APPENDIX M TO PART 50 [RESERVED]

APPENDIX N TO PART 50—INTERPRETATION OF THE NATIONAL AMBIENT AIR QUALITY STANDARDS FOR $PM_{2.5}$

1. General

(a) This appendix explains the data handling conventions and computations necessary for determining when the annual and 24-hour primary and secondary national ambient air quality standards (NAAQS) for $PM_{2.5}$ specified in §50.7 and §50.13 of this part are met. $PM_{2.5}$, defined as particles with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers, is measured in the ambient air by a Federal reference method (FRM) based on appendix L of this part, as applicable, and designated in accordance with part 53 of this chapter, or by a Federal equivalent method (FEM) designated in accordance with part 53 of this chapter, or by an Approved Regional Method (ARM) designated in accordance with part 58 of this chapter. Data handling and computation procedures to be used in making comparisons between reported $PM_{2.5}$ concentrations and the levels of the $PM_{2.5}$ NAAQS are specified in the following sections.

(b) Data resulting from exceptional events, for example structural fires or high winds, may be given special consideration. In some cases, it may be appropriate to exclude these data in whole or part because they could result in inappropriate values to compare with the levels of the $PM_{2.5}$ NAAQS. In other cases, it may be more appropriate to retain the data for comparison with the levels of the $PM_{2.5}$ NAAQS and then for EPA to formulate the appropriate regulatory response.

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

Annual mean refers to a weighted arithmetic mean, based on quarterly means, as defined in section 4.4 of this appendix.

Creditable samples are samples that are given credit for data completeness. They include valid samples collected on required sampling days and valid ''make-up'' samples taken for missed or invalidated samples on required sampling days.

Daily values for $PM_{2.5}$ refers to the 24-hour average concentrations of $PM_{2.5}$ calculated (averaged from hourly measurements) or measured from midnight to midnight (local standard time) that are used in NAAQS computations.

Designated monitors are those monitoring sites designated in a State or local agency PM Monitoring Network Description in accordance with part 58 of this chapter.

Design values are the metrics (*i.e.*, statistics) that are compared to the NAAQS levels to determine compliance, calculated as shown in section 4 of this appendix:

(1) The 3-year average of annual means for a single monitoring site or a group of monitoring sites (referred to as the ''*annual standard design value*''). If spatial averaging has been approved by EPA for a group of sites which meet the criteria specified in section 2(b) of this appendix and section 4.7.5 of appendix D of 40 CFR part 58, then 3 years of spatially averaged annual means will be averaged to derive the *annual standard design value* for that group of sites (further referred to as the ''*spatially averaged annual standard design value*''). Otherwise, the annual standard design value will represent the 3-year average of annual means for a single site (further referred to as the ''*single site annual standard design value*'').

(2) The 3-year average of annual 98th percentile 24-hour average values recorded at each monitoring site (referred to as the ''*24-hour standard design value*'').

Extra samples are non-creditable samples. They are daily values that do not occur on scheduled sampling days and that can not be used as make-ups for missed or invalidated scheduled samples. Extra samples are used in mean calculations and are subject to selection as a 98th percentile.

Make-up samples are samples taken to supplant missed or invalidated required scheduled samples. Make-ups can be made by either the primary or the collocated instruments. Make-up samples are either taken before the next required sampling day or exactly one week after the missed (or voided) sampling day. Also, to be considered a valid make-up, the sampling must be administered according to EPA guidance.

98th percentile is the daily value out of a year of $PM_{2.5}$ monitoring data below which 98 percent of all daily values fall.

Year refers to a calendar year.

2.0 Monitoring Considerations.

(a) Section 58.30 of this chapter specifies which monitoring locations are eligible for making comparisons with the $PM_{2.5}$ standards.

(b) To qualify for spatial averaging, monitoring sites must meet the criterion specified in section 4.7.5 of appendix D of 40 CFR part 58 as well as the following requirements:

(1) The annual mean concentration at each site shall be within 10 percent of the spatially averaged annual mean.

(2) The daily values for each site pair among the 3-year period shall yield a correlation coefficient of at least 0.9 for each calendar quarter.

(3) All of the monitoring sites should principally be affected by the same major emission sources of $PM_{2.5}$. For example, this could be demonstrated by site-specific chemical speciation profiles confirming all major component concentration averages to be within 10 percent for each calendar quarter.

(4) The requirements in paragraphs (b)(1) through (3) of this section shall be met for 3 consecutive years in order to produce a valid spatially averaged annual standard design value. Otherwise, the individual (single) site annual standard design values shall be compared directly to the level of the annual NAAQS.

(c) Section 58.12 of this chapter specifies the required minimum frequency of sampling for $PM_{2.5}$. Exceptions to the specified sampling frequencies, such as a reduced frequency during a season of expected low concentrations (*i.e.*, ''seasonal sampling''), are subject to the approval of EPA. Annual 98th percentile values are to be calculated according to equation 5 in section 4.5 of this appendix when a site operates on a ''seasonal sampling'' schedule.

3.0 Requirements for Data Used for Comparisons With the $PM_{2.5}$ NAAQS and Data Reporting Considerations.

(a) Except as otherwise provided in this appendix, only valid FRM/FEM/ARM $PM_{2.5}$ data required to be submitted to EPA's Air Quality System (AQS) shall be used in the design value calculations.

(b) $PM_{2.5}$ measurement data (typically hourly for continuous instruments and daily for filter-based instruments) shall be reported to AQS in micrograms per cubic meter ($\mu g/m^3$) to one decimal place, with additional digits to the right being truncated.

(c) Block 24-hour averages shall be computed from available hourly $PM_{2.5}$ concentration data for each corresponding day of the year and the result shall be stored in the first, or start, hour (*i.e.*, midnight, hour '0') of the 24-hour period. A 24-hour average shall be considered valid if at least 75 percent (*i.e.*, 18) of the hourly averages for the 24-hour period are available. In the event that less than all 24 hourly averages are available (*i.e.*, less than 24, but at least 18), the 24-hour average shall be computed on the basis of the hours available using the number of available hours as the divisor (e.g., 19). 24-hour periods with seven or more missing hours shall be considered valid if, after substituting zero for all missing hourly concentrations, the 24-hour average concentration is greater than the level of the standard. The computed 24-hour average $PM_{2.5}$ concentrations shall be reported to one decimal place (the additional digits to the right of the first decimal place are truncated, consistent with the data handling procedures for the reported data).

(d) Except for calculation of spatially averaged annual means and spatially averaged annual standard design values, all other calculations shown in this appendix shall be implemented on a site-level basis. Site level data shall be processed as follows:

(1) The default dataset for a site shall consist of the measured concentrations recorded from the designated primary FRM/FEM/ARM monitor. The primary monitor shall be designated in the appropriate State or local agency PM Monitoring Network Description. All daily values produced by the primary sampler are considered part of the site record (*i.e.*, that site's daily value); this includes all creditable samples and all extra samples.

(2) Data for the primary monitor shall be augmented as much as possible with data from collocated FRM/FEM/ARM monitors. If a valid 24-hour measurement is not produced from the primary monitor for a particular day (scheduled or otherwise), but a valid sample is generated by a collocated FRM/FEM/ARM instrument (and recorded in AQS), then that collocated value shall be considered part of the site data record (*i.e.*, that site's daily value). If more than one valid collocated FRM/FEM/ARM value is available, the average of those valid collocated values shall be used as the daily value.

(e) All daily values in the composite site record are used in annual mean and 98th percentile calculations, however, not all daily values are give credit towards data completeness requirements. Only ''creditable'' samples are given credit for data completeness. Creditable samples include valid samples on scheduled sampling days and valid make-up samples. All other types of daily values are referred to as ''extra'' samples.

4.0 Comparisons With the $PM_{2.5}$ NAAQS.

4.1 Annual $PM_{2.5}$ NAAQS.

(a) The annual $PM_{2.5}$ NAAQS is met when the annual standard design value is less than or equal to 15.0 micrograms per cubic meter ($\mu g/m^3$).

(b) For single site comparisons, 3 years of valid annual means are required to produce a valid annual standard design value. In the case of spatial averaging, 3 years of valid spatially averaged annual means are required to produce a valid annual standard design value. Designated sites with less than 3 years of data shall be included in annual spatial averages for those years that data completeness requirements are met. A year meets data completeness requirements when at least 75 percent of the scheduled sampling days for each quarter have valid data. [Quarterly data capture rates (expressed as a percentage) are specifically calculated as the number of creditable samples for the quarter divided by the number of scheduled samples for the quarter, the result then multiplied by 100 and rounded to the nearest integer.] However, years with at least 11 samples in each quarter shall be considered valid, notwithstanding quarters with less than complete data, if the resulting annual mean, spatially

averaged annual mean concentration, or resulting annual standard design value concentration (rounded according to the conventions of section 4.3 of this appendix) is greater than the level of the standard. Furthermore, where the explicit 11 sample per quarter requirement is not met, the site annual mean shall still be considered valid if, by substituting a low value (described below) for the missing data in the deficient quarters (substituting enough to meet the 11 sample minimum), the computation still yields a recalculated annual mean, spatially averaged annual mean concentration, or annual standard design value concentration over the level of the standard. The low value used for this substitution test shall be the lowest reported daily value in the site data record for that calendar quarter over the most recent 3-year period. If an annual mean is deemed complete using this test, the original annual mean (without substituted low values) shall be considered the official mean value for this site, not the result of the recalculated test using the low values.

(c) The use of less than complete data is subject to the approval of EPA, which may consider factors such as monitoring site closures/moves, monitoring diligence, and nearby concentrations in determining whether to use such data.

(d) The equations for calculating the annual standard design values are given in section 4.4 of this appendix.

4.2 24-Hour $PM_{2.5}$ NAAQS.

(a) The 24-hour $PM_{2.5}$ NAAQS is met when the 24-hour standard design value at each monitoring site is less than or equal to 35 μg/m³. This comparison shall be based on 3 consecutive, complete years of air quality data. A year meets data completeness requirements when at least 75 percent of the scheduled sampling days for each quarter have valid data. However, years shall be considered valid, notwithstanding quarters with less than complete data (even quarters with less than 11 samples), if the resulting annual 98th percentile value or resulting 24-hour standard design value (rounded according to the conventions of section 4.3 of this appendix) is greater than the level of the standard.

(b) The use of less than complete data is subject to the approval of EPA which may consider factors such as monitoring site closures/moves, monitoring diligence, and nearby concentrations in determining whether to use such data for comparisons to the NAAQS.

(c) The procedures and equations for calculating the 24-hour standard design values are given in section 4.5 of this appendix.

4.3 *Rounding Conventions.* For the purposes of comparing calculated values to the applicable level of the standard, it is necessary to round the final results of the calculations described in sections 4.4 and 4.5 of this appendix. Results for all intermediate calculations shall not be rounded.

(a) Annual $PM_{2.5}$ standard design values shall be rounded to the nearest 0.1 μg/m³ (decimals 0.05 and greater are rounded up to the next 0.1, and any decimal lower than 0.05 is rounded down to the nearest 0.1).

(b) 24-hour $PM_{2.5}$ standard design values shall be rounded to the nearest 1 μg/m³ (decimals 0.5 and greater are rounded up to the nearest whole number, and any decimal lower than 0.5 is rounded down to the nearest whole number).

4.4 Equations for the Annual $PM_{2.5}$ NAAQS.

(a) An annual mean value for $PM_{2.5}$ is determined by first averaging the daily values of a calendar quarter using equation 1 of this appendix:

Equation 1

$$\bar{X}_{q,y,s} = \frac{1}{n_q}\sum_{i=1}^{n_q} X_{i,q,y,s}$$

Where:

$\bar{X}_{q,y,s}$ = the mean for quarter q of the year y for site s;

n_q = the number of daily values in the quarter; and

$x_{i\ q,y,s}$ = the i^{th} value in quarter q for year y for site s.

(b) Equation 2 of this appendix is then used to calculate the site annual mean:

Equation 2

$$\bar{X}_{y,s} = \frac{1}{4}\sum_{q=1}^{4} \bar{X}_{q,y,s}$$

Where:

$\bar{X}_{y,s}$ = the annual mean concentration for year y (y = 1, 2, or 3) and for site s; and

$\bar{X}_{q,y,s}$ = the mean for quarter q of year y for site s.

(c) If spatial averaging is utilized, the site-based annual means will then be averaged together to derive the spatially averaged annual mean using equation 3 of this appendix. Otherwise (*i.e.*, for single site comparisons), skip to equation 4.B of this appendix.

Equation 3

$$\bar{x}_y = \frac{1}{n_s}\sum_{s=1}^{n_s} \bar{x}_{y,s}$$

Where:

$\bar{x}_y$ = the spatially averaged mean for year y,

$\bar{x}_{y,s}$ = the annual mean for year y and site s for sites designated to be averaged that meet completeness criteria , and

n_s = the number of sites designated to be averaged that meet completeness criteria.

(d) The annual standard design value is calculated using equation 4A of this appendix when spatial averaging and equation 4B of this appendix when not spatial averaging:

Equation 4A

When spatial averaging

$$\bar{x} = \frac{1}{3}\sum_{y=1}^{3} \bar{x}_y$$

Equation 4B

When not spatial averaging

$$\bar{x} = \frac{1}{3}\sum_{y=1}^{3} \bar{x}_{y,s}$$

Where:

$\bar{x}$ = the annual standard design value (the spatially averaged annual standard design value for equation 4A of this appendix and the single site annual standard design value for equation 4B of this appendix); and

$\bar{x}_y$ = the spatially averaged annual mean for year y (result of equation 3 of this appendix) when spatial averaging is used, or

$\bar{x}_{y,s}$ the annual mean for year y and site s (result of equation 2 of this appendix) when spatial averaging is not used.

(e) The annual standard design value is rounded according to the conventions in section 4.3 of this appendix before a comparison with the standard is made.

4.5 Procedures and Equations for the 24-Hour $PM_{2.5}$ NAAQS

(a) When the data for a particular site and year meet the data completeness requirements in section 4.2 of this appendix, calculation of the 98th percentile is accomplished by the steps provided in this subsection. Table 1 of this appendix shall be used to identify annual 98th percentile values, except that where a site operates on an approved seasonal sampling schedule, equation 5 of this appendix shall be used instead.

(1) *Regular procedure for identifying annual 98th percentile values.* Identification of annual 98th percentile values using the regular procedure (table 1) will be based on the creditable number of samples (as described below), rather than on the actual number of samples. Credit will not be granted for extra (non-creditable) samples. Extra samples, however, are candidates for selection as the annual 98th percentile. [The creditable number of samples will determine how deep to go into the data distribution, but all samples (creditable and extra) will be considered when making the percentile assignment.] The annual creditable number of samples is the sum of the four quarterly creditable number of samples.

Procedure: Sort all the daily values from a particular site and year by descending value. (For example: (x[1], x[2], x[3], * * *, x[n]). In this case, x[1] is the largest number and x[n] is the smallest value.) The 98th percentile is determined from this sorted series of daily values which is ordered from the highest to the lowest number. Using the left column of table 1, determine the appropriate range (*i.e.*, row) for the annual creditable number of samples for year y (cn_y). The corresponding ''n'' value in the right column identifies the rank of the annual 98th percentile value in the descending sorted list of daily site values for year y. Thus, $P_{0.98,\ y}$ = the nth largest value.

TABLE 1

Annual creditable number of samples for year "y" (cn_y)	$P_{0.98,\ y}$ is the nth maximum value of the year, where n is the listed number
1–50	1
51–100	2
101–150	3
151–200	4
201–250	5
251–300	6
301–350	7
351–366	8

(2) Formula for computing annual 98th percentile values when sampling frequencies are seasonal.

Procedure: Calculate the annual 98th percentiles by determining the smallest measured concentration, x, that makes W(x) greater than 0.98 using equation 5 of this appendix:

Equation 5

$$W(x) = \frac{d_{High}}{d_{High} + d_{Low}} F_{High}(x) + \frac{d_{Low}}{d_{High} + d_{Low}} F_{Low}(x)$$

Where:

d_{High} = number of calendar days in the ''High'' season;

d_{Low} = number of calendar days in the ''Low'' season;

$d_{High} + d_{Low}$ = days in a year; and

$$F_a(x) = \frac{\text{number of daily values in season a that are } \leq \times}{\text{number of daily values in season a}}$$

Such that ''a'' can be either ''High'' or ''Low''; ''x'' is the measured concentration; and ''$d_{High}/(d_{High} + d_{Low})$ and $d_{Low}/(d_{High} + d_{Low})$'' are constant and are called seasonal ''weights.''

(b) The 24-hour standard design value is then calculated by averaging the annual 98th percentiles using equation 6 of this appendix:

Equation 6

$$P_{0.98} = \frac{\sum_{y=1}^{3} P_{0.98,\,y}}{3}$$

(c) The 24-hour standard design value (3-year average 98th percentile) is rounded according to the conventions in section 4.3 of this appendix before a comparison with the standard is made.

[71 FR 61227, Oct. 17, 2006, as amended at 73 FR 1502, Jan. 9, 2008]

APPENDIX O TO PART 50—REFERENCE METHOD FOR THE DETERMINATION OF COARSE PARTICULATE MATTER AS $PM_{10-2.5}$ IN THE ATMOSPHERE

1.0 Applicability and Definition

1.1 This method provides for the measurement of the mass concentration of coarse particulate matter ($PM_{10-2.5}$) in ambient air over a 24-hour period. In conjunction with additional analysis, this method may be used to develop speciated data.

1.2 For the purpose of this method, $PM_{10-2.5}$ is defined as particulate matter having an aerodynamic diameter in the nominal range of 2.5 to 10 micrometers, inclusive.

1.3 For this reference method, $PM_{10-2.5}$ concentrations shall be measured as the arithmetic difference between separate but concurrent, collocated measurements of PM_{10} and $PM_{2.5}$, where the PM_{10} measurements are obtained with a specially approved sampler, identified as a ''PM_{10c} sampler,'' that meets more demanding performance requirements than conventional PM_{10} samplers described in appendix J of this part. Measurements obtained with a PM_{10c} sampler are identified as ''PM_{10c} measurements'' to distinguish them from conventional PM_{10} measurements obtained with conventional PM_{10} samplers. Thus, $PM_{10-2.5} = PM_{10c} - PM_{2.5}$.

1.4 The PM_{10c} and $PM_{2.5}$ gravimetric measurement processes are considered to be nondestructive, and the PM_{10c} and $PM_{2.5}$ samples obtained in the $PM_{10-2.5}$ measurement process can be subjected to subsequent physical or chemical analyses.

1.5 Quality assessment procedures are provided in part 58, appendix A of this chapter. The quality assurance procedures and guidance provided in reference 1 in section 13 of this appendix, although written specifically for $PM_{2.5}$, are generally applicable for PM_{10c}, and, hence, $PM_{10-2.5}$ measurements under this method, as well.

1.6 A method based on specific model PM_{10c} and $PM_{2.5}$ samplers will be considered a reference method for purposes of part 58 of this chapter only if:

(a) The PM_{10c} and $PM_{2.5}$ samplers and the associated operational procedures meet the requirements specified in this appendix and all applicable requirements in part 53 of this chapter, and

(b) The method based on the specific samplers and associated operational procedures have been designated as a reference method in accordance with part 53 of this chapter.

1.7 $PM_{10-2.5}$ methods based on samplers that meet nearly all specifications set forth in this method but have one or more significant but minor deviations or modifications from those specifications may be designated as ''Class I'' equivalent methods for $PM_{10-2.5}$ in accordance with part 53 of this chapter.

1.8 $PM_{2.5}$ measurements obtained incidental to the $PM_{10-2.5}$ measurements by this method shall be considered to have been obtained with a reference method for $PM_{2.5}$ in accordance with appendix L of this part.

1.9 PM_{10c} measurements obtained incidental to the $PM_{10-2.5}$ measurements by this method shall be considered to have been obtained with a reference method for PM_{10} in accordance with appendix J of this part, provided that:

(a) The PM_{10c} measurements are adjusted to EPA reference conditions (25 °C and 760 millimeters of mercury), and

(b) Such PM_{10c} measurements are appropriately identified to differentiate them from PM_{10} measurements obtained with other (conventional) methods for PM_{10} designated in accordance with part 53 of this