# Design Value Report

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# Topics

- Background

- Common features

- Pollutant specific features

- Questions and answers

# What is a Design Value

- Design Values are the metrics (i.e. statistics) that are compared to the National Ambient Air Quality Standards (NAAQS) to determine compliance with the Federal regulations for air quality (40 CFR Part 50). They are specific to each criteria pollutant.  For pollutants with more than one NAAQS, there is a distinct design value for each NAAQS.

# Report Purpose

- The purpose of this report is to provide the capability to calculate the 3-year Design Values for a selected set of monitors and years.

- Pollutants where 1-year statistics are used for NAAQS Determinations are not displayed (they are provided by the Quick Look Report)

- The intent is that the statistics calculated by AQS match as closely as possible the official Design Values that are utilized for NAAQS determinations.

# Pollutants With 3-Year Standars

- Ozone

- PM 10

- PM 2.5

- NO2

- SO2

- Lead

# Common Features

- Each pollutant has its own specific report and workfile format

- Each pollutant has its own DV folder in Discoverer

- The report shows a snapshot of the state of the AQS database at the time it was run (i.e. it may display preliminary or incomplete data)

- Intermediate calculations are shown to allow the user to determine how the design value and its validity are determined.

# Ozone: DV Statistics

- There are two NAAQS standards in effect for 8-hour Ozone – the 1997 standard and the 2008 standard.

- Design Values are calculated for Monitors (rather than Sites)

- The 3-year Design Value is the mean of the annual 4th highest daily maximum 8-hour average
  - For both the 1997 and 2008 standards, the design value is computed to 3 digits after the decimal with additional digits truncated.
  - For the 1997 standard the 3rd digit is then rounded (values < 5 rounded down and values >= 5 rounded up)

# Ozone: Validity

- The 3-year design value is marked as valid if three consecutive years of data are available and the following criteria are met:
  - The 3-year completeness is greater than or equal to 90% and at least one of the following is true for each of the 3 years:
    - The annual completeness is at least 75%
    - The annual 4th maximum is greater than the level of the standard

  **OR**
  - The 3-year average of the annual 4th maxima is greater than the level of the standard.

# PM 2.5: DV Statistics

- There are two NAAQS Standards for PM 2.5 – An annual standard and a 24-hour standard

  – The annual standard is the 3-year average of the weighted annual arithmetic means of each of the years (rounded to 1 digit after decimal)

  – The 24-hour standard is the 3-year average of the 98th percentiles of each of the years (rounded to zero digits after decimal)

# PM 2.5:  Site Statistics

- Design values are calculated from daily values at the site-level (as distinct from the monitor level)

  - If a measurement is taken at the primary monitor at a site, it is the site value for the day.

  - If no value is taken at the primary monitor, then the site value is the average of the values at the collocated monitors at the site.

- AQS does not compute spatially averaged design values.

# PM 2.5:  24-Hour DV Validity

- The 24-hour design value is marked as complete if there are 3 consecutive years of data and any of the following are met:

    - The 3-year design value is greater than the level of the standard

    - All quarters are at least 75% complete

    - For any year with quarters that are less than 75% complete, the annual 98th percentile value is greater than the level of the standard.

# PM 2.5:  Annual DV Validity

- The annual design value is marked as complete if all three years are present and any of the following criteria are met:

    - Each calendar quarter is at least 75% complete

    - All quarters have at least 11 values and the corresponding annual mean or 3-year DV is greater than the level of the standard.

    - For any quarter with less than 11 values, substituting the 3-year minimum for that quarter for the missing values would result in a 3-year DV greater than the level of the standard.

# PM 2.5:  Substituted Means

- AQS computes a set  of "substituted means" that are provided in the workfile and Discoverer.
  - Quarterly substituted mean:  For quarters with less than 11 values:  Substitute for the missing values the minimum daily average for that quarter from the 3-year period to get a total of 11 values.
  - Annual substituted mean:  For years with incomplete quarters, average the substituted quarterly means where present and quarterly means where not.
  - 3-Year substituted mean:  For 3-year periods with substituted annual means, average the substituted annual means where present and annual means where not.

- From 40 CFR Part 50.6:  The level of the national primary and secondary 24-hour ambient air quality standards for particulate matter is 150 micrograms per cubic meter (µg/m3 ), 24-hour average concentration. The standards are attained when the expected number of days per calendar year with a 24-hour average concentration above 150 µg/m3 is equal to or less than one.

- The design value statistic is the 3-year average of the annual expected number of exceedances.

- Expected Exceedances:   If PM10sampling is scheduled less frequently than every day, or if some scheduled samples are missed, a PM10value will not be available for each day of the year. To account for the possible effect of incomplete data, an adjustment must be made to the data collected at each monitoring location to estimate the number of exceedances in a calendar year. In this adjustment, the assumption is made that the fraction of missing values that would have exceeded the standard level is identical to the fraction of measured values above this level.

- Estimated exceedances are calculated quarterly, and then summed for the year.

- Estimated exceedance = Actual number of exceedances X (number of day is quarter / number of sampled days in quarter).  Example if there is one actual exceedance in a quarter with complete one-in-six sampling, then the estimated exceedance count would be 6.

- Rounding:  Quarterly estimates are rounded to 2 digits and annual estimates are rounded to 1.

# PM 10:  Exceptions

- If the exceedance is the first (ever) for the monitor, it will not be adjusted if every day sampling is initiated and maintained for 4 calendar quarters.

# PM 10: Validity

- The 3-year design value is marked as valid if three consecutive years of data are available and if either of the following criteria are met:

  – Observation Percent >= 75% for each quarter for all 3 years

  – 3-Year Estimated Exceedances > 1

# NO2: DV Statistics

- There are two NAAQS Standards for NO2 – An annual standard and a 1-hour standard
  - The annual standard design value is the single-year annual arithmetic mean of all hourly values for the year (not shown on report).
  - The 1-hour standard design value is the 3-year average of the annual 98th percentiles of the daily maxima.
    - The 1-hour standard will be calculated at the site-level (as distinct from the monitor-level). AQS requires a primary monitor to be designated at each NO2 site, and only data from the primary monitor will be utilized for design value calculations.

# NO2: Calculations

- Two distinct annual 98th percentile values are calculated for each year, as shown below, and the highest is used as the annual value:
  - The 98th percentile is taken from the set of daily maxima of valid days (days with 18 or more samples) .
  - The 98th percentile is taken from the set of daily maxima for all days with at least 1 sample.

# NO2: Validity

- The 1-hour design value is marked as valid if any of the following criteria are met:
  - All quarters in the 3-year period are at least 75% complete.
  - At least 75 percent of the days in each quarter have at least one reported hourly value, and the design value is above the level of the standard.
  - The design value is less than the level of the standard and passes the "high value test" below.
  - The design value is above the level of the standard and passes the "low value test" below.

# NO2: High Value Test

- For the quarter that is less than 75% complete:

  - There must be at least 200 valid days across all 3 years for that quarter.

  - Each corresponding quarter must be at least 50% complete.

  - The number of missing days below 75% shall have as their substitution value the largest daily maximum across **all** days in that calendar quarter across all 3 years. If the 3-year average of the annual 98th percentiles of this set is below the level of the standard, then the test is passed.

- For the quarter that is less than 75% complete:

  - There must be at least 200 valid days across all 3 years for that quarter.

  - The number of missing days below 75% shall have as their substitution value the **minimum** daily maximum across **valid** days in that calendar quarter across all 3 years. If the 3-year average of the annual 98$^{th}$ percentiles of this set is above the level of the standard, then the test is passed.

# SO2:  DV Statistics

- The 1-hour standard design value for SO2 is the 3-year average of the annual 99$^{th}$ percentile values of the daily maxima.

- Design values are calculated at the site-level (as distinct from the monitor-level).  Where there are multiple monitors at a site, for each year AQS uses the monitor with the highest average quarterly completeness.  In the event that two monitors have the same average quarterly completeness, AQS uses the one with the smallest POC.

# SO2: Calculations

- Two distinct annual 99$^{th}$ percentile values are calculated for each year, as shown below, and the highest is used as the annual value:

  – The 99$^{th}$ percentile is taken from the set of daily maxima of **valid** days (days with 18 or more samples).

  – The 99$^{th}$ percentile is taken from the set of daily maxima for **all** days with at least 1 sample.

# SO2:  Validity

- The 1-hour design value is marked as  valid if any of the following criteria are met:

  - All quarters in the 3-year period are at least 75% complete

  - At least 75 percent of the days in each quarter have at least one reported hourly value, and the design value is above the level of the standard.

  - The design value is less than the level of the standard and passes the "high value test" below.

  - The design value is above the level of the standard and passes the "low value test" below

# SO2: High Value Test

- For the quarter that is less than 75% complete:
  - There must be at least 200 valid days across all 3 years for that quarter
  - Each corresponding quarter must be at least 50% complete
  - The number of missing days below 75% shall have as their substitution value the largest daily maximum across **all** days in that calendar quarter across all 3 years. If the 3-year average of the annual 98th percentiles of this set is below the level of the standard, then the test is passed.

# SO2:  Low Value Test

- For the quarter that is less than 75% complete:

  - There must be at least 200 valid days across all 3 years for that quarter

  - The number of missing days below 75% shall have as their substitution value the **<u>minimum</u>** daily maximum across **<u>valid</u>** days in that calendar quarter across all 3 years.  If the 3-year average of the annual 98th percentiles of this set is above the level of the standard, then the test is passed.

# Lead: DV Statistics

- The design value for lead is the maximum 3-month average of the monthly mean concentrations for the 3-year period.

  - The month associated with each 3-month roling average is the 3$^{rd}$ month of the period (e.g. the month for the average of January, February, and March is March).

  - Each 3-month mean is rounded to 2 digits after the decimal.

# Lead: Site Statistics

- Lead design values are calculated from daily values at the site-level (as distinct from the monitor level)

  - If a measurement is taken at the primary monitor at a site, it is the site value for the day.

  - If no value is taken at the primary monitor, then the site value is the average of the values at the collocated monitors at the site.

# Lead: AQS DV Parameters

- Lead Design Values can be calculated from a combination of data from Pb-TSP/LC (14129), Pb-PM10/LC (85149), and Pb-TSP/STP (12128)
  - If valid 3-month Pb-PM10mean shows a violation and either is greater than the 3-month Pb-TSP mean or there is no corresponding valid 3-month Pb-TSP mean present, then that 3-month Pb-PM10 mean will be the site-level mean for that 3-month period.
  - Prior to 2009, if only Pb-TSP/STP (12128) is present, it is utilized to compute the site-level 3-month means (with no adjustments for STP vs LC)

# Lead:  DV Validity

- The Lead design value is marked as valid if any of the following criteria are met:
  - It is above the level of the standard.
  - There are 36 valid 3-month averages for the 3-year period.  A 3-month average is considered valid if it meets any of the following criteria:
    - If each month in the period is 75% complete.
    - It passes either the above NAAQS or below NAAQS tests defined below

# Lead:  Above NAAQS Test

- The 3-month average must be above the level of the standard.

- Data substitution will be done in each month of the 3-month period that is less than 75% complete.

- The substitution value is the lowest reported daily value for the corresponding month in the 3-year period.

- The test passes if by substituting enough values in the month for it to be 75% complete, the 3-month average is above the level of the standard.

# Lead:  Below NAAQS Test

- The 3-month average must be below the level of the standard.

- Data substitution will be done in each month of the 3-month period that is less than 75% complete but at least 50%.

- The substitution value is the highest reported daily value for the corresponding month in the 3-year period.

- The test passes if by substituting enough values in the month for it to be 100% complete, the 3-month average is below the level of the standard.

# Questions?