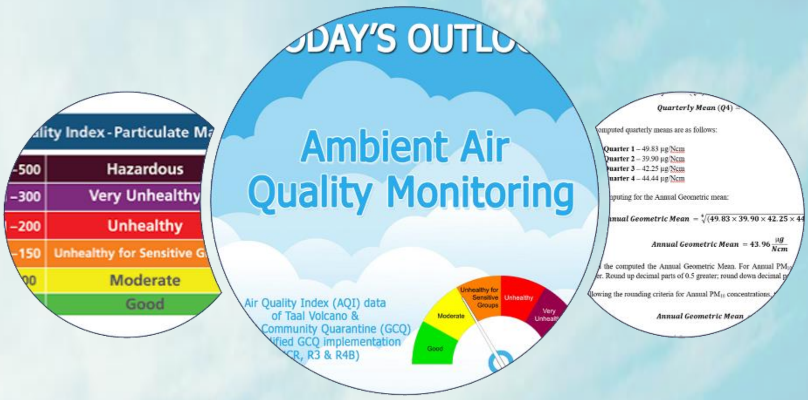
PROCEDURAL MANUAL ON DATA HANDLING PROTOCOL FOR CRITERIA AIR POLLUTANTS



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Guideline on Data Handling Conventions for the Criteria Pollutants National Ambient Air Quality Guideline Values (NAAQGV)

This guideline provides information for the DENR Environmental Management Bureau (EMB) on the proper procedures in determining whether a certain air quality monitoring station is meeting the guideline values set for in the Philippine Clean Air Act and its Implementing Rules and Regulations (IRR). It clarifies requirements for data handling and completeness. It tells you how to handle missing data, different sampling frequencies, and calculating spatial averages for criteria air pollutants.

How is this guideline presented and organized?

This guideline is organized in a question-and-answer format. Questions are sorted by topic into chapters:

- Chapter 1: Comparing Your Data to the National Ambient Air Quality Guideline Values (NAAQGVs)
- Chapter 2: Data Capture Requirements
- Chapter 3: Required Sampling Frequency
- Chapter 4: Determination of Airsheds as Attainment or Non-Attainment Area
- Chapter 5: Conversion of Concentration Values to AQI Values

Chapter 1: Comparing your data to the National Ambient Air Quality Guideline Values

Pursuant to Section 12 of the Republic Act (RA) 8740, the set of National Ambient Air Quality Guideline Values (NAAQGVs) shall be complied to protect public health safety and welfare.

1.1. Criteria for determining compliance with the National Air Quality Guideline Values

Pollutants	1-hour 98th Percentile	8-hour 98th Percentile	24-Hour 98th Percentile	Annual Guideline Value	Remarks
TSP, PM_{10} and $PM_{2.5}$			✓	✓	1. 24-Hour Maximum limits represented by ninety-eight percentile (98%) values not to exceed more than once a year. 2. Annual Geometric mean shall not exceed the Annual Guideline Value
SO_2			✓	✓	1. 24-Hour Maximum limits represented by ninety-eight percentile (98%) values not to exceed more than once a year. 2. Annual Arithmetic mean shall not exceed the Annual Guideline Value
NO_2			✓		1. 24-Hour Maximum limits represented by ninety-eight percentile (98%) values not to exceed more than once a year.
O_3 and CO	✓	✓			1. 1-Hour and 8-Hour Maximum limits represented by ninety-eight percentile (98%) values not to exceed more than once a year.

Note:

(1) Total Suspended Particulates (TSP); (2) Particulate Matter 10 (PM_{10}); (3) Particulate Matter 2.5 ($PM_{2.5}$); (4) Sulfur Dioxide (SO_2); (5) Nitrogen Dioxide (NO_2); (6) Ozone (O_3); (7) Carbon Monoxide (CO)

1.2. How do I round my numbers? How many decimal places do I keep?

- If you're doing an initial calculation with 24-hour average $PM_{2.5}$ concentrations, such as entering 24-hour averages into a computer program, use one decimal place. Truncate any extra digits.

  Example: **10.314 µg/Ncm** truncates to **10.3 µg/Ncm**
  10.37 µg/Ncm truncates to **10.3 µg/Ncm**

- If you're doing an initial calculation with 24-hour average PM_{10} concentrations, such as entering 24-hour averages into a computer program, use the integer part. Truncate any decimal parts.

  Example: **45.29 µg/Ncm** truncates to **45 µg/Ncm**
  45.816 µg/Ncm truncates to **45 µg/Ncm**

- If you're comparing a result to a guideline value which includes deciding whether to use incomplete data (less than 75 % data capture rate) with high concentrations, round as follows:

  ✓ Annual $PM_{2.5}$: Round to the nearest 0.1 µg/Ncm. Round decimals 0.05 or greater up and those less than 0.05 down.

  Example: 25.049 rounds to **25.0** µg/Ncm (not above the Guideline Value)
  25.05 rounds to **25.1** µg/Ncm (above the Guideline Value)

  ✓ 3 – year average $PM_{2.5}$: Round to the nearest 0.1 µg/Ncm. Round decimals 0.05 or greater up and those less than 0.05 down.

  Example: 25.031 rounds to **25.0** µg/Ncm (not above the Guideline Value)
  25.07 rounds to **25.1** µg/Ncm (above the Guideline Value)

  ✓ 24-Hour $PM_{2.5}$: Round to the nearest 1 µg/Ncm. Round decimals 0.5 or greater up and those less than 0.5 down.

  Example: 35.49 rounds to **35** µg/Ncm (not above the Guideline Value)
  35.5 rounds to **36** µg/Ncm (above the Guideline Value)

  ✓ Annual PM_{10}: Round to the nearest 1 µg/Ncm. Round decimals 0.5 or greater up and those less than 0.5 down.

  Example: 60.486 rounds to **60** µg/Ncm (not above the Guideline Value)
  60.51 rounds to **61** µg/Ncm (above the Guideline Value)

  ✓ 3 – year average PM_{10}: Round to the nearest 1 µg/Ncm. Round decimals 0.5 or greater up and those less than 0.5 down.

Example: 60.492 rounds to **60** µg/Ncm (not above the Guideline Value)
60.53 rounds to **61** µg/Ncm (above the Guideline Value)

- ✓ 24-Hour PM_{10}: Round to the nearest 10 µg/Ncm. Round integers of 5 or greater up and those less than 5 down.

  Example: 154.893 rounds to **150** µg/Ncm (not above the Guideline Value)
  155.51 rounds to **160** µg/Ncm (above the Guideline Value)

- ✓ Annual TSP: Round to the nearest 1 µg/Ncm. Round decimals 0.5 or greater up and those less than 0.5 down.

  Example: 90.486 rounds to **90** µg/Ncm (not above the Guideline Value)
  90.51 rounds to **91** µg/Ncm (above the Guideline Value)

- ✓ 3 – year average TSP: Round to the nearest 1 µg/Ncm. Round decimals 0.5 or greater up and those less than 0.5 down.

  Example: 90.492 rounds to **90** µg/Ncm (not above the Guideline Value)
  90.53 rounds to **91** µg/Ncm (above the Guideline Value)

- ✓ 24-Hour TSP: Round to the nearest 10 µg/Ncm. Round integers of 5 or greater up and those less than 5 down.

  Example: 234.893 rounds to **230** µg/Ncm (not above the Guideline Value)
  235.51 rounds to **240** µg/Ncm (above the Guideline Value)

- ✓ Annual SO_2: Round to the nearest 1 µg/Ncm. Round decimals 0.5 or greater up and those less than 0.5 down.

  Example: 80.486 rounds to **80** µg/Ncm (not above the Guideline Value)
  80.51 rounds to **81** µg/Ncm (above the Guideline Value)

- ✓ 24-Hour SO_2: Round to the nearest 10 µg/Ncm. Round integers of 5 or greater up and those less than 5 down.

  Example: 184.893 rounds to **180** µg/Ncm (not above the Guideline Value)
  185.51 rounds to **190** µg/Ncm (above the Guideline Value)

1.3. How do I compute for the Annual Geometric Mean of Particulates (TSP, PM_{10}, $PM_{2.5}$) for Manual and Continuous Monitoring?

Pursuant to footnotes in Table 1, Section 1, Rule VII, Part II of DENR Administrative Order (DAO) 2000-81 or the Implementing Rules and Regulations (IRR) of the Republic Act (RA) 8749 of the Philippines and DAO 2020-14, Annual mean of TSP, PM_{10} and $PM_{2.5}$ shall be calculated using the formula of Geometric Mean.

The annual geometric mean of TSP, PM_{10} and $PM_{2.5}$ refers to the average of four (4) quarters represented by the geometric mean of three (3) months.

Calculate the annual average of geometric mean from the four-quarterly means by using the formula below:

$$\textbf{Annual Average of Geometric Mean} = \frac{X_1 + X_2 + X_3 + X_4}{4}$$

$Where$:

$$X_{(1,2,3,4)} - Quarterly\ Average\ Measurements\ represented\ by\ the\ geometric\ mean\ of\ three\ (3)\ months\ \left(\frac{\mu g}{Ncm}\right)$$

Calculate the monthly geometric mean using the formula below:

$$\textbf{Monthly Geometric Mean} = \sqrt[m]{(X_1 \times X_2 \times X_3 \times \ldots \times X_n)}$$

$Where$:

$$m - Number\ of\ 24\ Hour\ Concentration\ Measurements\ in\ a\ month$$
$$X_n - 24 - Hour\ Concentration\ Measurements\ in\ a\ month\ \left(\frac{\mu g}{Ncm}\right)$$

1.3.1. Manual Monitoring for Particulates (TSP, PM_{10} and $PM_{2.5}$)

For manual sampling, which is conducted once every six (6) days, it is expected to have 4-5 sampling periods per month. Months having 28-29 days should have four (4) complete sampling periods and months having 30-31 days should have five (5) complete sampling periods.

The minimum number of required sampling periods are as follows:

1. Daily data capture requirement, the minimum sampling hours in a day is eighteen (18) hours which is equivalent to 75% of twenty-four (24) hours.
2. For months having 28-29 days, the minimum number of samples shall be three (3), which is equivalent to 75% of four (4) sampling periods.
3. For months having 30-31 days, the minimum number of samples shall be four (4), which is equivalent to 75% of five (5) sampling periods.

Example:

Suppose we have five (5) PM_{10} concentrations for the month of January. Following the manual sampling frequency of "once every six (6) days", the concentrations are as follows:

January	**Concentration (µg/Ncm)**
01	47
07	45
13	50
19	45
25	52

Computing for the monthly geometric mean concentration of PM_{10} for the month of January:

$$\textbf{\textit{Geometric Mean (January)}} = \sqrt[5]{(\mathbf{47 \times 45 \times 50 \times 45 \times 52})}\,\frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\textbf{\textit{Geometric Mean (January)}} = \mathbf{47.72}\,\frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

The PM_{10} geometric mean for the month of January is **47.72 µg/Ncm**.

To compute for the quarterly mean, suppose we have the PM_{10} geometric mean (in µg/Ncm) for each month from February to December.

Quarter 1		**Quarter 2**		**Quarter 3**		**Quarter 4**	
January	47.72	**April**	39.98	**July**	43.56	**October**	46.54
February	45.23	**May**	41.95	**August**	41.76	**November**	43.91
March	56.47	**June**	37.76	**September**	41.42	**December**	42.87
Average	49.77	**Average**	39.90	**Average**	39.90	**Average**	44.44

Computing for the quarterly mean of each quarter:

$$\textbf{\textit{Quarterly Mean}}\ (\boldsymbol{Q1}) = \frac{\mathbf{47.72 + 45.23 + 56.47}}{\mathbf{3}}\,\frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\textbf{\textit{Quarterly Mean}}\ (\boldsymbol{Q1}) = \mathbf{49.80}\,\frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\textbf{\textit{Quarterly Mean}}\ (\boldsymbol{Q2}) = \frac{\mathbf{39.98 + 41.95 + 37.76}}{\mathbf{3}}\,\frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\textbf{\textit{Quarterly Mean}}\ (\boldsymbol{Q2}) = \mathbf{39.90}\,\frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\textbf{\textit{Quarterly Mean}}\ (\boldsymbol{Q3}) = \frac{\mathbf{43.56 + 41.76 + 41.42}}{\mathbf{3}}\,\frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\textbf{\textit{Quarterly Mean}}\ (\boldsymbol{Q3}) = \mathbf{42.25}\,\frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\textbf{\textit{Quarterly Mean}}\ (\boldsymbol{Q4}) = \frac{\mathbf{46.54 + 43.91 + 42.87}}{\mathbf{3}}\,\frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\textbf{\textit{Quarterly Mean}}\ (\boldsymbol{Q4}) = \mathbf{44.44}\,\frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

The computed quarterly average represented by the geometric mean of three (3) months each quarter are as follows:

- **Quarter 1 –** 49.80 µg/Ncm
- **Quarter 2 –** 39.90 µg/Ncm
- **Quarter 3 –** 42.25 µg/Ncm
- **Quarter 4 –** 44.44 µg/Ncm

Then, computing for the Annual Average of Geometric mean:

$$\text{Annual Average of Geometric Mean} = \frac{(\mathbf{49.80 + 39.90 + 42.25 + 44.44})}{\mathbf{4}} \frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\boldsymbol{Annual\ Average\ of\ Geometric\ Mean} = \mathbf{44.10} \frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

Round the computed Annual Average Geometric Mean. For Annual PM_{10}, round to the nearest integer. Round up decimal parts of 0.5 greater; round down decimal parts less than 0.5.

Following the rounding criteria for Annual PM_{10} concentrations, the Annual Geometric Mean is:

$$\boldsymbol{Annual\ Geometric\ Mean} = \mathbf{44} \frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

After computing for the Annual Geometric Mean, compare your result to the guideline value for PM_{10}. The guideline value for PM_{10} with an averaging period of 1 year is 60 µg/Ncm. Since 44 µg/ncm is less than 60 µg/Ncm. This means that the result meets the annual guideline value of 60 µg/Ncm for PM_{10}.

1.3.2. Continuous Monitoring for TSP, PM_{10} and $PM_{2.5}$

For continuous monitoring, there are 28-31 daily (24-hour) average concentrations per month (varies depending on the number of days in a month).

The minimum number of required sampling periods are as follows:

1. Daily data capture requirement, the minimum sampling hours in a day is eighteen (18) hours which is equivalent to 75% of twenty-four (24) hours.
2. For months having 28 days, the minimum number of samples shall be twenty-one (21), which is equivalent to 75% of twenty-eight (28) sampling periods.
3. For months having 29 days, the minimum number of samples shall be twenty-two (22), which is equivalent to 75% of twenty-nine (29) sampling periods.
4. For months having 30 days, the minimum number of samples shall be twenty-three (23), which is equivalent to 75% of thirty (30) sampling periods.
5. For months having 31 days, the minimum number of samples shall be twenty-four (24), which is equivalent to 75% of thirty-one (31) sampling periods.

Example:

Suppose we have twenty-four (24) daily PM_{10} concentrations (in µg/Ncm) for the month of January which has 31 days:

Date	Concentration (µg/Ncm)	Date	Concentration (µg/Ncm)
January 01	56	**January 17**	42
January 02	61	**January 18**	52
January 03	43	**January 19**	37
January 04	58	**January 20**	48
January 05	66	**January 21**	50
January 06	41	**January 22**	52
January 07	29	**January 23**	59
January 08	45	**January 24**	60
January 09	35	**January 25**	No Data
January 10	36	**January 26**	No Data
January 11	65	**January 27**	No Data
January 12	44	**January 28**	No Data
January 13	32	**January 29**	No Data
January 14	54	**January 30**	No Data
January 15	31	**January 31**	No Data
January 16	57		

Computing for the monthly geometric mean concentration of PM_{10} for the month of January:

$$\boldsymbol{Geometric\ Mean\ (January)} = \sqrt[24]{\begin{pmatrix} \mathbf{56 \times 61 \times 43 \times 58 \times 66 \times 41 \times 29 \times 45 \times 35 \times 36 \times 65 \times 44 \times 32 \times 54 \times 31 \times} \\ \mathbf{57 \times 42 \times 52 \times 37 \times 48 \times 50 \times 52 \times 59 \times 60} \end{pmatrix}} \frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\boldsymbol{Geometric\ Mean\ (January) = 46.74} \frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

The PM_{10} geometric mean for the month of January is **46.74 µg/Ncm**. To compute for the quarterly mean, suppose we have the PM_{10} geometric mean (in µg/Ncm) for each month from February to December.

The $PM_{2.5}$ monthly geometric mean are as follows:

Quarter 1		Quarter 2		Quarter 3		Quarter 4	
January	46.74	**April**	36.81	**July**	43.01	**October**	42.56
February	47.23	**May**	39.31	**August**	44.87	**November**	43.76
March	46.34	**June**	41.52	**September**	50.62	**December**	47.77
Average	47.20	**Average**	39.21	**Average**	46.17	**Average**	44.70

Computing for the quarterly mean of each quarter:

$$\boldsymbol{Quarterly\ Mean\ (Q1)} = \frac{\mathbf{46.74 + 47.23 + 46.34}}{\mathbf{3}} \frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q1) = 46.77\ \frac{\mu g}{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q2) = \frac{36.81 + 39.31 + 41.52}{3} \frac{\mu g}{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q2) = 39.21\ \frac{\mu g}{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q3) = \frac{43.01 + 44.87 + 50.62}{3} \frac{\mu g}{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q3) = 46.17\ \frac{\mu g}{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q4) = \frac{42.56 + 43.76 + 47.77}{3} \frac{\mu g}{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q4) = 44.70\ \frac{\mu g}{Ncm}}$$

The computed quarterly average represented by the geometric mean of three (3) months each quarter are as follows:

- **Quarter 1** – 46.77 µg/Ncm
- **Quarter 2** – 39.21 µg/Ncm
- **Quarter 3** – 46.17 µg/Ncm
- **Quarter 4** – 44.70 µg/Ncm

Then, computing for the Annual Average of Geometric mean:

$$\text{Annual Average of Geometric Mean} = \frac{\boldsymbol{(46.77 + 39.21 + 46.17 + 44.70)}}{\boldsymbol{4}} \boldsymbol{\frac{\mu g}{Ncm}}$$

$$\text{Annual Average of Geometric Mean} = \boldsymbol{44.21 \frac{\mu g}{Ncm}}$$

Round the computed the Annual Average Geometric Mean. For Annual TSP, round to the nearest integer. Round up decimal parts of 0.5 greater; round down decimal parts less than 0.5.

Following the rounding criteria for Annual PM_{10} concentrations, the Annual Geometric Mean is:

$$\boldsymbol{Annual\ Geometric\ Mean\ = 44\ \frac{\mu g}{Ncm}}$$

After computing for the Annual Geometric Mean, compare your result to the guideline value for PM_{10}. The guideline value for PM_{10} with an averaging period of 1 year is 60 µg/Ncm. Since

44 µg/ncm is less than 60 µg/Ncm. This means that the result meets the annual guideline value of 60 µg/Ncm for PM_{10}.

1.4. How do I compute for the Annual Arithmetic Mean of SO_2 for Manual and Continuous Monitoring?

Pursuant to footnotes in Table 1, Section 1, Rule VII, Part II of DENR Administrative Order (DAO) 2000-81 or the Implementing Rules and Regulations (IRR) of the Republic Act (RA) 8749 of the Philippines, Annual mean of SO_2 shall be calculated using the formula of Arithmetic Mean.

Calculate the annual arithmetic mean from the four-quarterly means by using the formula below:

$$\textbf{Annual Arithmetic Mean} = \frac{X_1 + X_2 + X_3 + X_4}{4}$$

Where:

$$X_{(1,2,3,4)} - Quarterly\ Measurements\ \left(\frac{\mu g}{Ncm}\right)$$

1.4.1. Manual Monitoring for SO_2

For manual sampling, which is conducted once every six (6) days, it is expected to have 4-5 sampling periods per month. Months having 28-29 days should have four (4) sampling periods and months having 30-31 days should have five (5) sampling periods.

The minimum required number of measurements are as follows:

1. Daily data capture requirement, the minimum sampling hours in a day is eighteen (18) hours which is equivalent to 75% of twenty-four (24) hours.
2. For months having 28-29 days, the minimum number of samples shall be three (3), which is equivalent to 75% of four (4) sampling periods.
3. For months having 30-31 days, the minimum number of samples shall be four (4), which is equivalent to 75% of five (5) sampling periods.

Example:

Suppose we have five (5) daily SO_2 concentrations for the month of January. Following the manual sampling frequency of “once every six (6) days”, the concentrations are as follows:

January	Concentration (µg/Ncm)
01	56.57
07	43.21
13	33.98

19	55.54
25	35.68

Computing for the average SO_2 concentration for the month of January:

$$\boldsymbol{Average\ Concentration\ (January)} = \frac{\mathbf{56.57 + 43.21 + 33.98 + 55.54 + 35.68}}{\mathbf{5}} \frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\boldsymbol{Average\ Concentration\ (January)} = \mathbf{45.00} \frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

The average SO_2 concentration for the month of January is **45.00 µg/Ncm**. To compute for the quarterly mean, suppose we have the average SO_2 concentrations (in µg/Ncm) for each month from February to December.

The average SO_2 concentrations are as follows:

Quarter 1		Quarter 2		Quarter 3		Quarter 4	
January	45.00	**April**	23.45	**July**	54.34	**October**	43.96
February	45.23	**May**	43.34	**August**	50.21	**November**	42.76
March	56.47	**June**	37.54	**September**	49.34	**December**	48.68
Average	48.90	**Average**	34.78	**Average**	51.30	**Average**	45.13

Computing for the quarterly mean of each quarter:

$$\boldsymbol{Quarterly\ Mean\ (Q1)} = \frac{\mathbf{45.00 + 45.23 + 56.47}}{\mathbf{3}} \frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q1)} = \mathbf{48.90} \frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q2)} = \frac{\mathbf{23.45 + 43.34 + 37.54}}{\mathbf{3}} \frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q2)} = \mathbf{34.78} \frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q3)} = \frac{\mathbf{54.34 + 50.21 + 49.34}}{\mathbf{3}} \frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q3)} = \mathbf{51.30} \frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q4)} = \frac{\mathbf{43.96 + 42.76 + 48.68}}{\mathbf{3}} \frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q4)} = \mathbf{45.13} \frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

The computed quarterly means are as follows:

- **Quarter 1 –** 48.90 µg/Ncm
- **Quarter 2 –** 34.78 µg/Ncm
- **Quarter 3 –** 51.30 µg/Ncm
- **Quarter 4 –** 45.13 µg/Ncm

Then, computing for the Annual Arithmetic mean:

$$\boldsymbol{Annual\ Arithmetic\ Mean}\ = \frac{(\mathbf{48.90+34.78+51.30+45.13})}{\mathbf{4}}\frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\boldsymbol{Annual\ Arithmetic\ Mean}\ = \mathbf{45.03}\frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

Round the computed the Annual Arithmetic Mean. For Annual SO_2 round to the nearest integer. Round up decimal parts of 0.5 greater; round down decimal parts less than 0.5.

Following the rounding criteria for Annual SO_2 concentrations, the Annual Arithmetic Mean is:

$$\boldsymbol{Annual\ Arithmetic\ Mean}\ = \mathbf{45}\ \frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

After computing for the Annual Arithmetic Mean, compare your result to the guideline value for SO_2. The guideline value for SO_2 with an averaging period of 1 year is 80 µg/Ncm. Since 45 µg/ncm is less than 80 µg/Ncm. This means that the result meets the annual guideline value of 80 µg/Ncm for SO_2.

1.4.2. Continuous Monitoring for SO_2

For continuous monitoring, there are 28-31 daily (24-hour) average concentrations per month (varies depending on the number of days in a month).

The minimum required number of measurements are as follows:

1. Daily data capture requirement, the minimum sampling hours in a day is eighteen (18) hours which is equivalent to 75% of twenty-four (24) hours.
2. For months having 28 days, the minimum number of samples shall be twenty-one (21), which is equivalent to 75% of twenty-eight (28) sampling periods.
3. For months having 29 days, the minimum number of samples shall be twenty-two (22), which is equivalent to 75% of twenty-nine (29) sampling periods.

4. For months having 30 days, the minimum number of samples shall be twenty-three (23), which is equivalent to 75% of thirty (30) sampling periods.
5. For months having 31 days, the minimum number of samples shall be twenty-four (24), which is equivalent to 75% of thirty-one (31) sampling periods.

Example:

Suppose we have twenty-seven (27) daily SO_2 concentrations (in μg/Ncm) for the month of January which has 31 days:

Date	Concentration (μg/Ncm)	Date	Concentration (μg/Ncm)
January 01	56	**January 17**	42
January 02	61	**January 18**	52
January 03	43	**January 19**	37
January 04	58	**January 20**	48
January 05	66	**January 21**	50
January 06	41	**January 22**	52
January 07	29	**January 23**	59
January 08	45	**January 24**	60
January 09	35	**January 25**	31
January 10	36	**January 26**	34
January 11	65	**January 27**	45
January 12	44	**January 28**	No Data
January 13	32	**January 29**	No Data
January 14	54	**January 30**	No Data
January 15	31	**January 31**	No Data
January 16	57		

Computing for the average SO_2 concentration for the month of January:

$$\boldsymbol{Average\ Concentration\ (January)} \\ = \boldsymbol{(56+61+43+58+66+41+29+45+35+36+65+44+32+54+31} \\ \boldsymbol{+57+42+52+37+48+50+52+59+60+31+34} \\ \boldsymbol{+45)/27\ \frac{\mu g}{Ncm}}$$

$$\boldsymbol{Average\ Concentration\ (January) = 46.78\frac{\mu g}{Ncm}}$$

The average SO_2 concentration for the month of January is **46.78 μg/Ncm**.

To compute for the quarterly mean, suppose we have the average SO_2 concentrations (in μg/Ncm) for each month from February to December.

The average SO_2 concentrations are as follows:

Quarter 1		Quarter 2		Quarter 3		Quarter 4	
January	46.77	**April**	59.21	**July**	44.21	**October**	47.31
February	46.12	**May**	35.24	**August**	47.31	**November**	42.67
March	49.32	**June**	46.67	**September**	51.86	**December**	49.23
Average	47.40	**Average**	47.04	**Average**	47.79	**Average**	46.40

Computing for the quarterly mean of each quarter:

$$\boldsymbol{Quarterly\ Mean\ (Q1) = \frac{46.77 + 46.12 + 49.32}{3} \frac{\mu g}{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q1) = 47.40\ \frac{\mu g}{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q2) = \frac{59.21 + 35.24 + 46.67}{3} \frac{\mu g}{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q2) = 47.04\ \frac{\mu g}{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q3) = \frac{44.21 + 47.31 + 51.86}{3} \frac{\mu g}{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q3) = 47.79\ \frac{\mu g}{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q4) = \frac{47.31 + 42.67 + 49.23}{3} \frac{\mu g}{Ncm}}$$

$$\boldsymbol{Quarterly\ Mean\ (Q4) = 46.40\ \frac{\mu g}{Ncm}}$$

The computed quarterly means are as follows:

- **Quarter 1** – 47.40 µg/Ncm
- **Quarter 2** – 47.04 µg/Ncm
- **Quarter 3** – 47.79 µg/Ncm
- **Quarter 4** – 46.40 µg/Ncm

Then, computing for the Annual Arithmetic mean:

$$\boldsymbol{Annual\ Arithmetic\ Mean\ = \frac{47.40 + 47.04 + 47.79 + 46.40}{4} \frac{\mu g}{Ncm}}$$

$$\boldsymbol{Annual\ Arithmetic\ Mean\ = 47.16 \frac{\mu g}{Ncm}}$$

Round the computed Annual Arithmetic Mean of SO_2, round to the nearest integer. Round up decimal parts of 0.5 greater; round down decimal parts less than 0.5.

Following the rounding criteria for Annual SO_2, the Annual Arithmetic Mean is:

$$\textit{Annual Arithmetic Mean} = 47\,\frac{\mu g}{Ncm}$$

After computing for the Annual Arithmetic Mean, compare your result to the guideline value for SO_2. The guideline value for SO_2 with an averaging period of 1 year is 80 µg/Ncm. Since 47 µg/ncm is less than 80 µg/Ncm. This means that the result meets the annual guideline value of 80 µg/Ncm for SO_2.

1.5. How do I compute the 24-Hour 98th percentile for TSP, PM_{10}, $PM_{2.5}$, NO_2 and SO_2?

1.5.1. Manual Sampling for Particulates (TSP, PM_{10}, $PM_{2.5}$) and SO_2

In-order to compute for the 98th Percentile *Chapter 2.1.* shall be complied.

Example:

Suppose we have forty-seven (47) PM_{10} samples which is equivalent to 78% *(each month complied with the minimum 75% data capture requirement)* of sixty (60) sampling periods during Calendar Year 2020:

Following the manual sampling frequency of "once every six days". The sampling measurements are as follows:

No. of Samples	Concentration (µg/Ncm)	No. of Samples	Concentration (µg/Ncm)
1	32.12	**31**	69.76
2	45.31	**32**	54.32
3	56.83	**33**	46.66
4	23.46	**34**	47.76
5	33.98	**35**	43.76
6	45.23	**36**	31.86
7	56.23	**37**	37.78
8	34.51	**38**	38.86
9	56.43	**39**	36.64
10	65.67	**40**	43.87
11	32.40	**41**	54.59
12	45.43	**42**	23.56
13	27.23	**43**	24.56
14	49.76	**44**	32.10
15	50.32	**45**	25.67
16	45.67	**46**	30.13
17	76.43	**47**	23.56

18	59.76
19	43.86
20	58.34
21	43.56
22	43.56
23	54.41
24	60.32
25	43.54
26	54.21
27	27.86
28	52.01
29	34.97
30	60.43

Sort all data values collected from lowest to highest according to the sampling measurements:

Rank	Concentration (μg/Ncm)	Rank	Concentration (μg/Ncm)
1	23.46	**31**	49.76
2	23.56	**32**	50.32
3	23.56	**33**	52.01
4	24.56	**34**	54.21
5	25.67	**35**	54.32
6	27.23	**36**	54.41
7	27.86	**37**	54.59
8	30.13	**38**	56.23
9	31.86	**39**	56.43
10	32.1	**40**	56.83
11	32.12	**41**	58.34
12	32.4	**42**	59.76
13	33.98	**43**	60.32
14	34.51	**44**	60.43
15	34.97	**45**	65.67
16	36.64	**46**	69.76
17	37.78	**47**	76.43
18	38.86		
19	43.54		
20	43.56		
21	43.56		
22	43.76		
23	43.86		
24	43.87		
25	45.23		
26	45.31		
27	45.43		
28	45.67		
29	46.66		
30	47.76		

To calculate for the rank of the 98th percentile value, multiply the number of samples taken in a year by 0.98.

$$\boldsymbol{Number\ of\ Samples\ x\ 0.98 = 47\ x\ 0.98}$$

$$\boldsymbol{Product} = 46.06$$

After multiplying the number of samples, take the integer part of the product and add 1. This step gives you the ranking that corresponds to the 98th percentile:

$$\boldsymbol{Rank = 46 + 1}$$

$$\boldsymbol{Rank = 47}$$

Therefore, the 98th percentile is rank **47**. Rank 47 corresponds to **76.43 µg/Ncm**.

$$\boldsymbol{98th\ Percentile} = \textbf{76.43 µg/Ncm}$$

98th Percentile is below the PM10 24-Hour Guideline Value of 150 ug/Ncm

1.5.2 Continuous Monitoring for Particulates (TSP, PM10 and PM2.5) and SO2

In-order to compute for the 98th Percentile *Chapter 2.1.* shall be complied.

Example:

Suppose we completed monitoring 366 PM_{10} measurements during Calendar Year 2019.
The CY2019 continuous monitoring measurements for PM_{10} are as follows:

Day	Concentration (µg/Ncm)
1	87
2	85
3	90
.	.
.	.
.	.
357	84
358	78
359	93
.	.
.	.
.	.
364	75
365	86
366	54

Sort all data values collected from lowest to highest according to the monitored concentrations:

Rank	Concentration (µg/Ncm)
1	54
2	75
3	78
.	.
.	.
.	.
357	84
358	85
359	86
.	.
.	.
.	.
364	87
365	90
366	93

To calculate for the rank of the 98th percentile, multiply number of samples taken in a year by 0.98.

$$\boldsymbol{Number\ of\ Samples\ x\ 0.98\ = 366\ x\ 0.98}$$
$$\boldsymbol{Product\ = 358.68}$$

After multiplying the number of samples by 0.98, take the integer part of the product and add 1. This step gives you the ranking that corresponds to the 98th percentile:

$$\boldsymbol{Rank\ = 358 + 1}$$

$$\boldsymbol{Rank\ = 359}$$

Therefore, the 98th percentile is rank **359**. Rank 359 corresponds to **86 µg/Ncm**.

$$\boldsymbol{98th\ Percentile\ = 86\ \frac{\mu g}{Ncm}}$$

98th Percentile is below the PM10 24-Hour Guideline Value of 150 ug/Ncm

1.6. How do I compute the 1-Hour 98th Percentile for Continuous CO and O_3?

In-order to compute for the 98th Percentile *Chapter 2.1.* shall be complied.

For continuous monitoring, there are 8760 - 8784 1-hour average concentration values in a year (varies depending if the year being monitored is or is not a leap year).

The minimum required number of measurements are as follows:

1. For years having 8,760 hours, the minimum number of hours with samples shall be 6,570.
2. For years having 8,784 hours, the minimum number of hours with samples shall be 6,588.

Example:

Suppose we have 7751 1-Hour rolling continuous monitoring O_3 measurements during Calendar Year 2017.

The CY2017 continuous monitoring measurements for O_3 are as follows are as follows:

Hourly Data	**Concentration (µg/Ncm)**
1	65
2	95
3	75
.	.
.	.
.	.
6467	No Data
6468	57
6469	94
.	.
.	.
.	.
6598	91
6599	No Data
6600	83
.	.
.	.
.	.
8759	87
8760	No Data

Sort all data values collected from lowest to highest according to the sampling measurements:

Rank	**Concentration (µg/Ncm)**
1	57
2	65
3	75
.	.
.	.
.	.
7596	83
7597	87
7598	91
.	.
.	.
.	.
7749	91
7750	94

7751	95

To calculate for the rank of the 98th percentile value, multiply number of samples taken in a year by 0.98.

$$\boldsymbol{Number\ of\ Samples\ x\ 0.98\ = 7751\ x\ 0.98}$$

$$\boldsymbol{Product\ = 7595.98}$$

After multiplying the number of samples, take the integer part of the product and add 1. This step gives you the ranking that corresponds to the 98th percentile:

$$\boldsymbol{Rank\ = 7595 + 1}$$

$$\boldsymbol{Rank\ = 7596}$$

Therefore, the 98th percentile is rank **7596**. Rank 7596 corresponds to **83 µg/Ncm**.

$$\boldsymbol{98th\ Percentile\ = 83\ \frac{\mu g}{Ncm}}$$

98th Percentile is below the O3 1-Hour Guideline Value of 140 ug/Ncm

1.7. How do I compute the 8-Hour 98th Percentile for Continuous CO and O_3?

In-order to compute for the 98th Percentile *Chapter 2.1.* shall be complied.

For continuous monitoring, there are 8760 - 8784 8-hour rolling average concentration values in a year (varies depending if the year being monitored is or is not a leap year).

The minimum required number of measurements are as follows:

1. For years having 8,760 hours, the minimum number of hours with samples shall be 6,570.
2. For years having 8,784 hours, the minimum number of hours with samples shall be 6,588.

Example:

Suppose we have monitoring 7,329 8-hour rolling average data during Calendar Year 2020.

The CY2020 continuous monitoring measurements for CO are as follows are as follows:

8-Hour Rolling Average Data	Concentrations (ppm)
1	51
2	68
3	No Data

.	**.**
.	**.**
.	**.**
7501	85
7502	87
7503	73
.	**.**
.	**.**
.	**.**
7653	No Data
7654	97
7655	No Data
.	.
.	.
.	.
8783	41
8784	31

Sort all data values collected from lowest to highest according to the continuous monitoring measurement concentrations:

Rank	Concentration (ppm)
1	31
2	41
3	51
.	**.**
.	**.**
.	**.**
7182	68
7183	73
7184	85
.	**.**
.	**.**
.	**.**
7328	87
7329	97

To calculate for the rank of the 98th percentile value, multiply number of samples taken in a year by 0.98.

$$\boldsymbol{Number\ of\ Samples\ x\ 0.98\ = 7329\ x\ 0.98}$$
$$\boldsymbol{Product\ = 7182.42}$$

After multiplying the number of samples, take the integer part of the product and add 1. This step gives you the ranking that corresponds to the 98th percentile:

$$Rank = 7182 + 1$$
$$Rank = 7183$$

Therefore, the 98th percentile is rank **7183**. Rank 7183 corresponds to **73 ppm.**

$$98th\ Percentile = 73\ ppm$$

98th Percentile is above the CO 8-Hour Guideline Value of 9 ppm

1.8. How to compute for the Maximum 24-Hour concentration for TSP, PM10, PM2.5 and SO2, and 1 hour, 8 hour for CO and O3?

The maximum concentration is the highest value or the 1st rank in a set of data.

Example:

Suppose we have forty-seven (47) 24-Hour TSP samples which is equivalent to 78% of sixty (60) sampling periods during Calendar Year 2020:

Following the manual sampling frequency of "once every six days". The sampling measurements are as follows:

No. of Sampling	Concentration (μg/Ncm)	No. of Sampling	Concentration (μg/Ncm)
1	32.12	**31**	69.76
2	45.31	**32**	54.32
3	56.83	**33**	46.66
4	23.46	**34**	47.76
5	33.98	**35**	43.76
6	45.23	**36**	31.86
7	56.23	**37**	37.78
8	34.51	**38**	38.86
9	56.43	**39**	36.64
10	65.67	**40**	43.87
11	32.40	**41**	54.59
12	45.43	**42**	23.56
13	27.23	**43**	24.56
14	49.76	**44**	32.10
15	50.32	**45**	25.67
16	45.67	**46**	30.13
17	76.43	**47**	23.56
18	59.76		
19	43.86		
20	58.34		
21	43.56		
22	43.56		
23	54.41		

24	60.32
25	43.54
26	54.21
27	27.86
28	52.01
29	34.97
30	60.43

Sort all data values collected from highest to lowest according to the sampling measurements:

Rank	Concentration (μg/Ncm)	Rank	Concentration (μg/Ncm)
1	76.43	26	43.76
2	69.76	27	43.56
3	65.67	28	43.56
4	60.43	29	43.54
5	60.32	30	38.86
6	59.76	31	37.78
7	58.34	32	36.64
8	56.83	33	34.97
9	56.43	34	34.51
10	56.23	35	33.98
11	54.59	36	32.4
12	54.41	37	32.12
13	54.32	38	32.1
14	54.21	39	31.86
15	52.01	40	30.13
16	50.32	41	27.86
17	49.76	42	27.23
18	47.76	43	25.67
19	46.66	44	24.56
20	45.67	45	23.56
21	45.43	46	23.56
22	45.31	47	23.46
23	45.23		
24	43.87		
25	43.86		

Based on the above, the highest or the 1st rank 24-hour concentration is **76.43 μg/Ncm.**

Following the rounding criteria for 24-hour concentrations, the 24-hour maximum concentration for Year 2020 is:

$$\boldsymbol{Maximum\ 24 - Hour\ Concentration\ = 76\ \frac{\mu g}{Ncm}}$$

The Maximum 24-Hour Concentration for CY2020 is below the TSP 24-Hour Guideline Value of 230 μg/Ncm.

1.9. What if I want to show I meet the Annual NAAQGV but I don’t have complete data?

With reference to USEPA 40 CFR Part 50 Appendix N DENR-EMB may have compelling reasons to use less complete data, but the DENR-EMB Regional Director must approve it.

The EMB Regional Offices may want to consider filling in for missing scheduled sampling days using the procedures in 1.9.1 with the following requirements:[1]

- Have at least 50% of the scheduled number of samples for each quarter for all three years.
- Show that the emissions and meteorology for the substitute quarters and for the quarters in question are almost the same.
- Meet the NAAQGV based on the incomplete data.

1.9.1. How do I fill in for missing data to show I meet the Annual NAAQGV?

First, you should meet the criteria from Question 1.9. Then, you may use this approach to fill in for missing scheduled sampling days:

- Replace missing data with the maximum data value across all three years for the same quarter.

1.9.1.1. How you may use maximum observed values to substitute for missing data to replace each missing data for Manual and Continuous Monitoring Stations?

Replace each missing scheduled sampling day in an incomplete quarter with the maximum observed value from the same site and the same quarter (from any of the three years).

Example: ***How to substitute maximum observed values for missing data and use them to calculate the Annual Geometric Mean for $PM_{2.5}$.***

In this example, assume that:

1. Your $PM_{2.5}$ manual sampling was conducted once every six (6) days.
2. In Years 1 and 3, the annual geometric mean of $PM_{2.5}$ are 13 ug/Ncm and 11 ug/Ncm respectively.
3. In 3rd quarter of Year 2 (see Table 1.9-1), you only have 12 samples from 16 scheduled sampling days.
4. The total $PM_{2.5}$ concentration of the 12 samples is 292.1 ug/Ncm.
5. You meet the criteria from Question 1.9.
6. Emissions and meteorology are typical for Quarter 3 throughout the three years.

[1] https://www3.epa.gov/ttn/naaqs/aqmguide/collection/cp2/19990401_oaqps_epa-454_r-99-009_guideline_data_handling_pm_naaqs.pdf

Table 1.9-1: $PM_{2.5}$ Quarterly Statistics for Year 2 (in ug/Ncm)

Quarter (n)	Number of Samples (N)	Total Concentration* (S_n)	Quarterly Average* (X_n)
1	15	332.9	11.89
2	16	426.0	14.69
3	12	292.1	12.70
4	16	369.9	13.21

**Calculated from available* $PM_{2.5}$ *concentrations.*

With these assumptions, you can substitute data from Quarter 3 of all three years to show you meet the annual $PM_{2.5}$ NAAQGV following the steps below:

Step 1. <u>Combine four (4) substituted maximum values with the 12 PM2.5 samples collected in Quarter 3 of Year 2.</u>

Substitute the maximum $PM_{2.5}$ concentration observed in Quarter 3 in any of the most recent three years for all four (4) missing samples. The maximum may occur on one of the 12 non-missing days in Quarter 3 of Year 2, or in Quarter 3 of Year 1 or Year 3.

You review Quarter 3 data for all three years, and find the maximum value is 40.1 µg/Ncm. It occurred in Quarter 3 of Year 2. (You would get the same results if the maximum for that quarter occurred in Year 1 or Year 3). Substitute 40.1 µg/Ncm for each of the four (4) missing sampling days scheduled in Year 2, Quarter 3.

Step 2. <u>Calculate the average for Quarter 3 of Year 2 using the formula below:</u>

$$\boldsymbol{Quarterly\ mean}\ (\frac{\boldsymbol{ug}}{\boldsymbol{Ncm}}) = \frac{\boldsymbol{S_n + (X_p + m)}}{\boldsymbol{N + m}}$$

Where:

$m - Missing\ Samples$

$X_p - Maximum\ Value\ from\ 3\ quarters\ of\ 3\ years\ being\ reviewed$

$S_n - Total\ Concentration$

$N - Number\ of\ availables\ daily\ samples$

Calculate the average of Quarter 3 of year 2:

$$\boldsymbol{Quarterly\ mean} = \frac{\boldsymbol{292.1 + (40.1\ \mathrm{X}\ 4)}}{\boldsymbol{12 + 4}} (\frac{\boldsymbol{ug}}{\boldsymbol{Ncm}})$$

$$\boldsymbol{Quarterly\ mean} = \frac{\boldsymbol{292.1 + 160.4}}{\boldsymbol{16}} (\frac{\boldsymbol{ug}}{\boldsymbol{Ncm}})$$

$$\textbf{Quarterly mean} = \mathbf{28.28}\ \boldsymbol{ug/Ncm}$$

Since missing samples are filled; the data capture of Quarter 3 of Year 2 will be 100%.

Step 3. Calculate the annual mean for Year 2:

$$\textbf{Annual Mean} = \frac{\mathbf{11.89 + 14.69 + 28.2 + 13.21}}{\mathbf{4}}\frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

$$\textbf{Annual Mean} = \mathbf{17.0}\ \frac{\mu \boldsymbol{g}}{\boldsymbol{Ncm}}$$

Chapter 2: Data Capture Requirements

This Chapter was based on Section 4 (3) of DENR Memorandum Circular (DMC) 2005-13 or the "Guidelines for the Designation of Attainment and Non-Attainment Areas in an Airshed".

2.1. How do I make sure my data is complete enough to meet the guideline values?

At least 75 percent (%) of scheduled monitoring data must be reported for purposes of determining attainment of National Guideline Values.

A representative annual statistic must have four representative quarters. All measurements collected at a site are included in the annual average.

a) A quarter is considered representative if it includes three representative months

b) A month is representative when it includes data for 75 percent of the scheduled sampling days Example, if TSP is sampled once every six days, in a 31-day month 5 or 6 samples are expected. A minimum of 4 or 5 samples respectively, would make a representative month. Continuous samplers provide data to estimate 24-hour daily average TSP concentrations. In this case at least 23 daily averages constitute a representative month (75% of 31 days).

c) A day is representative if there is 75 percent completeness within each of the three 8-hour periods of the day. Each representative day includes a minimum of 18 hourly samples, with at least 6 samples in each of the three periods (12 a.m. until 8 a.m., 8 a.m. until 4 p.m., and 4 p.m. until 12 a.m.) and no more than two consecutive hourly measurements missing. This applies to an automatic daily sampling of pollutants.

d) 8-hour average data is representative if there is 75 percent completeness of data in 8 hours. A minimum of six (6) hours with data will make a representative 8-hour average data.

e) An hour is representative if there is 75 percent completeness of data within an hour. A minimum of forty-five (45) minutes with data will make a representative hour.

Table 2.1-1: Required Data Capture

Represented Data	**Required Data Capture**	**Remarks**
Annual	Shall have 4 representative quarters	Less than 4 quarters is not a representative annual data
Quarter	Shall have 3 representative months (at least 75% data capture per month)	Less than 3 months is not a representative quarter data
Month	Shall have 75% data capture per month	Less than 75% data capture is not a representative monthly data
Daily	Shall have at-least 75% data capture per day which is equivalent to 18 hours (minimum of 6 hourly samples in each 8-hour periods for automatic daily sampling of pollutants)	Less than 75% data capture is not a representative daily data
8-Hour	Minimum of 6 hourly samples in each 8-hour periods	Less than 75% data capture is not a representative 8-Hour data
1-Hour	Minimum of forty-five (45) minutes	Less than 75% data capture is not a representative 1-Hour data

2.2. How do I round numbers for 75% Data Capture?

When determining the 75% data capture, round decimals 0.5 or greater up and those less than 0.5 down.

Example: 74.49% rounds to **74%**
75.8% rounds to **76%**

2.3. How do I compute for percent data capture rate of Daily, Monthly, Quarterly and Annual Data?

A. Daily (24 Hours)

Calculate the daily percent data capture using the formula below:

$$\boldsymbol{Percent\ Data\ Capture\ (Daily)}\ \ (\%) = \frac{X_n}{m}\ X\ 100$$

Where:

$m - Number\ of\ Hours\ in\ a\ Day$

$X_n - No.\ of\ hours\ with\ sample$

Example:

Suppose there are 19 hours with data in a day.

$$\boldsymbol{Daily\ Percent\ Data\ Capture}\ (\%) = \frac{\mathbf{19}}{\mathbf{24}}\ \boldsymbol{X}\ \mathbf{100}$$

$$\boldsymbol{Daily\ Percent\ Data\ Capture}\ = \mathbf{79}\ \%$$

In this example, the data capture rate in a day is 79%.

B. Monthly

Calculate the monthly percent data capture using the formula below:

$$\boldsymbol{Monthly\ Percent\ Data\ Capture}\ (\%) = \frac{X_n}{m}\ X\ 100$$

Where:

$$m - Number\ of\ Sampling\ Periods\ in\ a\ month$$

$$X_n - No.\ of\ Samples\ in\ a\ month$$

Example:

Suppose there are four (4) samples for the month of January which has 5 sampling periods since it has 31 days:

$$\boldsymbol{Monthly\ Percent\ Data\ Capture}\ (\%) = \frac{\mathbf{4}}{\mathbf{5}}\ \boldsymbol{X}\ \mathbf{100}$$

$$\boldsymbol{Monthly\ Percent\ Data\ Capture}\ = \mathbf{80}\ \%$$

The data capture rate for the month of January is 80%.

C. Quarterly

Calculate the quarterly percent data capture using the formula below:

$$\boldsymbol{Quarterly\ \ percent\ data\ capture}\ = \frac{\boldsymbol{X_1 + X_2 + X_3}}{\boldsymbol{m}}\ \%$$

Where:

$$m - Number\ of\ Months\ in\ Quarter$$

$$X_n - Monthly\ Percent\ Data\ Capture\ (\%)$$

Example:

To compute for the q$\boldsymbol{uarterly\ percent\ data\ capture}$, assume that the AQM Station monthly percent data capture are as follows:

January = 78%, February = 89% and March = 90%

$$\boldsymbol{Quarterly\ percent\ data\ capture} = \frac{78 + 89 + 90}{3}\ \%$$

$$\boldsymbol{Quarterly\ percent\ data\ capture} = \mathbf{86}\%$$

In this example, the data capture rate for the Quarter is 86%.

D. Annual

Calculate the annual percent data capture using the formula below:

$$\boldsymbol{Annual\ percent\ data\ capture} = \frac{\boldsymbol{X_1 + X_2 + X_3 + X_4}}{\boldsymbol{m}}\ \%$$

Where:

$m - Number\ of\ Quarter\ in\ a\ year$

$X_n - Quarterly\ Mean\ Percentage\ (\%)$

Example:

To compute for the *Annual* ***percent data capture***, assume that the AQM Station quarterly mean percent data capture are as follows:

1st Quarter = 78%, 2nd Quarter = 89%, 3rd Quarter = 75% and 4th Quarter = 90%

$$\boldsymbol{Annual\ percent\ data\ capture} = \frac{\boldsymbol{78 + 89 + 75 + 90}}{\boldsymbol{4}}\ \%$$

$$\boldsymbol{Annual\ percent\ data\ capture} = \boldsymbol{83}\%$$

In this example, the annual data capture rate is 83%.

2.4. Continuous Monitoring Data Capture Computation (24 Hours, 1 Month, 1 Quarter, 1 Year)

A. Daily

Calculate the daily percent data capture using the formula below:

$$\boldsymbol{Daily\ Percent\ Data\ Capture}\ (\%) = \frac{X_n}{m}\ X\ 100$$

Where:

$m - Number\ of\ Hours\ in\ a\ Day$

$X_n - No.\ of\ hours\ with\ sample$

Example:

Suppose there are 21 hours with samples in a day.

$$\boldsymbol{Daily\ Percent\ Data\ Capture}\ (\%) = \frac{\boldsymbol{21}}{\boldsymbol{24}}\ \boldsymbol{X\ 100}$$
$$\boldsymbol{Daily\ Percent\ Data\ Capture}\ (\%) = \boldsymbol{88}\ \%$$

In this example, the data capture rate for the day is 88%.

B. Monthly

Calculate the monthly percent data capture using the formula below:

$$\boldsymbol{Monthly\ Percent\ Data\ Capture}\ (\%) = \frac{X_n}{m}\ X\ 100$$

Where:

$m - Number\ of\ Sampling\ Periods\ in\ a\ month$

$X_n - No.\ of\ Samples\ in\ a\ month$

Example:

Suppose there are 26 samples for the month of January which has 31 days:

$$\boldsymbol{Monthly\ Percent\ Data\ Capture}\ (\%) = \frac{\mathbf{26}}{\mathbf{31}}\ \boldsymbol{X}\ \mathbf{100}$$

$$\boldsymbol{Monthly\ Percent\ Data\ Capture}\ (\%) = \mathbf{84}\ \%$$

In this example, the data capture rate for the month of January is 84%.

C. Quarterly

Calculate the quarterly percent data capture using the formula below:

$$\boldsymbol{Quarterly\ \ percent\ data\ capture}\ = \frac{\boldsymbol{X_1 + X_2 + X_3}}{\boldsymbol{m}}\ \%$$

Where:

$m - Number\ of\ Months\ in\ Quarter$

$X_n - Monthly\ Percent\ Data\ Capture\ (\%)$

Example:

To compute for the q$\boldsymbol{uarterly\ percent\ data\ capture}$, assume that the AQM Station monthly percent data capture are as follows:

April = 78%, May = 80% and June = 84%

$$\boldsymbol{Quarterly\ percent\ data\ capture} = \frac{78 + 80 + 84}{3}\ \%$$

$$\boldsymbol{Quarterly\ percent\ data\ capture} = \mathbf{81}\%$$

In this example, the data capture rate for the Quarter is 81%.

D. Annual

Calculate the annual percent data capture using the formula below:

$$\boldsymbol{Annual\ percent\ data\ capture} = \frac{\boldsymbol{X_1 + X_2 + X_3 + X_4}}{\boldsymbol{m}}\ \%$$

Where:

$$m - Number\ of\ Quarter\ in\ a\ year$$

$$X_n - Quarterly\ Mean\ Percentage\ (\%)$$

Example:

To compute for the *Annual* $\boldsymbol{percent\ data\ capture}$, assume that the AQM Station quarterly mean percent data capture are as follows:

1st Quarter = 80%, 2nd Quarter = 84%, 3rd Quarter =97% and 4th Quarter = 98%

$$\boldsymbol{Annual\ percent\ data\ capture} = \frac{\boldsymbol{80 + 84 + 97 + 98}}{\boldsymbol{4}}\ \%$$

$$\boldsymbol{Annual\ percent\ data\ capture} = \boldsymbol{90}\%$$

In this example, the annual data capture rate is 90%.

Chapter 3: Required Sampling Frequency

The conduct of 24-hour manual sampling shall be once every six (6) days for Sulfur Dioxide (SO2), Nitrogen Dioxide (NO2) and Suspended Particulate matter pursuant to Table 1 (footnote c), Section 1, Rule VII Part II of DAO 2000-81 or the Implementing Rules and Regulations (IRR) of RA8749.

Example of annual schedule for the conduct of manual sampling for Particulate Matter 10 (PM10):

January 2021

Sun	Mon	Tue	Wed	Thu	Fri	Sat
27	28	29	30	31	1	**2**
3	4	5	6	7	**8**	9
10	11	12	13	**14**	15	16
17	18	19	**20**	21	22	23
24	25	**26**	27	28	29	30
31	1	2	3	4	5	6

February 2021

Sun	Mon	Tue	Wed	Thu	Fri	Sat
31	**1**	2	3	4	5	6
7	8	9	10	11	12	**13**
14	15	16	17	18	**19**	20
21	22	23	24	**25**	26	27
28	1	2	3	4	5	6

March 2021

Sun	Mon	Tue	Wed	Thu	Fri	Sat
28	1	2	**3**	4	5	6
7	8	**9**	10	11	12	13
14	**15**	16	17	18	19	20
21	22	23	24	25	26	**27**
28	29	30	31	1	2	3

April 2021

Sun	Mon	Tue	Wed	Thu	Fri	Sat
28	29	30	31	1	**2**	3
4	5	6	7	**8**	9	10
11	12	13	**14**	15	16	17
18	19	**20**	21	22	23	24
25	**26**	27	28	29	30	1

May 2021

Sun	Mon	Tue	Wed	Thu	Fri	Sat
25	26	27	28	29	30	1
2	3	4	5	6	7	**8**
9	10	11	12	13	**14**	15
16	17	18	19	**20**	21	22
23	24	25	**26**	27	28	29
30	31	1	2	3	4	5

June 2021

Sun	Mon	Tue	Wed	Thu	Fri	Sat
30	31	**1**	2	3	4	5
6	**7**	8	9	10	11	12
13	14	15	16	17	18	**19**
20	21	22	23	24	**25**	26
27	28	29	30	1	2	3

July 2021

Sun	Mon	Tue	Wed	Thu	Fri	Sat
27	28	29	30	**1**	2	3
4	5	6	**7**	8	9	10
11	12	**13**	14	15	16	17
18	**19**	20	21	22	23	24
25	26	27	28	29	30	31

August 2021

Sun	Mon	Tue	Wed	Thu	Fri	Sat
25	26	27	28	29	30	31
1	2	3	4	5	6	**7**
8	9	10	11	12	**13**	14
15	16	17	18	**19**	20	21
22	23	24	**25**	26	27	28
29	30	**31**	1	2	3	4

September 2021

Sun	Mon	Tue	Wed	Thu	Fri	Sat
29	30	31	1	2	3	4
5	**6**	7	8	9	10	11
12	13	14	15	16	17	**18**
19	20	21	22	23	**24**	25
26	27	28	29	**30**	1	2

October 2021

Sun	Mon	Tue	Wed	Thu	Fri	Sat
26	27	28	29	30	1	2
3	4	5	**6**	7	8	9
10	11	**12**	13	14	15	16
17	**18**	19	20	21	22	23
24	25	26	27	28	29	**30**
31	1	2	3	4	5	6

November 2021

Sun	Mon	Tue	Wed	Thu	Fri	Sat
31	1	2	3	4	**5**	6
7	8	9	10	**11**	12	13
14	15	16	**17**	18	19	20
21	22	**23**	24	25	26	27
28	**29**	30	1	2	3	4

December 2021

Sun	Mon	Tue	Wed	Thu	Fri	Sat
28	29	30	1	2	3	4
5	6	7	8	9	10	**11**
12	13	14	15	16	**17**	18
19	20	21	22	**23**	24	25
26	27	28	**29**	30	31	1

Legend:

Sampling Schedule (green-shaded cells; shown in bold above)

3.1. Start and End Time of Manual Sampling

Manual reference method samplers / instruments are equipped with timer functions. With reference to USEPA 40 CFR Part 50 - Appendix B, the conduct of 24-Hour manual sampling for TSP, PM_{10} and $PM_{2.5}$ shall start and stop from midnight to midnight.

Example:

Assume that you will conduct 24-hour $PM_{2.5}$ sampling on March 10, 2021. The instrument timer shall be set to:

Start Time: March 10, 2021, 12:00AM
End Time: March 10, 2021, 11:59PM

Chapter 4: Determination of Airsheds as Attainment or Non-Attainment Area

"Airsheds" are areas with similar climate, meteorology and topology which affect the interchange and diffusion of pollutants in the atmosphere. Sub-areas within Airsheds may therefore have similar air quality, and face similar problems, development programs and prospects.

The designation of attainment and non-attainment areas shall be based on monitoring data collected using the reference methods and other equivalent methods and other equivalent methods approved by the Bureau in Part II (National Ambient Air Quality Guideline Values) of DAO 2000-81 and/or other relevant information, including meteorological data, and data covering existing nearby sources.

4.1. Determination of Attainment Areas

Attainment areas shall be designated as attainment area if any of the following conditions are met:[2]

Note: The annual geometric mean of any pollutant refers to the average of four (4) quarters represented by the geometric mean of three (3) months. While the annual arithmetic mean of any pollutants refers to the average of four (4) quarters represented by the arithmetic mean of three (3) months.

1. The calculated maximum representative annual concentration *(refers to the Annual Geometric Mean of TSP, PM_{10} and $PM_{2.5}$, while Annual Arithmetic mean for SO_2)* for any site in the area during each year of the three years shall not exceed the annual NAAQGVs.

   Example:

   Three (3) years data of Total Suspended Particulates (TSP) monitoring

[2] DENR Memorandum Circular 2005-013

Airshed Station	Annual Geometric Mean, ug/Ncm			Annual NAAQGV, ug/Ncm	Remarks
	Year 1	**Year 2**	**Year 3**		
Site 1	80	78	85	90	Within the Annual NAAQGV
Site 2	58	55	75	90	Within the Annual NAAQGV
Site 3	77	22	36	90	Within the Annual NAAQGV

2. The calculated **annual concentrations** are representative for only two years and the **maximum concentration** for any site in the area is equal to or less than three-fourths of the level of the NAAQGVs.

Airshed with 2-year representative air quality monitoring data shall satisfy two (2) conditions (i. Annual Concentration, ii. Maximum Concentration):

i. The calculated **annual concentrations** *(refers to the Annual Geometric Mean of TSP, PM_{10} and $PM_{2.5}$, while Arithmetic mean for SO_2)* representative for two years is equal to or less than three-fourths of the level of the Annual NAAQGVs. (e.g. 67 ug/Ncm for TSP)

ii. The **maximum concentration** *(refers to the maximum 24-Hour average concentration of TSP, PM_{10}, $PM_{2.5}$ and SO_2 measured for each year)* for any site in the area is equal to or less than three-fourths of the level of the 24-hour NAAQGVs. (e.g. 173 ug/Ncm for TSP).

Example:

Two (2) years data of Particulate Matter 10 (PM_{10}) monitoring

Airshed Station	Annual Geometric Mean, ug/Ncm		Annual NAAQGV, ug/Ncm	¾ of Annual NAAQGV, ug/Ncm	Remarks
	Year 1	**Year 2**			
Site 1	43	41	60	45	Within ¾ of the Annual NAAQGV
	Maximum 24-Hour Concentration, ug/Ncm		**24-Hour NAAQGV, ug/Ncm**	**¾ of 24-Hour NAAQGV, ug/Ncm**	**Remarks**
	Year 1	**Year 2**			
	98	101	150	113	Within ¾ of the 24-Hour NAAQGV

3. The calculated **annual concentrations** are representative for only one year and the **maximum concentration** at any site is equal to or less than one-half of the level of the NAAQGVs.

Airshed with 1-year representative air quality monitoring data shall satisfy **two (2)** conditions (i. Annual Concentration, ii. Maximum Concentration):

i. The calculated **annual concentrations** *(refers to the Annual Geometric Mean of TSP, PM_{10} and $PM_{2.5}$, while Arithmetic mean for SO_2)* representative for two years is equal to or less than one-half of the level of the Annual NAAQGVs. (e.g. 45 ug/Ncm for TSP)

ii. The **maximum concentration** (*refers to the maximum 24-Hour average concentration of TSP, PM_{10}, $PM_{2.5}$ and SO_2 measured for each year)* for any site in the area is equal to or less than one-half of the level of the 24-hour NAAQGVs. (e.g. 115 ug/Ncm for TSP)

Example:

One (1) year data of monitoring data of Sulfur Dioxide (SO_2)

Airshed Station	Annual Arithmetic Mean, ug/Ncm	Annual NAAQGV, ug/Ncm	½ of Annual NAAQGV, ug/Ncm	Remarks
	1-Year			
Site 1	38	80	40	Within ½ of the Annual NAAQGV
	Maximum 24-Hour Concentration, ug/Ncm	**24-Hour NAAQGV, ug/Ncm**	**½ of 24-Hour NAAQGV, ug/Ncm**	**Remarks**
	1-Year			
	88	180	90	Within ½ of the 24-Hour NAAQGV

4.2. Determination of Non-Attainment Areas

An area is non-attainment if the calculated representative annual concentration *(refers to the Annual Geometric Mean of TSP, PM_{10} and $PM_{2.5}$, while Arithmetic mean for SO_2)* at any site during any of three years exceeds the Annual NAAQGVs.

Example:

Three (3) years data of Particulate Matter 10 (PM10) monitoring

Airshed Station	Annual Geometric Mean, ug/Ncm			Annual NAAQGV, ug/Ncm	Remarks
	Year 1	Year 2	Year 3		
Site 1	45	78	22	60	Exceeded the Annual NAAQGV in Year 2, "Non-attainment Area".

Note: Airsheds monitoring data with less than 3-year valid data shall be considered invalid.

Extreme concentration or highly irregular events do not generally significantly influence the annual mean. However, their exclusion can be considered on a case-by-case basis.

Chapter 5: Conversion of Concentration Values to AQI Values

The Air Quality Index (AQI) is a simple, color-coded, unitless index that is an effective way to communicate air pollution concentrations to the general public, it provides an indication of the quality of the air and its health effects. Simple equation can be used to convert concentration values (ug/Ncm) to AQI values (unitless).[3]

5.1. How do I convert pollutant concentration to AQI?

To calculate for the Air Quality Index (AQI), the formula shall be used:

$$I_p = \frac{I_{Hi} - I_{Lo}}{BP_{Hi} - BP_{Lo}}(C_p - BP_{Lo}) + I_{Lo}$$

Where:

I_p – *AQI value for the pollutant*

C_p – *Pollutant concentration*

BP_{Hi} – *Breakpoint* $\geq C_p$

BP_{Lo} – *Breakpoint* $\leq C_p$

I_{Hi} – *AQI value corresponding to* BP_{Hi}

I_{Lo} – *AQI value corresponding to* BP_{Lo}

The table below shows the Air Quality Index (AQI) range and category.

Table 5.2-1. Air Quality Index (AQI) Range and Category

TSP		CATEGORY
ILO	IHI	
0	50	GOOD
51	100	FAIR
101	150	UNHEALTHY FOR SENSITIVE GROUPS
151	200	VERY UNHEALTHY
201	300	ACUTELY UNHEALTHY
301	500	EMERGENCY

The table below shows the Air Quality Indices per type pollutant.

3 https://www.epa.gov/sites/production/files/2014-05/documents/zell-aqi.pdf

Table 5.2-2. Air Quality Indices per pollutant

Air Quality Indices - The following shall describe the six (6) levels of air quality for suspended particulates, sulfur dioxide, photochemical oxidants or ozone, carbon monoxide, and nitrogen dioxide anywhere in the Philippines. Levels above those indicated, with the exception of TSP, shall be considered Emergency:

Pollutants	Category	BP_{lo} - BP_{hi}
(a) Particulate Matter (µg/Ncm)		
(1) Total Suspended Particulates - (24-Hour)	Good	0-80
	Fair	81-230
	Unhealthy	231-349
	Very Unhealthy	350-599
	Acutely Unhealthy	600-899
	Emergency	900- and above
(2) PM_{10} - (24-Hour)	Good	0-54
	Fair	55-154
	Unhealthy	155-254
	Very Unhealthy	255-354
	Acutely Unhealthy	355-424
	Emergency	425-504
(3) $PM_{2.5}$ - (24-Hour)	Good	0 - 25
	Fair	25.1 - 35.0
	Unhealthy	35.1 – 45.0
	Very Unhealthy	45.1 – 55
	Acutely Unhealthy	55.1 – 90
	Emergency	91 - Above
(b) Sulfur Dioxide (ppm) [24-Hour]		
	Good	0.000-0.034
	Fair	0.035-0.144
	Unhealthy	0.145-0.224
	Very Unhealthy	0.225-0.304
	Acutely Unhealthy	0.305-0.604
	Emergency	0.605-0.804
(c) Ozone (ppm) [8-hour]		
	Good	0.000-0.064
	Fair	0.065-0.084
	Unhealthy	0.085-0.104
	Very Unhealthy	0.105-0.124
	Acutely Unhealthy	0.125-0.374
	Emergency	([1])
[1] *When 8-hour O3 concentrations exceed 0.374 ppm, AQI values of 301 or higher must be calculated with 1-hour O3 concentrations.*		
1-Hour (ppm)[2]	Good	-
	Fair	-
	Unhealthy	0.125 – 0.164
	Very Unhealthy	0.165 – 0.204
	Acutely Unhealthy	0.205 – 0.404
	Emergency	0.405 – 0.504
[2] *Areas are generally required to report the AQI based on 8-hour ozone values. However, there are a smaller number of areas where an AQI based on 1-hour ozone values would be more precautionary. In these cases, in addition to calculating the 8-hour ozone index value, the 1-hour index value may be calculated and the maximum of the two values is reported.*		
(d) Carbon Monoxide (ppm) [8-hour]	Good	0.0 – 4.4
	Fair	4.5 – 9.4
	Unhealthy	9.5 – 12.4
	Very Unhealthy	12.5 – 15.4
	Acutely Unhealthy	15.5 – 30.4
	Emergency	30.5 – 40.4

TSP 24-HOUR				
TSP (AQI)		**CATEGORY**	**TSP (µg/Ncm)**	
I_{LO}	**I_{HI}**		**BP_{LO}**	**BP_{HI}**
0	50	GOOD	0	80
51	100	FAIR	81	230
101	150	UNHEALTHY FOR SENSITIVE GROUPS	231	349
151	200	VERY UNHEALTHY	350	599
201	300	ACUTELY UNHEALTHY	600	899
301	500	EMERGENCY	900	ABOVE

PM 10 24-HOUR				
PM_{10} **(AQI)**		**CATEGORY**	PM_{10} **(µg/Ncm)**	
I_{LO}	**I_{HI}**		**BP_{LO}**	**BP_{HI}**
0	50	GOOD	0	54
51	100	FAIR	55	154
101	150	UNHEALTHY FOR SENSITIVE GROUPS	155	254
151	200	VERY UNHEALTHY	255	354
201	300	ACUTELY UNHEALTHY	355	424
301	500	EMERGENCY	425	504

PM 10 24-HOUR				
$PM_{2.5}$ **(AQI)**		**CATEGORY**	$PM_{2.5}$ **(µg/Ncm)**	
I_{LO}	**I_{HI}**		**BP_{LO}**	**BP_{HI}**
0	50	GOOD	0	25
51	100	FAIR	25.1	35.0
101	150	UNHEALTHY FOR SENSITIVE GROUPS	35.1	45.0
151	200	VERY UNHEALTHY	45.1	55
201	300	ACUTELY UNHEALTHY	55.1	90
301	500	EMERGENCY	91	above

OZONE (O_3) 8-HOUR				
O_3 **(AQI)**		**CATEGORY**	O_3 **(ppm)**	
I_{LO}	**I_{HI}**		**BP_{LO}**	**BP_{HI}**
0	50	GOOD	0	0.064
51	100	FAIR	0.065	0.084
101	150	UNHEALTHY FOR SENSITIVE GROUPS	0.085	0.104
151	200	VERY UNHEALTHY	0.105	0.124
201	300	ACUTELY UNHEALTHY	0.125	0.374

301	500	EMERGENCY	0.375	ABOVE

O_3 (AQI)		CATEGORY	O_3 (μg/Nm³)	
I_{LO}	I_{HI}		BP_{LO}	BP_{HI}
0	50	GOOD	0	0.126
51	100	FAIR	0.128	0.165
101	150	UNHEALTHY FOR SENSITIVE GROUPS	0.167	0.204
151	200	VERY UNHEALTHY	0.206	0.243
201	300	ACUTELY UNHEALTHY	0.245	0.734
301	500	EMERGENCY	0.736	504

Conversion for Ozone (O_3):
1 ppm = 1.962 μg/Ncm
1 μg/m³ = 0.51 ppm

SULFUR DIOXIDE (SO_2)				
SO_2 (AQI)		CATEGORY	SO_2 (ppm) 24-hr	
ILO	IHI		BP_{LO}	BP_{HI}
0	50	GOOD	0	0.034
51	100	FAIR	0.035	0.144
101	150	UNHEALTHY FOR SENSITIVE GROUPS	0.145	0.224
151	200	VERY UNHEALTHY	0.225	0.304
201	300	ACUTELY UNHEALTHY	0.305	0.604
301	500	EMERGENCY	0.605	0.804

CARBON MONOXIDE (CO)				
CO (AQI)		CATEGORY	CO (ppm) 8-hr	
ILO	IHI		BP_{LO}	BP_{HI}
0	50	GOOD	0	4.4
51	100	FAIR	4.5	9.4
101	150	UNHEALTHY FOR SENSITIVE GROUPS	9.5	12.4
151	200	VERY UNHEALTHY	12.5	15.4
201	300	ACUTELY UNHEALTHY	15.5	30.4
301	500	EMERGENCY	30.5	40.4

SAMPLE PROBLEMS:

Problem # 1: TSP

Consider the measured concentration: 245 μg/Nm³ for TSP (24-hr).
Convert concentration to AQI:

$$I_p = \frac{I_{Hi} - I_{Lo}}{BP_{Hi} - BP_{Lo}}(C_p - BP_{Lo}) + I_{Lo}$$

$$I_p = \frac{150 - 101}{349 - 231 \frac{\mu g}{Ncm}} (245 - 231) \frac{\mu g}{Ncm} + 101$$

$$I_p = 106.81\ (Unhealthy\ for\ Sensitive\ Groups)$$

Unhealthy for Sensitive Groups – People with respiratory disease, such as asthma, should limit outdoor exertion.

Problem # 2: PM_{10}

Consider the measured concentration: 210 µg/Nm³ for PM_{10} (24-hr).
Convert concentration to AQI:

$$I_p = \frac{I_{Hi} - I_{Lo}}{BP_{Hi} - BP_{Lo}} (C_p - BP_{Lo}) + I_{Lo}$$

$$I_p = \frac{150 - 101}{254 - 155 \frac{\mu g}{Ncm}} (210 - 155) \frac{\mu g}{Ncm} + 101$$

$$I_p = 128.22\ (Unhealthy\ for\ Sensitive\ Groups)$$

Unhealthy for Sensitive Groups – People with respiratory disease, such as asthma, should limit outdoor exertion.

Problem # 3: O_3

Consider the measured concentration 0.14 ppm for O_3 (8-hr).
Convert concentration to AQI:

$$I_p = \frac{I_{Hi} - I_{Lo}}{BP_{Hi} - BP_{Lo}} (C_p - BP_{Lo}) + I_{Lo}$$

$$I_p = \frac{300 - 201}{0.374 - 0.125\ ppm} (0.14 - 0.125) ppm + 201$$

$$I_p = 206.96\ (Acutely\ unhealthy)$$

Acutely Unhealthy – People should limit outdoor exertion. People with heart or respiratory disease such as asthma should stay indoors and rest as much as possible.

References:

1. USEPA guideline on data handling conventions for the PM NAAQS. (https://www3.epa.gov/ttn/naaqs/aqmguide/collection/cp2/19990401_oaqps_epa-454_r-99-009_guideline_data_handling_pm_naaqs.pdf)
2. Department Administrative Order (DAO) 2000-81: “Implementing Rules and Regulations (IRR) of the Philippine Clean Air Act of 1999 or RA8749
3. Department Memorandum Circular (DMC) 2005-013: “Guidelines for the Designation of Attainment and Non-attainment Areas in an Airshed”
4. USEPA 40 CFR Appendix N to Part 50 - Interpretation of the National Ambient Air Quality Standards for PM2.5
5. USEPA 40 CFR Appendix L to Part 50 - Reference Method for the Determination of Fine Particulate Matter as PM2.5 in the Atmosphere
6. USEPA 40 CFR Appendix Q to Part 50 - Reference Method for the Determination of Lead in Particulate Matter as PM10 Collected From Ambient Air
7. USEPA Air Quality Index (AQI) formula (https://www.epa.gov/sites/production/files/2014-05/documents/zell-aqi.pdf)

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PROCEDURAL MANUAL ON DATA HANDLING PROTOCOL FOR CRITERIA AIR POLLUTANTS

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