Chapter 12

Ambient Data Reduction and Audit Procedures

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1.0 Introduction

Ambient air data must be validated and verified in a consistent and regimented manner to preserve the integrity and representativeness of the environmental conditions present at the time of collection. Data reduction is the conversion of raw data into a more ordered, simplified, user-friendly form. Data audits are a means to assure data integrity. The criteria listed within this chapter are an aid in producing a complete and accurate review of the ambient air pollutant and meteorological monitoring data prior to submission of the data to the Environmental Protection Agency's (EPA) Air Quality System (AQS). Government officials, environmental and public health scientists, and the public can access the reviewed data via the USEPA's AQS Data Mart (https://aqs.epa.gov/aqsweb/documents/data_mart_welcome.html).

2.0 Data Reduction

2.1 Data Reduction using a Data Acquisition System (DAS)

Almost all monitoring entities have incorporated a data acquisition system (DAS) to collect data and tabulate results from the continuous measurement of criteria pollutants and meteorological conditions. Most continuous monitors have the capability to output analog and digital data. The data logger receives the analyzer data and converts it to digital data and stores it in the data logger memory for subsequent automatic retrieval by a remote data management system. Data can be collected in short time periods (1-minute, 5-minute averages) and then tabulated over a large range of time scales (1-hour, 8-hour, 24-hours) along with a variety of statistical information on the collected data.

The use of digital data transfer has diminished the likelihood of data transfer errors, but there are two sources of potential error between the instrument (the analyzer) and the recording device (data logger):

- the analyzer output signal and
- data logger recording error

Minimizing errors between the analyzer signal and the data logger measured response is accomplished by verifying the analyzer output and calibrating the data logger channels. Gas analyzers typically have options to set the output voltages to full scale or to ramp the analog output voltages over the full output range; the output voltages can be verified with a certified voltmeter or the data logger. The data logger channels must be calibrated so that a known voltage supplied to each input channel corresponds to the recorded data logger response. Checking for data transfer errors is more complicated in that it requires the application of a data audit trail.

2.2 Data Audit Trail

A data audit trail is useful in checking for data recording/transfer errors. A data audit trail consists of following several data values (e.g., hourly data) from the analyzer, through collection and storage by the data logger, through data validation/review process, and finally checking

USEPA's Air Quality System (AQS) to verify the existence of that data. The same values must be traceable through all the steps of the data acquisition and reporting process.

2.3 Data Reduction using a Strip Chart

Many data collection systems utilize a chart recorder to aid in the visualization of the data and to serve as a data backup in the event of DAS failure. Because the strip chart can serve as a data backup, it is imperative that the strip chart trace corresponds to the DAS data. The chart recorder values should agree within ±2% of the corresponding DAS data. Chart recorders must be calibrated annually (see Chapter 6 of this manual). The verification frequency of the data logger will depend on the manufacturer's recommendations; however, the OAQ Quality Assurance Section recommends an annual verification of input voltages (or input currents). This will help eliminate any problems associated with the chart recorder and DAS.

Obtaining hourly averages from a chart recorder requires some manual manipulation of the data including the following methods:

- Digitizing software to convert the chart trace into x-y data (time-concentration) and then to tabulate the hourly concentration
- Mechanical devices (e.g., a planimeter) to obtain the area under the chart trace area, which then can be converted to an hourly concentration
- Manual interpretation/calculation of the chart trace to obtain an hourly average concentration

If the need should arise to manually estimate and calculate the hourly concentration or meteorological parameter value, the following method can be employed to obtain continuous data from a strip chart.

1. Ideally the monitoring system is automated to provide a daily or weekly zero check, which occurs at a preset time (e.g., midnight).

    a. Identify and annotate the zero checks.
    b. Ensure the strip chart has at least a zero trace at the beginning and end of the time period for the data that is to be reduced.
    c. Do not confuse the recorder offset or recorder electronic zero with the value of pollutant-free air sampled for a zero baseline trace response.
    d. If there is no daily or weekly zero, the biweekly 1-point QC audit zero can also be used to determine zero information.

2. Chart recorders periodically imprint the strip with the date and time. Ensure the date/time stamps are correct by checking them against known site visits or audits.

    a. Identify the site check annotation (initials of the person performing the check, site name, the chart speed, the date, parameter the start and end time of any site check or QA audits).

b. Verify that the date/time stamp are correct; annotate the date/time (hours) for the data in question.
c. Use the chart speed to establish the time (hours) of the data in question.

3. Interpretation/Calculation of the hourly concentration or parameter value.

a. Determine the hourly average for the interval of interest by estimating the average percent of chart deflection for the hour.
b. Subtract the zero and chart offset.
c. Multiply by the most recent monitor calibration relationship.

4. Examples of calculating a concentration or parameter value.

a. If an ozone chart average is 26%, the zero is 1%, and the chart offset is 5% (note: the zero and chart offset are reflected as one trace on the chart; they are not two individual traces), and the pollutant range is 0.5 ppm for 100% of chart, then

$$\text{Hourly Ozone Concentration} = (26\% - 6\%) \times \frac{500\ \text{ppb}}{100\%} = \quad 100\ \text{ppb}$$

b. If a wind direction chart average is 15% and the zero and offset value is 5% and the wind direction of 100% of chart corresponds to 540 degrees, then

$$\text{Hourly Wind Direction} = (15\% - 5\%) \times \frac{540^\circ}{100\%} = \quad 54^\circ$$

3.0 Data Audit

In order to guarantee uniformity in application and procedure, all data collected must be reviewed prior to being used by an agency for any purpose. The term "agency" shall include: Federal/State agencies, local (municipal/county) agencies, industrial entities/companies, consultants, and other agencies as may be determined by the Section Chief, Quality Assurance Section (QAS), Office of Air Quality (OAQ), Indiana Department of Environmental Management (IDEM) (hereby referred to as IDEM QA Section for the remainder of this chapter).

All data audits must be conducted by personnel not involved in either the data reduction process or data submittal. The responsibility of conducting the data audits shall be assigned to the QA staff of the agency, whenever possible. Within IDEM, data audits are performed by the Quality Assurance Section of the Air Monitoring Branch.

Affected agencies shall perform all required activities pertaining to data audits in accordance with the procedures set forth in this chapter. Failure to comply with required procedures can

result in the invalidation of affected data until such time that compliance with required procedures has been established.
All affected agencies shall:

1. Review all data prior to its use for both completeness and correctness. Data is considered complete if you have collected 75% of valid data within an hour, 75% of valid hours within a day, 75% of valid days within a month, 75% of valid days within a quarter, and 4 complete quarters within a calendar year. Those sites designated as Prevention of Significant Deterioration (PSD) should have 80% valid data instead of 75% (Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD), EPA-450/4-87-007). In addition, data is screened for correctness by adhering to the standard operating procedures for data review.

2. Document all missing or invalid data. Those hours that do not have a valid value must have an USEPA Air Quality System (AQS) null value reason code.

3. Submit validated air monitoring data in a format suitable for submission to USEPA's Air Quality System (AQS). Most data loggers will output hourly data in a format suitable for AQS submission (check with the data logger vendor regarding data output formats). The validated data should be submitted to the Air Monitoring Branch within forty-five (45) days after the end of the quarter.

4. In the event that data corrections are necessary after AQS data submission, submit corrected AQS formatted data and provide a listing of all data corrections to the AQS database to the IDEM Air Monitoring Branch. The corrections must be sent as soon as possible after identification of errors or irregularities to the original data, as well as the reason for the data corrections.

5. Provide the necessary training for all personnel involved with data audits. Training may involve EPA sponsored courses, State training, etc. Each agency shall outline what to evaluate when it comes to screening data and this should be in their QAPP and any related SOPs.

6. Maintain records of all data audits for at least three years. Make available, upon request, access to or copies of all records and documentation pertaining to activities required by this chapter.

4.0 Data Review Audit

The criteria identified in this section are general in nature and may be referenced when auditing data that will be submitted to AQS. The IDEM QA Section utilizes Standard Operating Procedure S-005-OAQ-M-QA-12-S-R4, Leading Environmental Analysis and Display System (LEADS) Validated Data Review Procedures to audit LEADS collected data. Other standard operating procedures for reviewing and auditing data must be approved by the IDEM QA Section Chief.

4.1 Data Audit Criteria

The data should be evaluated for non-representative (irregular) traces on the chart that may be the result of monitoring system malfunctions. Most DAS will create a trace from the analyzer responses or can export the data for use in another application to yield a data trace. In the event that a DAS trace is not available, the strip chart data can be used for evaluation. The types of errors that are likely to occur fall into two groups:

- small random errors that are only detectable if the "true value" is known and
- gross systematic errors, which are detectable because the data deviates greatly from what is expected

Small random errors are difficult to ascertain as they may be close to the "true value" and do not seem out of line from what is expected. The best approach in dealing with small random errors is through prevention (e.g., designing the sampling and data analysis procedures to minimize the potential for errors), checking the sampling system to decrease opportunities for systematic errors (equipment maintenance, calibrations), and relying on the knowledge that a few random errors of small magnitude will generally "average out." The primary concerns in the data trace audit are the systemic errors, errors that introduce a bias to the data (e.g., data different from data collected by near-by monitors or from what is expected) and should warrant further investigation as to the validity of the data.

Typical indications of systematic errors due to malfunctions of the sampling equipment include:

1. A straight line trace (other than minimum detectable) for several hours
2. A wide, solid trace indicating excessive noise or erratic behavior, such as spiking
3. A long steady increase or decrease in deflection
4. A cyclic trace pattern with a defined time period
5. A trace below the zero baseline
6. Excessive drifting of the zero or span (see Chapter 11 of this manual, Valid Data and Completeness Requirements)

The data for any time interval in which a malfunction of the sampling system is suspected should be investigated and invalidated, if necessary. In addition, calibrations, audits, system maintenance, other assigned null codes, etc. should be verified while reviewing the chart trace.

4.2 Continuous Pollutant Monitoring Data Audit Criteria

All continuous monitoring data shall be validated by the ambient monitoring staff and reviewed by the QA staff of the originating agency before submittal to AQS. The audit process shall incorporate standard operating procedures that are approved by the IDEM QA Section Chief.

For the criteria pollutants, the reviewer

- Needs to understand the formation, emissions, and transport of the criteria pollutant
- Use established screening criteria to identify potentially suspect data
- Investigate suspect data, and
- Invalidate data only if there is sufficient evidence to do so

When an exceedance of the National Ambient Air Quality Standards (NAAQS) primary or secondary standard is suspected, it needs to be verified, investigated, and recorded using Form 4 (See Chapter 12 appendix) for gas parameters or Form 5 (See Chapter 12 appendix) for particulates (reference: Standard Operating Procedure S-036-OAQ-AMB-QA-16-S-R6, Exceedance Review Reporting System Procedures).

The following information is provided as screening criteria for evaluating the validity of criteria pollutants. [Reference: *Sonoma Technology, Inc* Data Validation workshop presentations (http://www.ladco.org/reports/workshops/2011/data_validation/data_validation.html)] Using the Sonoma Technology workshop presentations, the criteria listed are intended as **general** guidelines and do not encompass all possibilities. Concentrations listed in the general guidelines are hourly averaged concentrations.

4.2.1 Ozone (O_3)

Ozone formation typically follows a diurnal pattern; increasing in the morning, highest in the afternoon, and decreasing in the evening or night. [Note: The diurnal cycle can vary greatly depending on the site location, emission sources, weather conditions, or ozone transport.]

1. The maximum ambient ozone hourly concentration should be in the range of 170 to 225 ppb. While concentrations greater than that are possible, it is more likely a span or calibration that has not been correctly flagged and needs to be investigated.
2. The minimum ozone concentration should be greater than negative 5 ppb.
3. A rate of change in ozone greater than 50 to 60 ppb/hour needs to be evaluated.
4. At any point in time, the ozone concentration should be within 50 ppb of the ozone concentration of near-by sites; the large value may be due to ozone transport being observed at one site and then appearing later at the near-by site.
5. Constant ozone concentrations (especially concentrations greater than 40 ppb) that remain unchanged for 4 to 5 consecutive hours may indicate analyzer malfunction.
6. Shifts in the baseline concentration should be investigated as it may indicate an analyzer instability problem.
7. Co-pollutant check: nitric oxide (NO); NO decreases as ozone increases and typically increases as ozone decreases.

4.2.2 Oxides of Nitrogen (NO, NO_2, NO_X)

Nitrogen dioxide (NO_2) is one of a group of highly reactive gases known as "oxides of nitrogen," or "nitrogen oxides (NOx)." NO_2 forms quickly from emissions from cars, trucks and buses, power plants, and off-road equipment.

1. The NO or NO_2 concentration should not exceed the NO_X concentration.
2. The maximum ambient NO_X concentration should be less than 700 ppb in urban areas and no greater than 300 ppb in rural areas.
3. The minimum concentration should be greater than negative 2 ppb.
4. A rate of change in NO, NO_X, NO_2 greater than 30 ppb/hr needs to be evaluated.
5. Constant NO, NO_X, or NO_2 concentrations (concentrations greater than 0 ppb) that remain unchanged for 4 to 5 consecutive hours may indicate an analyzer malfunction.
6. Shifts in the baseline concentration should be investigated as it may indicate an analyzer instability problem.
7. Co-pollutant check: Ozone. Nitric oxide decreases as ozone increases and typically increases as ozone decreases.

4.2.3 Carbon monoxide (CO)

Highest levels of CO typically occur during the colder months of the year when inversion conditions are more frequent.

1. The maximum ambient CO concentration expected to be observed may be greater than 8 ppm, but should be less than the CO NAAQS of 35 ppm.
2. The minimum CO concentration should be greater than or equal to 0 ppm.
3. A rate of change in CO greater than 5 ppm/hour needs to be investigated.
4. Constant CO concentrations (concentrations greater than 0 ppm) that remain unchanged for 4 to 5 hours may indicate an analyzer malfunction.
5. Shifts in the baseline concentration should be investigated as it is a common occurrence with CO analyzers.
6. Co-pollutant: nitric oxide; higher levels of CO are generally associated with areas of high traffic congestion and increased NO concentrations.

4.2.4 Sulfur dioxide (SO_2)

Sulfur dioxide is formed in the burning of sulfur containing fuels (e.g., high sulfur coal and oils), when gasoline is refined from oil, and the extraction of metals from ores.

1. The maximum ambient SO_2 concentration should be less than 150 ppb.
2. The minimum SO_2 concentration should be greater than negative 2 ppb.
3. A rate of change in SO_2 concentration greater than 40 ppb/hour needs to be investigated.
4. Constant SO_2 concentrations (concentrations greater than 0 ppb) that remain unchanged for 5 hours may indicate an analyzer malfunction.

5. Shifts in the baseline concentration should be investigated.

4.2.5 Particulates (Continuous)

Particulate matter (PM) is a mixture of solid particles (different shapes, sizes, and compositions) and liquid droplets found in air. PM results from primary emissions (emitted directly from sources) and emission of gaseous compounds that form secondary aerosols (through chemical reactions with oxygen and water vapor).

1. Maximum ambient $PM_{2.5}$ hourly concentrations should normally be less than 200 $\mu g/m^3$.
2. Minimum $PM_{10}/PM_{2.5}$ concentrations should be greater than negative 5 $\mu g/m^3$.
3. Rates of change in $PM_{10}/PM_{2.5}$ concentrations greater than 50 $\mu g/m^3$ per hour should be investigated.
4. Particulate concentrations (concentrations greater than 50 $\mu g/m^3$) that remain unchanged for 5 hours may indicate a monitor malfunction.
5. Collocated monitors should have similar concentrations.
6. At sites with both PM_{10} and $PM_{2.5}$ monitors, $PM_{2.5}$ concentrations should be less than PM_{10} concentrations.

4.3 Instructions for Completing a Gas/Particulate Pollutant Data Check Form

Ambient data collected by the State must be validated and reviewed prior to submission to USEPA's Air Quality System (AQS). The IDEM Ambient Monitoring Section is responsible for validating the data and the Quality Assurance Section is responsible for reviewing the data. Documentation of the pollutant data audit is accomplished by completing the appropriate Pollutant Data Check Form. The instructions for the QAS reviewer to complete the form include, but are not be limited to, the following general guidelines:

1. Use a standard data check form, Form 1 (See Chapter 12 appendix) for gas pollutants (CO, SO_2, O_3, and NO_2) and Form 2 (See Chapter 12 appendix) for continuous particulate pollutants.
2. Complete the top portion of Form: site name, AQS site number, month of the data period (e.g., January 2016), and the parameter.
3. Verify that the monitor or sampler is within its calibration period, either by checking the LEADS website or OAMD. The normal calibration frequency is six months for continuous gas analyzers and sulfate analyzers, annually for continuous (TEOM, BAM, SHARP, Aethalometer).
4. For the gaseous parameters, check the daily zero and span drift. Table 1 lists the allowable zero/span drifts for each gas parameter. Span drift must be no more than the Table 1 limits from one span to the next. Zero drift must not be more than the Table 1 limits from day to day or for other periods greater than daily. An explanation as to why the drift occurred must be documented.

Table 1. Allowable Zero/Span Drift

Parameter	Zero Drift	Span Drift
O_3	< ± 3.1 ppb (daily) < ± 5.1 ppb (> 24 h to 14 d)	< ± 7.1%
CO	< ± 0.41 ppm (daily) < ± 0.61 ppm (> 24 h to 14 d)	< ± 10.1%
NO/NOx/NO_2	< ± 3.1 ppb (daily) < ± 5.1 ppb (> 24 h to 14 d)	< ± 10.1%
SO_2	< ± 3.1 ppb (daily) < ± 5.1 ppb (> 24 h to 14 d)	< ± 10.1%

5. For continuous particulate parameters, verify that a flow rate verification was performed during that month and check that the results fall within the following limits.

    - < ± 4.1% of the transfer standard flow rate ($PM_{2.5}$)
    - < ± 5.1% of the design value flow rate ($PM_{2.5}$)
    - < ± 7.1% of the transfer standard flow rate (PM_{10})

6. For continuous particulate monitors, determine the data completeness, the number of days with valid data (i.e., days with ≥ 18 hours of valid concentration averages are considered complete) for the month. For gas parameters, review the valid data return from the LEADS monthly summary and record the value in the comments section.

7. Verify that the LEADS data has been validated using the correct time zone in which the site is located. If the incorrect time zone is selected, times for certain events (zero/spans, site checks, QA audits) will not correlate with the operator's log entries. In addition, the last hour for the month may not be validated if time zone is incorrect.

8. Verify LEADS data flags by checking the chart trace, the LEADS electronic logbook, and by checking for any memos stating that a problem had occurred.

9. Verify all high values. Table 2 lists the parameter and the criteria (or limit) for checking high values.

Table 2
High Data Concentrations Needing Verification

Parameter	Values to check
SO_2	Hourly average ≥ 0.075 ppm
NO_2	Hourly average ≥ 0.100 ppm
O_3	Hourly average ≥ 0.100 ppm and any 8 hour average ≥ 0.070 ppm
CO	Hourly average ≥ 35 ppm and any 8-hour average ≥ 9 ppm
PM_{10} (Continuous)	Daily average ≥ 100 μg/m^3
$PM_{2.5}$ (Continuous)	Daily average ≥ 25 μg/m^3

10. The indoor shelter temperature for the site must be checked. If the site temperature is not in the range of 15.0 to 33.0 degrees Celsius, then the data is invalid (this does not include meteorological parameters, certain PM_{10}/$PM_{2.5}$ continuous monitors, or any other samplers which have a larger temperature range as indicated by the manufacturer).

11. Review the LEADS Operator Log and the Validation Notes. The information in the logbook will identify any invalid periods, correction factors, or any other pertinent information.

12. Review all exceedances. A separate logbook or folder should be maintained with all paperwork showing that the exceedance was reviewed (see Section 5.1). If an exceedance is uncovered during the review, the reviewer will initiate the exceedance investigation.

13. For the gas parameters, examine the weekly LEADS 1-point QC checks to ensure that the gas pollutant results are within the prescribed range (< ±7.1% for ozone, < ±10.1% for gases CO, SO_2, and < ±15.1% for NO_2).

14. Examine the chart trace to determine unusual or strange responses during the time that the data was collected. Items to look for include spiking of the analyzer, a straight line for wind direction, responses below zero baseline, etc. Experience of the auditor and monitor specific characteristics will help determine other items to consider. For any manually reduced data (data not reduced by a data logger or analyzer), check 2 hours for every 24 hour day. The value being reported and the auditor's value must agree within 2% of the range of the analyzer.

15. The auditor must inform the parameter (network) operator of all unsatisfactory items indicated on Forms 1 or 2 and then conduct a follow-up audit to ensure any unsatisfactory items were corrected.

16. Additional information (e.g., exceedances, on-going equipment problems, site conditions affecting data collection) can be detailed in the Comments section of the data check sheet form.

17. The initials/name of the AMS staff person who reduced or validated the data must be documented on the form, along with the date that it was quality assured, initials of the QAS reviewer, and the status of the data (e.g., okay, corrections needed).

4.4 Intermittent Particulate Sampling Data Audits

Intermittent particulate sampling data audits primarily are concerned with the mass values of randomly selected particulate filters. The data check procedures for performing quality assurance checks of the filter masses are found in IDEM Standard Operating Procedure (SOP) S-046-OAQ-AMB-QA-15-T-R6, Particulate Filter Quality Assurance. Additional information regarding quality assurance checks of particulate filters can be found in Chapter 7 of this manual, Measurements of Particulates. At a minimum, the number of filters that must be checked for weighing accuracy must be the greater number of either three filters or 7% of a filter batch of 43 or more filters. Requirements regarding the mass differences between filter weights and rechecked filter weights for PM_{10} and $PM_{2.5}$ filters can be found in the aforementioned SOP and in Chapter 7 of this manual.

The Gravimetric Laboratory Information Management System (GLIMS) is used to track the initial and final filter weights and to calculate the particulate concentration with information regarding the respective flow rate and sample time of the filter. The sample flow rates and sampling times are either downloaded from the particulate monitor or entered by hand into GLIMS. A review of the flow rates and sampling times is necessary to ensure the information is associated with the correct particulate filter. The calculated particulate concentrations ($PM_{2.5}$, PM_{10}) must be reviewed to ensure the values do not exceed the National Ambient Air Quality Standards (NAAQS) and that those values that exceed the NAAQS are properly investigated. In situations where an exceedance of the NAAQS concentration is suspected, the intermittent particulate data may be compared to the data from the on-site continuous particulate sampler (e.g., Beta Attenuation Monitor (BAM), Tapered Element Oscillating Microbalance (TEOM) monitor, Synchronized Hybrid Ambient Real-time Particulate (SHARP) monitor), if available.

4.5 NAAQS Exceedance Memorandum

When high concentrations are identified by the Ambient Monitoring Section, the Quality Assurance Section should be notified of the site and date/time when the exceedance occurred. Sometimes the high concentration will be discovered during the data review process. In either situation, the QA staff member responsible for the review of that parameter is responsible for initiating the NAAQS exceedance memoranda (Forms 4 and 5 (See Chapter 12 appendix)). Form 4 is used for exceedances of the O_3, SO_2, CO, and NO_2 NAAQS; while Form 5 is utilized for exceedances of the $PM_{2.5}$ and PM_{10} NAAQS.

The purpose of the form is to identify if the data exceeding the NAAQS is of a valid nature.

Both exceedance verification forms (Forms 4 and 5) identify the audit results preceding and subsequent to the exceedance event. If the audits on both side of the NAAQS exceedance are considered valid, then that data is considered valid provided that no intervening Null Codes between the audits invalidates the data. If one audit or both audits had problems, the data may be suspect. The gas parameter audits may be performance evaluation (accuracy) audits, LEADS weekly 1-point QC audits or Site Operator manual 1-point QC audits. The particulate audits may be quarterly QA flow audits or monthly flow verifications. In some situations, this may entail a special QA audit after the exceedance to verify analyzer performance and data validity. Any invalid or missing data may be documented in the comments portion of exceedance forms.

4.6 Meteorological Data Audit Criteria

Listed below are criteria that may be useful in evaluating meteorological parameters. The criteria listed are intended as general guidelines that may indicate problems with the data and do not encompass all possibilities. These criteria should be adjusted according to local climatic conditions. Additional criteria may be obtained from federal guidelines such as Table 8-4 in Meteorological Monitoring Guidance for Regulatory Modeling Applications (EPA-454/R-99-005), *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements, Version 2.0,* (EPA-454/B-08-002, March 2008), and equipment manufacturer's information.

Documentation of the meteorological data audit is accomplished by completing the Meteorological Data Check Form (Form 3 (See Chapter 12 appendix)).

4.6.1 Wind Speed

1. Calms are defined as zero wind speed and zero wind direction
2. Any value less than zero or greater than 20 m/s (45mph)
3. Values which are unchanged for any three consecutive hours with the exception of calm hours
4. A change of ±5 m/s (11 mph) from one hour to the next consecutive hour
5. Any non-zero value less than the instrument's threshold limit
6. Any non-zero value which occurs during a corresponding zero wind direction
7. Any zero value which occurs during a corresponding non-zero wind direction
8. Five consecutive hourly values that are within ±0.2 mph of the next four hourly averages

4.6.2 Wind Direction

1. Calms are defined as zero wind speed and zero wind direction
2. Any value less than zero or greater than 360°
3. Values which remain unchanged for three consecutive hours
4. Any non-zero value which occurs during a corresponding zero wind speed
5. Any zero value which occurs during a corresponding non-zero wind speed
6. Value(s) which remain in the same sector (a sector is defined as any 90° portion of the 360° possible for wind direction) for more than 18 consecutive hours
7. Five consecutive hourly values within 2° of next four hourly values

4.6.3 Outdoor Temperature

1. Any value greater than 45 °C (113 °F) or less than -30 °C (-22 °F)
2. Values which are unchanged for any five consecutive hours
3. A change of ±5 °C (9 °F) from one hour to the next consecutive hour or change of 10 °C (18 °F) within an hour
4. Visually scan the chart for negative values or anomalies

4.6.4 Outdoor Temperature Difference

1. Any change in value which is greater than 0.1 °C/minute during daytime hours
2. Any change in value which is less than -0.1 °C/minute during nighttime hours
3. Any hourly change in the value which is greater than 5.0 °C or less than -3.0 °C

4.6.5 Dew Point

1. Dew point changes greater than 7 ° F in one hour
2. Five consecutive values within ±0.5 °C of next four hourly values
3. Dew point temperatures greater than 32.2 °C (90 °F)
4. Dew point temperatures less than -51.1 °C (-60 °F)

5. Dew point(s) which equal outdoor temperature(s) for more than twelve consecutive hours

6. Dew point values equal to or greater than the temperature values for a given hour

4.6.6 Relative Humidity

1. Relative humidity values less than zero or greater than 100%.

2. Relative humidity values that do no vary over a consecutive 12-hour period

4.6.7 Radiation (Solar & UV)

1. Radiation value(s) should be zero during nighttime/dark hours

2. Radiation value(s) should not exceed the range of the instrument

4.6.8 Atmospheric Pressure

In order to accurately observe guidelines for pressure data auditing, limit values for specific site locations must be calculated and applied properly.

1. Value(s) greater than 1060 mb (corrected to Sea Level)

2. Value(s) less than 940 mb (corrected to Sea Level)

3. Values which change more than 6 mb or 0.1 inches Hg within three consecutive hours

4.6.9 Precipitation

1. Any value(s) greater than 25 mm (~ 1 inch) in one hour

2. Any value(s) greater than 100 mm (~ 4 inches) in 24 hours

3. Any value(s) less than 50 mm (~ 2 inches) in three months

5.0 Toxics

As of the writing of this chapter, the toxics criteria is still in the developing stages and should be finalized sometime in 2019. Chapter 8 of the QA Manual, which serves as IDEM's QAPP, provides information on toxic data review for Photochemical Assessment Monitoring Station (PAMS) Ozone Precursors (VOCs), Toxics (VOCs), and Carbonyls.

5.1 Documentation of Audits

All data audits (Forms 1, 2, and 3) and NAAQS exceedance memoranda (Forms 4 and 5) shall be documented on standard forms used by the agency. The forms may be stored electronically or either in loose-leaf or bound format and shall be kept for at least three years. The IDEM/OAQ/QA Section stores files on the G drive.

6.0 Corrections to Ambient Data

6.1 Corrections to USEPA Air Quality Services (AQS) Data

When corrections to the AQS data are needed, the agency that submitted the data to the IDEM Air Monitoring Branch shall inform the IDEM Air Monitoring Branch of all ambient data corrections within forty-five (45) days of the detection of or notification of data irregularities. Correspondence from the agency should include a letter requesting corrections of the submitted data, reasons for the data corrections and a listing of all data requiring corrections. All corrections should be reported on a standard form that includes at least the following information (e.g., Form 6 (See Chapter 12 appendix)):

1. Agency
2. Site location or name (Do not use an agency-derived site number, e.g., Site 9)
3. Site AQS number
4. Parameter
5. Year
6. Date/Time of Corrected Data (Month, day, hour)
7. Value to be corrected (as printed in AQS)
8. Correct value
9. Comments

6.2 Corrections to Non-AQS Data

If non-AQS data is identified as incorrect, it must be corrected prior to the use of that data.

7.0 Inspection of Records

All reporting groups, upon request, shall make available to the IDEM QA Section and/or their representatives, all records pertaining to items required by this chapter. Failure to provide the information shall result in the invalidation of the subject data until the request is fulfilled.

Form 1
Indiana Department of Environmental Management
Office of Air Quality LEADS Gas Data Check Form

Site:			Date:	
AQS # :			Parameter:	
	S	**U**	**NA**	**Notes**
Valid Calibration (within parameter calibration frequency)				Cal date:
Daily Span Drift (< ± 7.1% O_3, < ± 10.1% CO, SO_2, NO_2)				
Zero Drift Daily: (< ± 0.41 ppm CO) (< ± 3.1 ppb O3, NO/NO_X, SO_2), (>24hr – 14 day): (< ± 0.61 ppm CO). (< ± 5.1 ppb O3, NO/NO_X, SO_2),				
Validated Data with Correct Time Zone				Time Zone:
LEADS Flags (3 letter combinations)				
*High Values Verified				
Shelter Temperature (59 to 91.4 ºF)				
Invalid Data Memos				
Exceedances Reviewed				
Weekly one-point QC check (LEADS SPN flag) (< ± 7.1% O3, < ± 10.1% SO_2 & CO, < ± 15.1%NO_2)				
Chart Trace				

S = Satisfactory, agrees with Quality Assurance values/findings
U = Unsatisfactory, does not agree with Quality Assurance values/findings
NA = Does not apply to this data check

*High Values = (≥ 0.100 ppm and 8 hour average ≥ 0.075 ppm O_3), (≥ 0.100 ppm NO_2), (≥ 0.075 ppm SO_2), (> 9 ppm CO)

Additional Comments:

Data Validator:

Data Check Completed Date:

Data Check Performed By:

Form 2
Indiana Department of Environmental Management
Office of Air Quality LEADS Particulate Data Check Form

Site:		Date:		
AQS # :		Parameter:		
	S	**U**	**NA**	**Notes**
Valid Calibration (within parameter calibration frequency)				Cal date:
Monthly flow verification performed? $\underline{PM_{2.5}}$ < ± 4.1% of transfer standard < ± 5.1% of design value $\underline{PM_{10}}$ < ± 7.1% of transfer standard				
Validated Data with Correct Time Zone				Time Zone:
Valid Sampling Days ≥ 75% (18 h) of hourly averages				Number of complete days:
LEADS Flags (3 letter combinations)				
*High Values Verified (≥ 100 μg/m^3 PM_{10}, ≥ 25 μg/m^3 $PM_{2.5}$				
Shelter Temperature (59 to 91.4 ºF)				
Invalid Data Memos				
Exceedances Reviewed				
Chart Trace				

S = Satisfactory, agrees with Quality Assurance values/findings

U = Unsatisfactory, does not agree with Quality Assurance values/findings

NA = Does not apply to this data check

Additional Comments:

Data Validator:

Data Check Completed Date:

Data Check Performed By:

Form 3
Indiana Department of Environmental Management
Office of Air Quality Meteorological Data Check Form

Site:		Date:			
AQS # :		Parameter:			
		S	**U**	**NA**	**Comments**
Valid Calibration					
Invalid Data Memos					
Correct Time Zone					
Met Parameters					
a.	Wind Speed (WS)				
b.	Wind Direction (WD)				
c.	Outdoor Temperature (OT)				
d.	Relative Humidity (RH)				
e.	Dew point (DP)				
f	Barometric Pressure (BP)				
g.	Std Dev. Horizontal Speed (SDHS)				
h.	Std. Dev Horizontal Direction				
i.	Vertical Wind Speed (VWS)				
j.	Std. Dev. Vert. Wind Speed				
k.	Vertical Wind Direction				
l	Solar Radiation (SR)				
m.	Ultraviolet (UV)				
n.	Precipitation (Prec)				
o.	Maximum Windgust (MWG)				
p.	Resultant Wind Speed (RWS)				
q.	Resultant Wind Direction (RWD)				

S = Satisfactory, Agrees with QA findings
U = Unsatisfactory, Does not agree with QA findings
NA = Not Applicable

Comments

Data Validator:
Data Check Completion Date:
Data Check Completed By:

Form 4

DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

INDIANAPOLIS

OFFICE MEMORANDUM

TO: Quality Assurance Section Chief, OAQ DATE:

FROM: [INSERT NAME OF QAS REVIEWER]

SUBJECT: **Fast Track Quality Assurance Information Regarding an Exceedance Event**

Site Name	AQS Number	Date	Time	Exceedance Value

Data Validity

[**INSERT Paragraph describing the O_3, SO_2, NO_2, CO Exceedance event including the NAAQS parameter value, validity of the data including data from nearby samplers, or any circumstances that would invalidate the data**]

Site Analyzer Information (see attached calibration form)

Analyzer Model & Serial No.:
Analyzer Calibration Date:
Calibrator Model & Serial No.:
Calibrator Certification Date:
Calibration calculations correct:

Information regarding audit conducted prior to listed event:

Audit Date:
Transfer Calibrator Model & Serial No.:
Transfer Calibrator Certification Date:
Audit settings and calculations are correct:
Comments or additional information:
Validation Point Difference:
Precision Point Difference:

Information regarding audit conducted after listed event:

Audit Date:
Transfer Calibrator Model & Serial No.:
Transfer Calibrator Certification Date:
Audit settings and calculations are correct:
Comments or additional information:
Validation Point Difference:
Precision Point Difference:

[Insert Graph of the Raw Data for Specified Site on Exceedance Date]

Figure 1. Graphical representation of the data collected at Insert Site Name on Insert Date. The shelter temperatures on Specified Date were in the range of Insert Temp range.

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cc: Air Monitoring Branch Chief, memo only
Ambient Monitoring Section 1 Chief, memo only
Ambient Monitoring Section 2 Chief, memo only
[Insert Name of AMS parameter specialist], memo only

Attachments:
(1) Analyzer Calibration Report
(2) Analyzer Audit Report Prior to the Listed Event
(3) Analyzer Audit Report Post Listed Event

Form 5

DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

INDIANAPOLIS

OFFICE MEMORANDUM

TO: Quality Assurance Section Chief, OAQ DATE:

FROM: [INSERT NAME OF QAS REVIEWER]

SUBJECT: **Fast Track Quality Assurance Information Regarding an Exceedance Event**

Site Name	AQS Number	Date	Exceedance Value

Data Validity

[**INSERT Paragraph describing the Particulate Exceedance event including information regarding the NAAQS value, validity of the data including corroborating data from collocated or continuous particulate monitors, or any circumstances that would invalidate the data**]

Site Analyzer Information (see attached calibration form)

Sampler Model & Serial No.:
Sampler Calibration Date:
Flow Transfer Standard Model & Serial No.:
Flow Transfer Standard Certification Date:
Temperature Probe/Barometer within Certification: Yes/No
Calibration calculations correct:

Information regarding audit conducted prior to listed event:

Audit Date:
Flow Transfer Standard Model & Serial No.:
Flow Transfer Standard Certification Date:
Temperature Probe/Barometer within Certification: Yes/No
Audit calculations correct:

Information regarding audit conducted after listed event:

Audit Date:
Flow Transfer Standard Model & Serial No.:
Flow Transfer Standard Certification Date:
Temperature Probe/Barometer within Certification: Yes/No
Audit calculations correct:

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cc: Air Monitoring Branch Chief, memo only
Ambient Monitoring Section 1 Chief, memo only
Ambient Monitoring Section 2 Chief, memo only
[Insert Name of AMS parameter specialist], memo only

Attachments:
(1) Sampler Calibration Report
(2) Sampler Audit Report Prior to the Listed Event
(3) Sampler Audit Report Post Listed Event

Form 6
Indiana Department of Environmental Management
Office of Air Quality AQS Data Corrections

Site: _____ **Parameter: _____**

AQS #: _____ **Operational Period: _____**

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Month	Day	Hour	Reported Value	Correct Value	Comments

Date of Request: _____

Name of Requester_____

Agency_____