Air Monitoring Directive Chapter 6: Ambient Data Quality

August 3, 2016

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1.0 Purpose

This Ambient Data Quality document forms a part (Chapter 6) of Alberta's Air Monitoring Directive (Alberta Environment and Parks 2016, as amended from time to time) and will hereafter be referred to as the Data Quality Chapter. Refer to Chapter 1 (the AMD Introduction) for requirements and definitions that apply to all parts of the AMD, a list of what components constitute the AMD, and details on review of and revisions to the AMD.

The purpose of the Data Quality Chapter is to specify the requirements for collecting, verifying and validating continuous ambient air quality and meteorological monitoring data.

DQ 1-A	*The person responsible must comply with the requirements set out in the Data Quality Chapter of the AMD on or before June 20, 2016 for all continuous ambient air monitoring.*

Figure 1 presents a flow chart of the suggested data collection and management process. The reporting aspect of the data process is described in the Reporting Chapter (Chapter 9) of the AMD.

1.1 Amendments

August 3, 2016

1. Update to document design/branding.

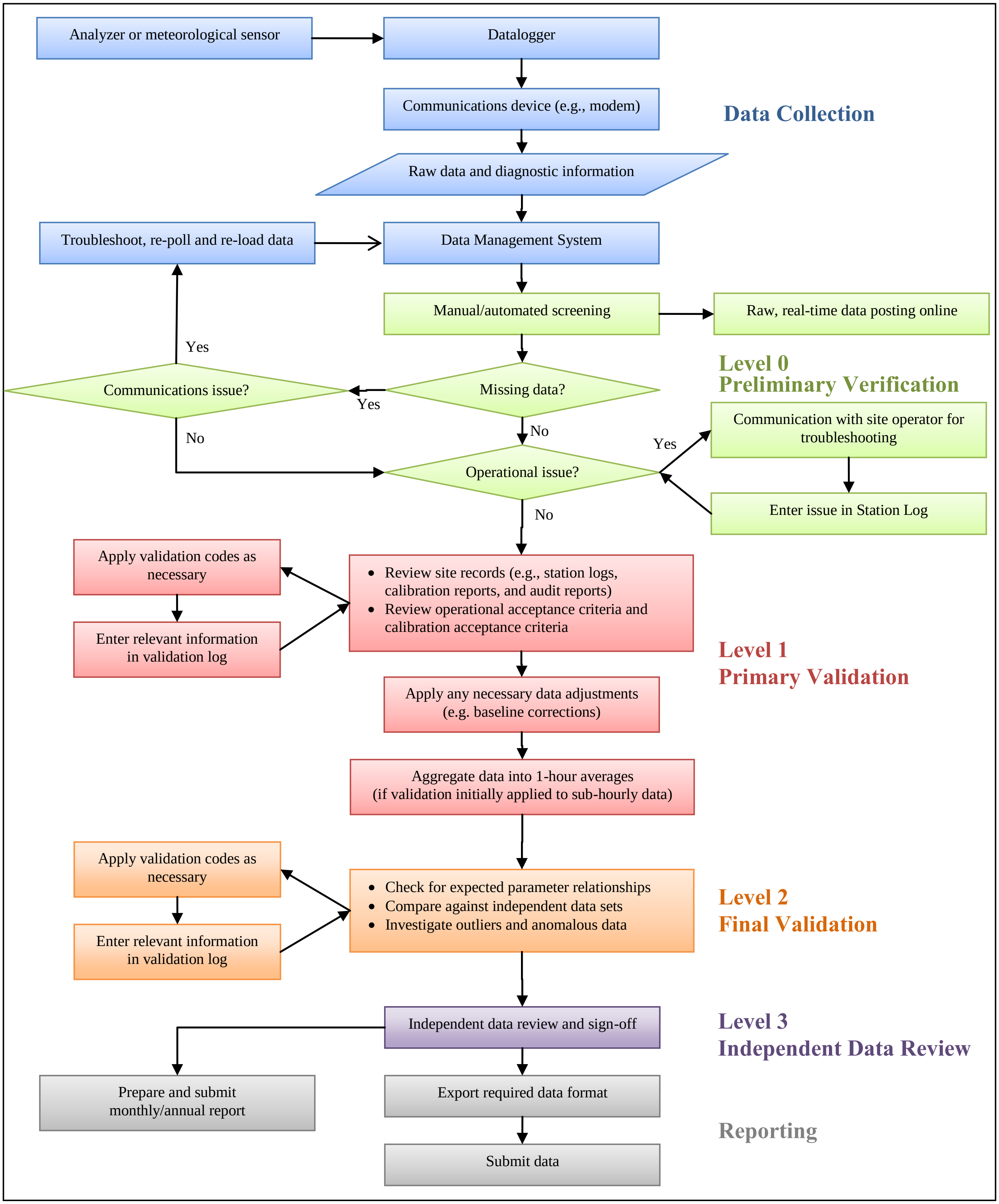

Figure 1 Data Collection and Management Process Flow Chart

2.0 Documents and Records

Minimum requirements for documents, records and maintaining a Quality System are given in the Quality System Chapter (Chapter 5) of the AMD.

All documents and records should be easily accessible. The majority of documents and records referred to in this section should be in electronic format to ensure accessibility and long-term storage.

2.1 Project Specific Documents

Documents required for continuous ambient data quality include, but are not limited to, procedures relevant to data collection, verification, validation, and reporting. These documents become part of the person responsible's Quality Assurance Plan (QAP).

The range of SOPs relevant to data handling should include data collection procedures and data verification and validation procedures.

2.2 Field Records

Recording of field data is necessary for ambient air monitoring, and serves as valuable input for the data validation process.

DQ 2-A	*The person responsible shall (a) maintain field records for each continuous ambient air monitoring station (b) containing:* *(i) instrument-specific information regarding all maintenance activities;* *(ii) quality control checks;* *(iii) troubleshooting activities;* *(iv) site visits; and* *(v) any other relevant information pertinent to instrument performance in accordance with the Data Quality Chapter.*

Field records should be used for validation purposes. Field records include station logs, which are chronological records of all of the events that occurred at a monitoring site. Paper copies of log notes can be maintained on-site, but electronic or web-based logging systems should be used so that information is better organized and readily available for the data validation process.

Requirements for retention and accessibility of documents and records are given in the Quality System Chapter (Chapter 5) of the AMD.

The following are types of information that may be recorded in a station log entry:

- technician name;

- date and time;
- the manufacturer's name, equipment type identification, and serial number or other unique identification;
- information about all routine and non-routine maintenance activities;
- a record of any damage, malfunction, modification, or repair to station systems and equipment;
- brief description of any corrective actions performed;
- any quality control information, including "as-found" and "as-left" information for calibration activities; and
- information relevant to instrument-specific performance specifications and acceptance criteria (e.g., leak checks, flow checks, etc.).

3.0 Data Collection and Management

Data acquisition is the process of collecting data, while data management refers to the process of organizing, storing, verifying, validating, and reporting data.

3.1 Data Collection

Data collected includes raw ambient data and also quality control data such as zero and span checks, calibration data, and instrument diagnostics.

Data output options for continuous analyzers generally include both analog and digital signals. Either analog or digital data are acceptable, but if analog data collection is implemented, quality assurance measures should confirm that data collected match the output from the analyzer.

Adoption of digital data acquisition is encouraged because it eliminates any noise that may be introduced with datalogger signal translation and can improve instrument sensitivity. Digital data acquisition can provide more instrument diagnostic information than is available through analog channels.

3.1.1 Datalogger Scan Rates

DQ 3-A When analog data collection systems are used for continuous ambient air monitoring, the person responsible shall implement:
(a) 1-second scan rates for all meteorological parameters; and
(b) scan rates at least as fast as actual instrument response times for continuous gas, intermittent and particulate parameters.

Scan rates are the intervals at which a datalogger retrieves an instrument value, which are subsequently used in calculations performed by the datalogger.

3.1.2 Data Averaging Intervals

Scanned data are the raw, unaveraged data retrieved from an instrument by a datalogger. Datalogger scan rates determine the level of data incorporated into an average value, where the minimum time resolution selected for averaging is the base average. Any subsequent averaging begins with the base average.

DQ 3-B	*The person responsible shall (a) collect and (b) store 1-minute base average intervals for QA/QC data, including zero/span and multipoint performance checks.*
DQ 3-C	*Base averages collected by the person responsible shall include at least 75 per cent of scanned data.*
DQ 3-D	*The person responsible shall (a) calculate and (b) retain final averages that:* *(i) are less than or equal to 1-hour; and* *(ii) include at least 75 per cent of base averages.*

Final data are reported as hourly average values, but data averaged over shorter intervals may be stored and used for validation.

Data retention requirements are included in the Quality System Chapter (Chapter 5) of the AMD.

3.1.3 Standard Deviation of Wind Direction

The standard deviation of wind direction is a calculated parameter primarily used to model dispersion in the atmosphere. Because wind direction is a circular variable, the calculation is not as straight-forward as calculating the standard deviation of a linear variable.

The United States Environmental Protection Agency (US EPA) has provided guidance for calculating the standard deviation of wind direction, and these calculation procedures are built in to modern dataloggers as standard calculation algorithms. Most dataloggers use the Yamartino method, which complies with US EPA guidelines for use with straight line Gaussian dispersion models to model plume transport. The Yamartino method requires less data storage and computing for data loggers than other methods.

DQ 3-E	*The person responsible shall collect hourly averages of standard deviation of wind direction from dataloggers using US EPA approved algorithms, unless an alternate algorithm has been documented and authorized in writing by the Director prior to implementation.*

DQ 3-F	*The standard deviation of wind direction, collected pursuant to DQ 3-E, must be calculated externally if hourly values are not collected at an hourly aggregation level using datalogger output.*

3.1.4 Analog Output Verification

It is important to ensure that datalogger output matches digital output directly from the analyzer.

DQ 3-G	*When analog data collections systems are used, the person responsible shall verify analog output by comparing to digital data output, at a minimum:* *(a) upon commencement of continuous ambient air monitoring; and* *(b) after any changes to the data collection system.*

Additional periodic checks (e.g., monthly) should be performed on analog output to ensure that time drifts or other data collection issues have not affected the data.

To report data correctly, a time adjustment may be necessary to ensure that the time associated with the sample accurately represents the period that was sampled.

Differences in time stamps may occur when comparing analog and digital output due to delayed instrument responses (e.g., for a semi-continuous instrument measurement cycle). Any specific methods used to correct for lag times in semi-continuous instrument output should be documented in an organization's QAP and SOPs.

External dataloggers override an instrument's internally logged digital time stamp, which may result in a disagreement between the datalogger and the instrument. For logged digital data, the datalogger will access the instrument's internal time stamp.

Examples of semi-continuous instruments which may require special analog data collection setup considerations include the Beta Attenuation Monitor (BAM), the FDMS version of the Tapered Element Oscillating Microbalance (TEOM), and continuous Gas Chromatography (GC) based instruments.

3.2 Data Management

It is important that data storage maintain the integrity of raw data. Additional records that should be stored with data include any data flags, instrument diagnostics, data verification results, and calibration results.

DQ 3-H	*The person responsible shall archive raw data collected from continuous ambient air monitoring stations separate and distinct from the validated data.*

4.0 Data Verification and Validation

Data verification and validation techniques are used to accept, reject, or qualify data in an objective and consistent manner. Data verification is primarily an evaluation of instrument or system performance, and is usually performed during or shortly after data collection activities, while data validation consists of actual qualification of data validity.

Software systems used to support data review and validation should have both graphical and tabular display and validation support capabilities. Tabular data review is valuable for identifying actual start and end times for data issues, but graphical displays can show behavior, relationships among parameters, outliers, and subtle changes that can be easily overlooked in tabular displays.

Basic steps involved in the data verification and validation process are presented here according to the following progressive levels:

- Level 0 - Preliminary Verification;
- Level 1 - Primary Validation;
- Level 2 - Final Validation;
- Level 3 - Independent Data Review; and
- Post-Final Validation.

4.1 Validation Process Records

During data validation, a number of decisions are made regarding whether data are valid, if data adjustments are necessary to obtain valid data, or if data do not meet acceptance criteria and are considered invalid. Data are identified as invalid using data validation codes.

4.1.1 Data Validation Codes

A data validation code is an indicator of validity or an indicator of the fact and reason that a data point is invalid or missing. Organizations may utilize a variety of different data validation codes internally, but it is necessary that the codes are consistent for all data submitted to central data repositories such as Alberta's Ambient Air Quality Data Warehouse. Data validation codes (both flags and qualifiers) currently available for continuous ambient data submission are provided on the AMD website.

A data flag is a code added to explain why a data point is missing (e.g., "C" for calibration or "P" for power failure). A data qualifier is a code added to a data point, which may or may not be valid, to describe the quality or characteristics of the data point (e.g., ">" for over range, or "L" for local interference).

DQ 4-A	*For all continuous ambient air data, the person responsible shall:* *(a) assign a data validation code to:* *(i) flag missing data;*

> (ii) *qualify data that fall outside the instrument's normal operating range; and*
> (iii) *qualify anomalous data that are deemed to be valid after review;*
> (b) *leave data validation codes blank for all valid data, besides those qualified in DQ 4-A(a)(iii);*
> (c) *define the data validation codes used internally in a QAP or associated SOP; and*
> (d) *translate internal data validation codes to equivalent codes accepted by Alberta's Ambient Air Quality Data Warehouse for reporting purposes.*

Valid data points will not have an associated data validation code. Validation codes are only added when data are missing or there is something anomalous to qualify. As per DQ 4-A(a)(iii), data points that appear anomalous, but that have been reviewed and deemed to be valid, are assigned a validation code. The list of current validation codes for submission to Alberta's Ambient Air Quality Data Warehouse is available from the AMD website.

4.1.2 Data Validation Logs

Data validation logs are used to provide a record of the validation process by summarizing and justifying decisions regarding application of validation codes. Record of any data adjustments, deletions, or modifications create an audit trail for all flagged and edited data and can save time and effort if questions arise about specific data at a later date. To ensure a defensible audit trail, suspect or invalid data should not be deleted.

> *DQ 4-B The person responsible shall keep a validation log that describes the basis or justification for all data validation activity for each continuous ambient air monitoring station.*

Data Validation Log entries should include the following information:

- who performed the validation action;
- when the validation action was completed;
- the parameter(s) affected;
- the identification of, and justification for, any data adjustments or invalidations;
- a brief description of any corrective action performed to address data issues;
- the identification of, and justification for, the validity of anomalous data or outliers; and
- any additional entries for post-validation changes.

4.1.3 Data Completeness Criteria

DQ 4-C	*The person responsible shall maintain, at a minimum, 90 per cent operational time for each continuous ambient monitoring instrument and accompanying data recording system, on a monthly basis for each parameter monitored.*

When calculating data completeness, data collected during QA/QC activities and any zeros, spans, calibrations, audit checks, or equipment start-up/stabilization are not included.

To minimize the risk of data loss when a data acquisition system goes down, some sort of back up (whether electronic, chart recorder or internal analyzer memory) should be used.

DQ 4-D	*When continuous ambient monitoring periods cover three months or less, the person responsible shall:* *(a) maintain at a minimum 90 per cent operational time for each instrument for the overall monitoring period,* *(b) extend monitoring to meet 90 per cent operational time for each instrument, or* *(c) if an instrument is operational for less than 75 per cent of the time in any calendar month, monitor for a new 30 day monitoring period.*

In the condition described in DQ 4-D (b), monitoring would be extended to meet the 90 per cent operational time based on the total number of hours lost in the monitoring period.

Monitoring should be scheduled to commence at the beginning of a calendar month in order to collect a full month of data.

4.2 Level 0 – Preliminary Verification

Level 0 data are raw data obtained directly from the data acquisition system or directly from the instrument. Under preliminary verification, these data may undergo a certain amount of manual or automated screening and flagging. Typical screening checks should include the following:

- identification of periods of missing data;
- verification of time stamps against reference time;
- verification that instrument diagnostics/datalogger flags indicate normal operation;
- comparison of data to upper and lower limits (e.g., physical limits, such as instrument thresholds, or limits established based on experience or historical data);
- rate-of-change flagging indicating that data changed too rapidly or not at all; and
- verification that zero, span, and multipoint performance checks are within specifications.

Most data acquisition systems have the capability to automatically flag and log comprehensive sets of instrument diagnostic data. Collection of instrument diagnostic parameters can be a very effective way to quickly identify and mitigate data quality problems.

Manual review of data graphs by experienced personnel is also recommended, as human judgment may compel reversal of an automated screening decision. This review should be carried out promptly after data collection and should take into account any field observations available at that time.

Frequent data review (e.g., daily) and prompt troubleshooting of any observed operational problems is recommended to help avoid significant data losses.

DQ 4-E	*If the quality of any recorded ambient data is suspect, the person responsible shall:* *(a) document any data identified as suspect during the preliminary verification process;* *(b) investigate and document the root cause of any data found to be invalid;* *(c) immediately begin any necessary corrective action upon determination of a root cause for invalid data;* *(d) document any corrective action taken; and* *(e) verify the effectiveness of corrective action taken to resolve the root cause.*

Investigation of suspect data may indicate that corrective action is not necessary (e.g., root cause was a brief power failure) or that corrective action is necessary to resume normal operation. Corrective action may involve remote systems adjustments, troubleshooting and repair on-site, or removal of instruments for repair. All data issues identified and corrective action taken should be documented in station log notes.

Organizations conducting ambient air monitoring activities are increasingly making data available to the public in near real-time on websites. Data available in real-time have generally only undergone preliminary verification (e.g., Level 0 data). Disclaimers should be included with all real-time data available to the public indicating that data are not fully validated. In some cases, public feedback may actually assist in data screening by alerting data providers to possible issues.

4.3 Level 1 – Primary Validation

Data validation begins with the outputs from data verification, and involves more thorough evaluation and documentation of issues identified during data screening, along with appropriate application of data validation codes. This level of validation should be performed on a weekly or monthly basis. Recommended validation actions include the following:

- review of all screening flags assigned during preliminary verification;
- review of all supporting site information and documentation;
- review of operational acceptance limits for each parameter/analyzer;
- review of daily zero/span and monthly calibration results for all gaseous parameters; and
- application of any necessary adjustments to data (e.g., baseline adjustments).

4.3.1 Review of Supporting Information and Documentation

All instrument status information, including any instrument diagnostics and datalogger flags applied during screening, should be reviewed carefully to determine data validity implications. In some cases, data that were identified as suspect during manual or automated screening may be determined to be valid following further investigation.

Any additional documentation or instrument diagnostics that were not available at the time of data collection, including station log notes and any calibration and audit records, should be reviewed and evaluated for data validity implications.

4.3.2 Operational Acceptance Criteria

Data validation should consider any instrument specific limitations that may invalidate data.

DQ 4-F	*The person responsible shall document the operational acceptance limits used during validation in a QAP or associated SOPs.*

Operational acceptance limits are specified in the Monitoring Chapter (Chapter 4) of the AMD.

Data which violate acceptance limits should be considered invalid unless other quality control information demonstrates otherwise.

Examples of instrument-specific limitations that may invalidate data include, but are not limited to, temperature tolerances, converter efficiency for NO_2 measurements, and unacceptable ranges of flow rates for particulate measurement instruments with size-cut inlets (e.g., $PM_{2.5}$ and PM_{10} measurements).

4.3.3 Calibration Acceptance Criteria

Calibration checks are used to maintain measurement uncertainty within established acceptance criteria. Calibration acceptance criteria are listed in the Calibration Chapter (Chapter 7) of the AMD.

4.3.4 Over-Range Values

Instrument operating ranges should be configured according to the Monitoring Chapter (Chapter 4) of the AMD. Most analyzers are capable of output ranges far exceeding the required ranges, but actual analyzer output may be limited by analog data signal translations. If over-range values occur regularly, the instrument range should be adjusted to be appropriate for the monitoring situation.

Operating ranges for monitoring instruments are specified in the Monitoring Chapter (Chapter 4) of the AMD.

Over-range values outside of required operating ranges should be invalidated, and instrument ranges should be corrected accordingly (for example relative humidity values > 100% or wind direction values > 360 degrees).

Over-range values outside of required operating ranges, which appear otherwise valid and indicative of anomalously high events (e.g., nearby wildfire), should remain valid.

For over-range values which are kept valid, data validation logs should be used to indicate that an exceptional event occurred and that the over-range value likely underestimates the actual concentration.

4.3.5 Baseline Adjustments

Analyzer zero drift is common in many continuous air quality instruments, and may be evident when the daily minimum concentration, often referred to as the baseline concentration, tends to increase or decrease from normal over a period of days or weeks. Analyzer drift can generally be confirmed by review of zero/span performance checks. A zero offset may be estimated from the lowest ambient measurements at a site, since concentration levels are often low for some pollutants at certain times during a day. Review of data graphs and tabulations allow for detection of uncorrected drift in the zero baseline of a continuous analyzer.

Generally, data affected by analyzer drift can be corrected by adjusting the data accordingly (e.g., a verified +2 ppb drift can be accounted for by subtracting 2 ppb from all data during the affected period). The degree of baseline shift may vary from day to day. Common adjustment approaches include applying a constant offset to all data during the period between adjacent zero checks (e.g., a step-wise adjustment), or interpolating zero adjustments between verified zero checks (e.g., gradually adjusting on a linear basis). These adjustments can be applied automatically by the datalogger or other data processing program, or manually applied during the data validation process.

DQ 4-G	*The person responsible shall maintain all continuous ambient air instruments within calibration specifications set out in the AMD or the instrument manufacturer's specific limits to minimize the need for zero adjustments.*
DQ 4-H	*When applying data adjustments based on zero check data, the person responsible shall (a) review, then (b) accept or reject the data being adjusted, to ensure that erroneous data adjustments are not applied.*

Data adjustments based on span check results should not be applied between instrument multipoint calibrations.

All zero check results should be accepted or rejected individually to ensure appropriate data adjustments are made. If adjustments are small, either adjustment approach is acceptable.

Adjustments based on span results are not recommended.

Upscale adjustments should be limited to actual full calibration adjustments, which are based on multiple upscale checks against a reference standard.

The most appropriate zero baseline adjustment approach should be determined so as to not negatively affect the reported ambient concentration values. Some zero check results may be unreliable due to equipment failure or other issues, and application of automated zero adjustments introduces the risk that erroneous adjustments may be applied to data.

4.3.6 Derived Parameter Relationships

Some continuous parameters are not measured directly by sensors or analyzers, but rather are derived based on measurements of other parameters.

DQ 4-I	*For continuous ambient air parameters not directly measured by sensors or analyzers, the person responsible shall apply adjustments equally to all parameters during validation procedures in order to preserve the relationship between the measured and derived parameters.*

In the case of NO/NO_2/NO_X, any adjustments applied to NO (e.g., baseline or zero adjustments) need to be applied equally to NO_X.

Commercially available NO_X analyzers detect only NO, where NO_2 is converted to NO for measurement purposes. NO_2 is reported as the difference between NO_X and NO. An analyzer can either report these concentrations directly or concentrations can be calculated external to the analyzer. If parameters are reported directly from an analyzer, any rounding after the calculation or translation of signal noise may affect the exact stoichiometry for composite parameters.

Examples of quantitative parameter relationships, along with validation considerations, are listed in Table 1.

Table 1 Validation Considerations for Parameter Relationships

Parameter	Validation Consideration
$NO/NO_2/NO_X$	The sum of nitrogen oxide (NO) and nitrogen dioxide (NO_2) should equal NO_X. When making data adjustments to any of these parameters (such as a baseline adjustment based on zero results) the relationship between these parameters must be preserved.
CH_4/NMHC/THC	The sum of methane (CH_4) and non-methane hydrocarbons (NMHC) should equal total hydrocarbons (THC). When making data adjustments to any of these parameters (such as a baseline adjustment or an adjustment to zero) the relationship between these parameters must be preserved.
PM_{10} and $PM_{2.5}$	If PM_{10} flow is split for measurement of $PM_{2.5}$ (e.g., PM_{10} is split into Coarse Particulate Matter (PM_C) and $PM_{2.5}$), PM_{10} is calculated as the sum of PM_C and $PM_{2.5}$.
VWS, VWD and SDWD	Vector wind speed (VWS) or vector wind direction (VWD) and standard deviation of wind direction (SDWD) should be invalid during the same time periods. If scalar parameters are collected in addition to vector parameters, invalidated scalar wind speed (SWS) or scalar wind direction (SWD) should result in invalid VWS, VWD and SDWD for the same period.
SWS and VWS	SWS can be equal to, but never less than VWS.
Delta Temperature	Delta temperature is calculated as the difference between temperatures measured at two levels. If the temperature is invalid at either level, delta temperature is also invalid.

4.3.7 Below Zero Adjustments

Analyzers are subject to instrument precision and zero noise limitations. The precision of an instrument is the degree of variation about the mean of repeated measurements of the same pollutant concentration. Zero noise is more specifically a measure of the deviations from zero while sampling constant zero air input.

DQ 4-J	*The person responsible shall adjust the continuous ambient hourly averages of all valid negative gas and particulate concentrations to zero pursuant to Table 2 prior to reporting this data.*

For example, a valid -1 ppb ozone reading should be reported as 0 ppb ozone.

It is important to distinguish normal noise from operational issues, as operational issues should be invalidated.

DQ 4-K	*Zero adjustments shall not be applied to sub-hourly intervals prior to aggregation into 1-hour averages.*

All adjustments of negative values to zero should be applied after baseline adjustments are made.

Table 2 lists the applicable reporting requirements, including lower acceptable limits defined for 1-hour $PM_{2.5}$ data adopted from the Canada-wide National Air Pollution Surveillance (NAPS) program.

Table 2 Zero Adjustment Criteria

Aggregation Level	Pollutant	Validation Criteria
< 1-hour	All parameters	All negative values determined valid shall remain negative prior to aggregation into hourly averages
1-hour	$PM_{2.5}$*	$-3 \le PM_{2.5} < 0$ adjusted to 0; $PM_{2.5} < -3$ invalid
	All gases	Below zero values determined valid are adjusted to zero

*Adopted from NAPS criteria (NAPS 2002).

4.4 Level 2 – Final Validation

The purpose of Level 2 validation is to verify that there are no inconsistencies among related data, or among regional data measured at nearby sites. Level 2 validation is a level of review where some general knowledge of pollutant and meteorological behavior can be used to determine if data are suspect.

Dependent data, or additional parameters measured at the same site, can be used to determine if expected parameter relationships exist. Independent data, or data from one or more nearby sites, can be used to verify some degree of regional consistency.

DQ 4-L *The person responsible shall a) identify and b) investigate all anomalous data and outliers collected using validated continuous ambient air data reduced to hourly averages.*

DQ 4-M *Justification for decisions regarding validity of anomalous data or outliers in DQ 4-L shall be recorded by the person responsible in data validation logs.*

DQ 4-N *The person responsible shall a) record decisions regarding the validity of anomalous data and outliers, and b) describe the justification for each decision in the data validation log referred to in DQ 4-M.*

Any anomalous data or outliers identified as inconsistent with dependent or independent data, or not representative of the time or place monitored, should be considered valid unless there is compelling evidence to the contrary.

Suspect data should be investigated by going back and making sure that nothing was missed during primary validation. This would include checking supporting site information and ensuring that validation codes were applied correctly. Further investigation of suspect data may determine that an instrument malfunction or other issue affected data in an unanticipated way.

Data found to be invalid should be treated according to DQ-4E (b), (c), (d), and (e).

Time series plots should be used to review data visually, since time series plots with multiple parameters displayed together can show relationships that are difficult to see with large amounts of tabular data. Some examples of dependent relationships between related parameters are listed below:

- O_3 and NO are often anti-correlated. NO reacts with O_3, which can result in low daytime O_3 in urban areas, and higher O_3 downwind of urban areas.
- O_3 is formed through photochemical process in the atmosphere, and concentrations often increase with higher UV and temperature measurements (e.g., diurnal highs during the middle of the day, and seasonal highs during the summer).
- Pollutant events are often evident in multiple parameters (e.g., PM, NO_X, and hydrocarbon may exhibit similar behavior).
- Pollutant levels might change abruptly if wind direction and wind speed change abruptly.
- PM_{10} particles are inclusive of $PM_{2.5}$, so $PM_{2.5}$ concentrations should not be greater than PM_{10} for collocated analyzers.
- High PM_{10} events are often associated with strong winds.
- Temperature and relative humidity are generally inversely related.
- Values of 0 for wind speed or wind direction for several consecutive hours when ambient temperature is below freezing and relative humidity is high (or precipitation recently occurred) may indicate a frozen sensor.

The above list is not comprehensive, and data contradictory to any of these examples may not be invalid, but may warrant additional investigation.

Independent data sets (e.g., site-to-site comparisons) are especially useful for meteorological data, as these parameters are often fairly consistent over large geographic areas. Data points originally identified as outliers could be justified as valid by citing similar spikes or dips during the same approximate time period at a nearby site.

4.5 Level 3 – Independent Assessment

Level 3 validation is a final cursory review of validated data by someone independent of both field operations and primary data validation. The intent of this level of review is not to repeat primary validation tasks, but rather to assure that data have undergone a final independent QA review and endorsement before data are submitted.

DQ 4-O	*The person responsible shall conduct a final data review using an individual independent of both field operations and primary data validation activities prior to submission to the Regulator.*
DQ 4-P	*The person responsible shall a) record and b) report certification statements from the individual in DQ 4-O in accordance with the Reporting Chapter of the AMD.*

The independent reviewer should have some knowledge of pollutant and meteorological behavior and be familiar enough with the site to evaluate data based on expected and historical behavior.

This level of review should involve validated data reduced to hourly averages which are reviewed manually using time series plots.

Any periods of data identified as suspect can be communicated to the data validator for investigation and subsequent data validation modifications, or for additional validation justification prior to data submittal. Certification statements are required for all reports (monthly/annual) and data submitted, as described in the Reporting Chapter (Chapter 9) of the AMD.

4.6 Post-Final Validation Procedures – Annual Validation

Despite the best efforts of all data validators, errors and omissions may occur in the data validation process. If errors or omissions in the data are suspected or discovered after the initial submittal of data, the post-validation step serves to re-evaluate the affected data.

Data reviews on an annual basis can highlight data issues or patterns which were not clear on a monthly basis.

DQ 4-Q	*The person responsible shall review all validated data for the previous calendar year as an annual quality assurance check prior to submitting an annual report to the Regulator.*

This review should include a cursory inspection of annual charts, and basic statistics including comparisons to historical mean, maximum and minimum values. The independent review certification in DQ 4-P should indicate that this annual validation review has been conducted by the person responsible. Annual reports will be submitted with a report certification form to verify that this review has been done, as per the Reporting Chapter (Chapter 9) of the AMD.

5.0 References

NAPS 2002. Memo to NAPS Network Managers, Workshop Participants, and NAPS Data Analysts. January 2002. Personal Communication.

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