstrated when a site fails to meet the completeness criteria. Nonattainment of the annual standard can be demonstrated on the basis of quarterly mean concentrations developed from observed data combined with one-half the minimum detectable concentration substituted for missing values. Expected annual values must exceed the levels allowed by the standard.

### *2.3 Adjustment for Exceptional Events and Trends.*

(a) An exceptional event is an uncontrollable event caused by natural sources of particulate matter or an event that is not expected to recur at a given location. Inclusion of such a value in the computation of exceedances or averages could result in inappropriate estimates of their respective expected annual values. To reduce the effect of unusual events, more than 3 years of representative data may be used. Alternatively, other techniques, such as the use of statistical models or the use of historical data could be considered so that the event may be discounted or weighted according to the likelihood that it will recur. The use of such techniques is subject to the approval of the Air Quality Division Administrator.

(b) In cases where long-term trends in emissions and air quality are evident, mathematical techniques should be applied to account for the trends to ensure that the expected annual values are not inappropriately biased by unrepresentative data. In the simplest case, if 3 years of data are available under stable emission conditions, this data should be used. In the event of a trend or shift in emission patterns, either the most recent representative year(s) could be used or statistical techniques or models could be used in conjunction with previous years of data to adjust for trends. The use of less than 3 years of data, and any adjustments are subject to the approval of the Air Quality Division Administrator.

## *3.0 Computational Equations for Annual Standard.*

### *3.1 Calculation of the Annual Arithmetic Mean.*

(a) An annual arithmetic mean value for PM<sub>10</sub> is determined by averaging the quarterly means for the 4 calendar quarters of the year. The following equation is to be used for calculation of the mean for a calendar quarter:

Equation 1

$$\bar{x}_q = (1/n_q) \times \sum_{i=1}^{n_q} x_i$$

where:

$\bar{x}_q$  = the quarterly mean concentration for quarter q, q=1, 2, 3, or 4,

$n_q$  = the number of samples in the quarter, and

$x_i$  = the  $i$ th concentration value recorded in the quarter.

- (b) The quarterly mean, expressed in  $\mu\text{g}/\text{m}^3$ , must be rounded to the nearest tenth (fractional values of 0.05 should be rounded up).
- (c) The annual mean is calculated by using the following equation:

Equation 2

$$\bar{x} = (1/4) \times \sum_{q=1}^4 \bar{x}_q$$

where:

$\bar{x}$  = the annual mean; and

$\bar{x}_q$  = the mean for calendar quarter q.

- (d) The average of quarterly means must be rounded to the nearest tenth (fractional values of 0.05 should be rounded up).
- (e) The use of quarterly averages to compute the annual average will not be necessary for monitoring or modeling data which results in a complete record, i.e., 365 days per year.
- (f) The expected annual mean is estimated as the average of three or more annual means. This multi-year estimate, expressed in  $\mu\text{g}/\text{m}^3$ , shall be rounded to the nearest integer for comparison with the annual standard (fractional values of 0.5 should be rounded up).

Example 1

Using Equation 1, the quarterly means are calculated for each calendar quarter. If the quarterly means are 52.4, 75.3, 82.1, and 63.2  $\mu\text{g}/\text{m}^3$ , then the annual mean is:

$$\bar{X} = (1/4) \times (52.4 + 75.3 + 82.1 + 63.2) = 68.25 \text{ or } 68.3.$$

3.2 Adjustments for Non-scheduled Sampling Days.

- (a) An adjustment in the calculation of the annual mean is needed if sampling is performed on days in addition to the days specified by the systematic sampling schedule. The quarterly averages would be calculated by using the following equation:

Equation 3

$$\bar{x}_q = \left( \frac{1}{m_q} \right) \times \sum_{j=1}^{m_q} \sum_{i=1}^{k_j} (x_{ij} / k_j)$$

where:

$\bar{x}_q$  = the quarterly mean concentration for quarter q, q=1, 2, 3, or 4;

$x_{ij}$  = the *i*th concentration value recorded in stratum *j*;

$k_j$  = the number of actual samples in stratum *j*; and

$m_q$  = the number of strata with data in the quarter.

- (b) If one sample value is recorded in each stratum, Equation 3 reduces to a simple arithmetic average of the observed values as described by Equation 1.

Example 2

- a. During one calendar quarter, 9 observations were recorded. These samples were distributed among 7 sampling strata, with 3 observations in one stratum. The concentrations of the 3 observations in the single stratum were 202, 242, and 180  $\mu\text{g}/\text{m}^3$ . The remaining 6 observed concentrations were 55, 68, 73, 92, 120, and 155  $\mu\text{g}/\text{m}^3$ . Applying the weighting factors specified in Equation 3, the quarterly mean is:

$$\bar{X}_q = (1/7) \times [(1/3) \times (202 + 242 + 180) + 155 + 68 + 73 + 92 + 120 + 155] = 110.1$$

- b. Note that these values are rounded to the nearest 1  $\mu\text{g}/\text{m}^3$  for the calculation of means.