Ambient Air Pollution and Meteorological Monitoring Guidance

By

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Technical Services Program
Air Pollution Control Division
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Acronyms

AADT – Annual Average Daily Traffic level on a road

ACU – Acquisition Control Unit

AERMOD - An air quality dispersion model developed from the collaboration of the American Meteorological Society (AMS) and the United States Environmental Protection Agency (EPA), the working group known as the **A**MS/**E**PA **R**egulatory **M**odel **I**mprovement **C**ommittee (AERMIC).

APCD - Colorado Air Pollution Control Division

ASOS – Automated Surface Observing System

ATSDR – Agency for Toxic Substances and Disease Registry

BAM – Beta Attenuation Monitor

California EPA – Environmental Protection Agency of the State of California

CFR – Code of Federal Regulations

CO – Carbon Monoxide

DCP – Data Collection Package

EA – Environmental Assessment

EIS – Environmental Impact Statement

EPA – United States Environmental Protection Agency

EPA AQS – Environmental Protection Agency Air Quality System

IFWS – Ice-Free Wind Sensor

JFD – Joint Frequency Distribution

m – meters

MET – Meteorological

NAD83 – North American Datum, 1983

NAAQS – National Ambient Air Quality Standards

NIST – National Institute of Standards and Technology

NO_2 – Nitrogen Dioxide

NOAA – National Oceanic and Atmospheric Administration

PSD – Prevention of Significant Deterioration

$PM_{2.5}$ – Particulate matter 2.5 microns or less in aerodynamic diameter

PM_{10} - Particulate matter 10 microns or less in aerodynamic diameter

PNNL – Pacific Northwest National Laboratory, Army Corps of Engineers

PRECIP – Precipitation

QA – Quality Assurance

QA/G-5 – The EPA document, "EPA Guidance for Quality Assurance Project Plans"

QA / R-5 – The EPA document, "EPA Requirements for Quality Assurance Project Plans"

QAPP – Quality Assurance Project Plan

REF – Reference

REG – Regulation

SAROAD – Storage and Retrieval of Aerometric Data

SODAR – Sonic Detection and Ranging

SO_2 – Sulfur Dioxide

SPEC / SPECS – Specifications

STAR – Stability Array

ug/m^3 – Concentration unit for air pollutants, micrograms pollutant per cubic meter of air

U-tek – re-usable gel packages of ice substitute, for shipping samples at fixed temperature

UTM – Universal Transverse Mercator coordinates

WMO – World Meteorological Organization

Executive Summary

The "Ambient Air Pollution and Meteorological Monitoring Guidance" document explains procedures for private companies and other governmental agencies monitoring air quality and meteorology voluntarily, or to meet requirements of the Colorado Air Pollution Control Division (APCD). The document discusses how to prepare an ambient air and meteorological monitoring plan for division approval. It discusses content, format, and submittal of the plan. It explains APCD guidance regarding siting, equipment, quality assurance, and quarterly reporting of air quality and meteorological data. The document also contains a useful appendix of relevant federal air monitoring guidance.

I. Introduction: Why Monitor Air Quality and Meteorology?

There are a number of reasons why companies and agencies in Colorado monitor air quality and meteorological conditions. Some of these reasons include:

- To obtain meteorological data for air quality modeling
- To obtain a "background concentration" for use in an air quality impact analysis
- To determine the attainment status of an area in regard to the National Ambient Air Quality Standards
- To satisfy Pre- or Post-Construction Monitoring requirements for a Prevention of Significant Deterioration permit issued by the APCD
- To satisfy requirements in a construction or combined operating/construction permit issued by the APCD
- To satisfy requirements in a permit issued by the Colorado Hazardous Waste Management Division
- To obtain data for use in an Environmental Impact Statement or Environmental Assessment
- To obtain data for use in a planning document, such as a Resource Management Plan for the Forest Service or Bureau of Land Management
- To collect data for use by neighbors or local governments
- To determine ambient impacts from an air pollution source.

When data is collected for regulatory or informational purposes, the Colorado Air Pollution Control Division (APCD) requires that it satisfy United States Environmental Protection Agency (EPA) procedures and guidance. As part of this process, the APCD requires the submission and approval of an air quality and meteorological monitoring plan. Air monitoring projects must also submit quarterly reports of the monitoring data. This document describes the requirements and contents of these monitoring plans and reports.

II. Determination of Which Air Quality and Meteorological Parameters to Monitor

Before beginning the development of an air quality and meteorological monitoring plan, the appropriate technical staff of the Continuous Monitoring and Data Systems Support Unit (CMDSS) and the Modeling, Meteorology, and Emission Inventory Unit (MMEIU) of the APCD/Technical Services Program determine which air quality and meteorological parameters to measure. Generally, the meteorological parameters monitored are determined by the air quality model that is used. A list of the minimum requirements for AERMOD is given as Figure 4 in Appendix A. The pollutants monitored are often determined by regulation (Prevention of Significant Deterioration, for one example), or by permit requirements.

The first step in a monitoring project is to decide which meteorological and air quality parameters to monitor, and to get APCD concurrence with the choices. To obtain concurrence, contact the MMEIU Unit with a description of the facility (type, location, emissions), the reason for the monitoring, and a list of the parameters to be monitored. Obtaining APCD concurrence on the project scope, before developing the monitoring plan, will save time and shorten the project review cycle.

It should be noted that some projects may consist of only meteorological monitoring. However, any measurement of air pollutant concentrations includes concurrent meteorological monitoring. This is because meteorology affects air pollution concentrations. Generally, the minimum height for wind speed and wind direction monitoring is 10 meters above ground. Depending on the site and pollution source geometry, higher levels of wind speed and wind direction data are often required. This means that many meteorological monitoring towers will have multiple levels. Thus, the proposal of which parameters to monitor should also include the height(s) at which they are sampled.

III. Choosing the Monitoring Location(s)

After the project has determined which air quality and meteorological parameters will be monitored, the monitoring locations need to be chosen. The project should obtain APCD approval of the monitoring location(s), prior to developing the plan. In order to obtain approval of the monitoring location(s), please send information regarding them to the CMDSS and MMEIU Units. The current coordinator for monitoring plan review and approval is Nancy Chick (303-692-3226 or nancy.chick@state.co.us). The monitoring location proposal must include the following elements:

- It must describe the reason for choosing this particular monitoring location.

- It must demonstrate that monitoring locations meet federal siting guidance in 40 Code of Federal Regulations (CFR) 58, Appendices D and E.

- For regulatory monitoring and modeling, it must demonstrate that monitoring locations meet EPA's Ambient Monitoring Guidelines for Prevention of Significant Deterioration and Meteorological Monitoring Guidance for Regulatory Modeling Applications.

- It must include maps, one showing the general location within Colorado, and one with a close-in view of the project area.

- It must include monitoring site coordinates (Universal Transverse Mercator or Latitude-Longitude), with the datum of the coordinates (such as NAD83).

- It must include site photographs, showing views in 4 cardinal directions (North, South, East, and West), taken from the proposed monitor location and including the ground cover of the area. Additional photographs showing potential air flow obstructions, such as nearby buildings, trees or topographic features should also be included.

- It must include distance to, and height of, all nearby obstructions to air flow to the monitor. Such obstructions can include trees, buildings, and topographic features.

- It must include the location(s) and height(s) of the air monitoring probes.

- It must include distance to the nearest roads and their average annual daily traffic (AADT), which can be obtained from the Colorado Department of Transportation website (currently at http://apps.coloradodot.info/dataaccess/). An estimate of AADT can be used for low traffic and dirt or gravel roads.

- It must include the information in Section II, above, regarding the parameters the project will monitor.

The appropriate technical staff of the CMDSS and/or MMEIU Units will respond to the monitoring site proposal with approval, further questions, or alternate suggestions regarding the monitoring locations. After the project and the APCD have reached concurrence on the parameters monitored and the site locations, the monitoring plan can be developed.

IV. Format of the Monitoring Plan

The monitoring plan may follow any format that is useful to the project, and comprehensible to the APCD. However, two formats that are commonly used are the PSD format and the QA/R-5 formats used by the Environmental Protection Agency. The plan may be in document control format (each section with a version, and date – See Figure 3 in Appendix A). However, the APCD does not require this.

PSD Format

The EPA document, "Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD), EPA-405/4-87-007, May 1987 has a table, Table I, Minimum Contents of a Monitoring Plan, which is reproduced as Figure 1 in Appendix A of this document. This format can be used to present the plan information.

PSD Guidelines Document web address:
http://www.epa.gov/ttnamti1/archive/files/ambient/criteria/reldocs/4-87-007.pdf

QA/R-5 Format

The EPA document, "EPA Requirements for Quality Assurance Project Plans", EPA QA/R-5, EPA/240/B-01/003, March 2001, gives project elements required in a monitoring plan. A companion document, "EPA Guidance for Quality Assurance Project Plans", EPA QA/G-5, EPA/240/R-02/009, December 2002, gives more details. Table 1 of EPA QA/G-5 summarizes these elements, and is reproduced as Figure 2 in Appendix A of this document. This format can be used to present the plan information. It should be noted that the EPA now requires all quality assurance project plans, for all environmental sampling projects in all media, to follow this format. Therefore, it may be efficient to use this format, if one expects to develop similar monitoring plans for EPA or other states in the future.

QA/R-5 EPA Requirements for Quality Assurance Project Plans web address:
http://www.epa.gov/quality/qs-docs/r5-final.pdf

QA/G-5 EPA Guidance for Quality Assurance Project Plans web address:
http://www.epa.gov/quality/qs-docs/g5-final.pdf

An initial draft of the monitoring plan, in electronic format, should be sent to the CMDSS Unit. The current coordinator for monitoring plan review and approval is Nancy Chick (303-692-3226 or nancy.chick@state.co.us). The APCD will review the draft. Typically, the APCD provides a response letter with comments and suggested changes. After all questions and issues are resolved, the APCD approves the plan. Once the plan is approved, the applicant should provide two hard copies and an electronic copy of the final version to APCD.

V. Elements of the Monitoring Plan

Regardless of the plan format chosen (see Section IV), all air quality and meteorological monitoring plans must cover certain information in order to be approved. This required information is described in Sections VI to XXV.

VI. Signature Page

An example format for the signature page is given as Figure 5 in Appendix A of this document. The signature page indicates that the APCD has approved the plan, and that the monitoring project agrees to collect all data according to the plan provisions. The signature page should contain:

- The Company or Monitoring Organization Name
- The Project Name
- Space for Project Leader to Sign the plan, with job title and date
- Space for APCD to Sign the plan

  (i.e., Air Pollution Control Division, Technical Services Program representative, with date)

VII. Project Description

This section of the plan should include information developed for Sections I and II above. The company or agency, reason for monitoring, and parameters to be monitored should be fully described. If the monitoring is being required because of construction or modification of a facility, the facility should be described with enough detail to perform credible dispersion modeling. The meteorological monitoring should be described, including the height(s) at which parameters such as wind speed, wind direction, and temperature are being measured. Include the reasons for conducting the monitoring, and the anticipated use of the data. It is especially important to indicate whether the meteorological data will be used for atmospheric dispersion modeling, and

whether the project is addressing federal Prevention of Significant Deterioration requirements. If monitoring is being done as a result of an APCD air pollution permit requirement, the permit number and the permit provision requiring monitoring should be cited.

The temporal period of the monitoring project (what time periods to monitor, and for how long monitoring will be conducted), should also be described. The plan should note that monitoring may occur for longer than planned if air pollution exceedances occur, or if data quality and recovery goals are not met.

VIII. Site Description

This section re-iterates the items previously supplied to the APCD under Section III, Choosing the Monitoring Location. Ideally, APCD has already approved the monitoring site(s) at this point. However, the items supplied under Section III need to be included in the monitoring plan.

IX. Personnel Description

The project should describe how the work will be accomplished. This includes a listing of any air monitoring firms and subcontractors, any laboratories involved, and who will be the site operator for routine visits. The plan should also include the individuals involved in quality assurance and auditing of the instrumentation. An organizational chart of personnel and reporting relationships is also required. An example organizational chart is shown as Figure 6 in Appendix A of this document. Any specialized training or experience of project personnel should also be described.

X. Equipment Description

The equipment used for meteorological and air pollutant monitoring must be described fully in the plan. Equipment descriptions must address the following items:

- All pollutant monitoring must be conducted using instruments that have EPA reference or equivalence status.

- All measuring devices (e.g., thermometers, barometers, and flow transfer standards) used to calibrate and audit the pollutant or meteorological monitoring instruments must have traceability to the National Institute of Standards and Technology (NIST).

- Meteorological equipment must meet specifications listed in the following documents:

The EPA document, "Ambient Monitoring Guidelines for Prevention of Significant Deterioration" (PSD), EPA-405/4-87-007, May 1987.
Web Address:
http://www.epa.gov/ttnamti1/archive/files/ambient/criteria/reldocs/4-87-007.pdf

The EPA document, "Meteorological Monitoring Guidance for Regulatory Modeling Applications", EPA-454/R-99-005, February 2000.
Web Address:
http://www.epa.gov/scram001/guidance/met/mmgrma.pdf

- Equipment must be listed in tables that show the manufacturer, model number, instrument specifications, etc.

- Manufacturer's specification sheets for all equipment must be provided. These can be placed in an appendix to the plan.

- Auxiliary devices such as aspirators for temperature and relative humidity sensors, and wind screens for precipitation buckets, must also be described.

- The data logger and site communications should be described. Include a chart showing how all parameters will be recorded. (For example, delta temperature is recorded to the nearest 0.01 degree C).

XI. Meteorological Monitoring

The plan must fully describe all monitoring. Special considerations for meteorological monitoring include:

- All meteorological parameters monitored must be listed in tables that detail how the data acquisition system is scanning, processing, and recording data. The tables must show the significant figures for the data (e.g., delta temperature is reported to the nearest 0.01 degree C).

- Meteorological data must be reported for both 15-minute and one hour averaging periods.

- Meteorological data must be reported in an electronic format, such as an excel spreadsheet or comma-separated, columnar format. This may be any format that is typically used by your organization. There should be an associated file that explains the format. Additionally, the data must be processed into text strings suitable for input into the Environmental Protection Agency's Air Quality System (AQS) format. Appendix E provides additional information regarding this format.

- Meteorological equipment must be calibrated at least two times per year. Meteorological equipment must undergo an independent audit at least two times

per year. APCD recommends that these be done in alternate quarters (calibrate in quarters 1 and 3, audit in quarters 2 and 4), so that the meteorological instruments are checked every three months.

- The plan should include standard operating procedures for installing, maintaining, and calibrating meteorological equipment and recording data.

- For modeling use, meteorological data recovery must meet provisions of the EPA document, "Meteorological Monitoring Guidance for Regulatory Modeling Applications", EPA-454/R-99-005, February 2000. This is 90% joint recovery for all parameters, for each quarter monitored.

- Data must be processed in to joint frequency distributions of wind speed and direction for each stability class. These distributions are prepared for each quarter, and for the year. An example is given as Figure 8 of Appendix A. Joint frequency distributions must be provided in electronic format, such as in a spreadsheet.

XII. Gaseous Monitoring

The plan must fully describe all monitoring. Special considerations for gaseous monitoring include:

- All gaseous parameters monitored must be listed in tables that detail how the data acquisition system is scanning, processing, and recording data. The tables must show the significant figures for the data (i.e., ozone is reported to the nearest part-per-billion).

- Gaseous data must be reported for one hour averaging periods. It is acceptable to also include 15-minute periods, as this is being done for the meteorological data.

- Gaseous data must be reported in an electronic format, such as an excel spreadsheet or comma-separated, columnar format. This may be any format that is typically used by your organization. There should be an associated file that explains the format. Additionally, the data must be processed into text strings suitable for input into the Environmental Protection Agency's Air Quality System (AQS) format. Appendix E provides additional information regarding this format.

- Gaseous equipment must be calibrated at least once per quarter. Gaseous equipment must undergo an independent audit every quarter.

- Sites monitoring under federal Prevention of Significant Deterioration (PSD) regulations must participate in the National Precision and Audit Program (NPAP). Contact EPA Region 8 for details. The monitoring plan must describe this participation.

- Gaseous data recovery must meet provisions of the EPA document, "Ambient Monitoring Guidelines for Prevention of Significant Deterioration" (PSD), EPA-405/4-87-007, May 1987. This is 80% recovery for all parameters, for each quarter monitored.

- For quarterly and annual reports, data must be summarized in a table that compares it to the appropriate National Ambient Air Quality Standards (NAAQS). For example, ozone data must list the five one-hour maxima for each quarter and the five 8-hour maxima for each quarter. Carbon monoxide data must include the five highest one-hour averages for the quarter and the five highest 8-hour averages for the quarter. These tables should also list the dates and times these maxima occurred. The annual summary report should include similar tables for the monitoring year.

- The plan should describe how NIST traceability is maintained for each gaseous parameter. For ozone, the plan should detail traceability as described in the EPA document, "Transfer Standards For The Calibration of Ambient Air Monitoring Analyzers For Ozone", Technical Assistance Document, EPA-454/B-10-001, November, 2010. Web Address: http://www.epa.gov/ttnamti1/files/ambient/qaqc/OzoneTransferStandardGuidance.pdf
  An annual comparison of the project's primary ozone standard to the EPA regional standard reference photometer must be conducted.

- The plan must describe procedures for midnight zero and span checks, and precision checks, for all gaseous instrumentation.

- The plan should include standard operating procedures for installing, maintaining, and calibrating monitors and recording data.

XIII. Continuous Monitoring of Particulate Matter ($PM_{2.5}$ and PM_{10})

The plan must fully describe all monitoring. Special considerations for continuous monitoring of particulate matter 2.5 microns or less in diameter ($PM_{2.5}$) and particulate matter 10 microns or less in diameter (PM_{10}) include:

- All continuous particulate parameters monitored must be listed in tables that detail how the data acquisition system is scanning, processing, and recording data. The tables must show the significant figures for the data (e.g., PM_{10} concentrations are reported to the nearest 0.1 ug/m^3).

- Continuous particulate matter data must be reported for one hour and 24-hour averaging periods. It is acceptable to also include 15-minute periods, to be compared with the 15-minute meteorological data.

- Continuous particulate matter data must be reported in an electronic format, such as an excel spreadsheet or comma-separated, columnar format. This may be any format that is typically used by your organization. There should be an associated file that explains the format. Additionally, the data must be processed into text strings suitable for input into the Environmental Protection Agency's Air Quality System (AQS) format. Appendix E provides additional information regarding this format.

- This instrument output file must also be provided in an electronic format, such as an excel spreadsheet or comma-separated, columnar format. For continuous particulate monitors, the electronic format must include all parameters tracked by the instrument. (For example, the Beta Attenuation Monitor (BAM) tracks the status of various data invalidation flags each hour).

- All particulate monitoring equipment must be calibrated at least once per quarter. Particulate monitoring equipment must undergo an independent audit every quarter.

- Sites monitoring under federal Prevention of Significant Deterioration (PSD) regulations must participate in the National Precision and Audit Program (NPAP). Contact EPA Region 8 for details. The monitoring plan must describe this participation.

- Continuous particulate matter data recovery must meet provisions of the EPA document, "Ambient Monitoring Guidelines for Prevention of Significant Deterioration" (PSD), EPA-405/4-87-007, May 1987. This is 80% recovery for all parameters, for each quarter monitored.

- For quarterly and annual reports, data must be summarized in a table that compares it to the appropriate National Ambient Air Quality Standards (NAAQS). One-hour maxima should also be listed for all continuously-monitored pollutants. For example, continuous PM_{10} data must list the five one-hour maxima for each quarter and the five 24-hour average maxima for each quarter. The quarterly mean concentration must also be included. These tables should also list the dates and times these maxima occurred. The annual summary report should include similar tables for the monitoring year.

- The plan should describe how NIST traceability is maintained for each important parameter tracked by the continuous particulate monitoring instrument. For example, the plan should detail traceability for instrument flow rate, temperature, and pressure.

- The plan should indicate whether the instrument is reporting data based on flow rates corrected to "actual" or "standard" temperature and pressure conditions. PM_{10} should be reported in standard temperature and pressure conditions, while $PM_{2.5}$ is reported through calculation at "actual" temperature and pressure conditions.

- The plan should describe how flow rates are checked (in many cases, a monthly instrument flow check is required by EPA).

- The plan should describe required maintenance checks for these instruments.

- The plan should include standard operating procedures for installing, maintaining, and calibrating samplers and collecting data.

XIV. Filter-Based Sampling of Particulate Matter ($PM_{2.5}$ and PM_{10})

The plan must fully describe all monitoring. Special considerations for filter-based sampling of particulate matter 2.5 microns or less in diameter ($PM_{2.5}$) and particulate matter 10 microns or less in diameter (PM_{10}) include:

- All filter-based particulate samplers must be listed in tables that list the sampler used and its performance specifications. The plan must include standard operating procedures for filter installation, filter removal, and filter transport to the laboratory. There must also be a standard operating procedure for all laboratory weighing and chemical analyses. For low-volume samplers, the filters must be transported under temperature-controlled conditions (with ice substitute like U-tek or Blue Ice and maximum / minimum thermometers), as described in the $PM_{2.5}$ procedures. (Low-volume PM_{10} filters must be transported under the same conditions as those required for $PM_{2.5}$ filters).

- Filter-based particulate matter data must be reported for 24 hour averaging periods. The sampling frequency must be included in the plan, for APCD approval. Sample dates should follow the nation-wide sampling schedule. The schedule is generally placed on the EPA web site at:
  http://www.epa.gov/ttnamti1/calendar.html
  This schedule may also obtained by contacting APCD.

- Filter-based particulate matter data must be reported in an electronic format, such as an excel spreadsheet or comma-separated, columnar format. This may be any format that is typically used by your organization. There should be an associated file that explains the format. Additionally, the data must be processed into text strings suitable for input into the Environmental Protection Agency's Air Quality

System (AQS) format. Appendix E provides additional information regarding this format.

- All particulate monitoring equipment must be calibrated at least once per quarter. Particulate monitoring equipment must undergo an independent audit every quarter.

- Sites monitoring under federal Prevention of Significant Deterioration (PSD) regulations must participate in the National Precision and Audit Program (NPAP). Contact EPA Region 8 for details. The monitoring plan must describe this participation.

- All particulate matter data recovery must meet provisions of the EPA document, "Ambient Monitoring Guidelines for Prevention of Significant Deterioration" (PSD), EPA-405/4-87-007, May 1987. This is 80% recovery for all parameters, for each quarter monitored.

- For quarterly and annual reports, data must be summarized in a table that compares it to the appropriate National Ambient Air Quality Standards (NAAQS). For example, PM_{10} data must list the five 24-hour maxima for each quarter. The quarterly mean concentration must also be included. These tables should also list the dates and times these maxima occurred. The annual summary report should include similar tables for the monitoring year.

- The plan should describe how NIST traceability is maintained for each important parameter tracked by the filter-based particulate monitoring instrument. For example, the plan should detail traceability for instrument flow rate, temperature, and pressure.

- The plan should indicate whether the instrument is reporting data based on flow rates corrected to "actual" or "standard" temperature and pressure conditions. PM_{10} should be reported in standard temperature and pressure conditions, while $PM_{2.5}$ is reported through calculation at "actual" temperature and pressure conditions.

- The plan should describe how flow rates are checked (in many cases, a monthly instrument flow check is required by EPA).

- The plan should describe required maintenance checks for these instruments.

- The plan should include standard operating procedures for installing, maintaining, and calibrating samplers and collecting samples.

XV. Air Toxics

For projects that are monitoring toxic air pollutants, there are some additional considerations. Plans for air toxics monitoring should include the following items.

- Air Monitoring should use approved EPA methodologies. Many of these methods can be found in two EPA documents:

  Compendium of Methods for the Determination of Inorganic Compounds in Ambient Air, United States Environmental Protection Agency, Washington, DC 20460, Office of Research and Development, EPA/625/R-96/010a, June 1999.

  Web Address: http://www.epa.gov/ttnamti1/files/ambient/inorganic/iocompen.pdf

  Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air - Second Edition, United States Environmental Protection Agency, Center for Environmental Research Information, EPA/625/R-96/010b, January 1999.

  Web Address: http://www.epa.gov/ttnamti1/files/ambient/airtox/tocomp99.pdf

- The plan should include standard operating procedures for installing, maintaining, and calibrating samplers and collecting samples.

- The plan should describe chain-of-custody for samples that are transported to the laboratory.

- Standard operating procedures for all laboratory analyses should be included. These should provide for quality assurance samples such as blanks, duplicates, and spikes. Detection limits must be determined for all analytes.

- The plan should provide for quarterly audits and calibrations of the air toxics sampling equipment.

- The plan should indicate what levels of concern will be used to analyze the results.

California EPA standards, http://www.arb.ca.gov/toxics/cattable.htm) and the

Agency for Toxic Substances and Disease Registry Minimal Risk Levels
http://www.atsdr.cdc.gov/mrls/index.asp ,
have been used for these projects.

XVI. Calibrations of Equipment

The following considerations must be addressed in the sampling plan.

- Calibrations for all air pollution measurement equipment must be conducted at least once per quarter. The plan should provide for calibrations after equipment replacement or after significant maintenance /repair. The plan must include standard operating procedures that describe the calibration methods.

- Calibrations for all meteorological monitoring equipment must be conducted at least twice per year. The plan should provide for calibrations after equipment replacement or after significant maintenance /repair. The plan must include standard operating procedures that describe the calibration methods.

- The standard operating procedures should include examples of the data sheets used for recording the calibrations for each different piece of equipment.

XVII. Audits of Equipment

The following considerations must be addressed in the sampling plan.

- Audits for all air pollution measurement equipment must be conducted at least once per quarter. The audits must be conducted by an individual who is not involved in day-to-day project operations. The audit must use equipment that is independent of that used for the calibrations. The plan must include standard operating procedures that describe the audit methods.

- Sites monitoring under federal Prevention of Significant Deterioration (PSD) regulations must participate in the National Precision and Audit Program (NPAP). Contact EPA Region 8 for details. The monitoring plan must describe this participation.

- Audits for all meteorological monitoring equipment must be conducted at least twice per year. The audits must be conducted by an individual who is not involved in day-to-day project operations. The audit must use equipment that is independent of that used for the calibrations. The plan must include standard operating procedures that describe the audit methods.

- For meteorological equipment, the APCD recommends that calibrations and audits occur in alternate quarters. For example, calibrate during quarters 1 and 3, and audit during quarters 2 and 4. This provides for a check of the equipment during each quarter. It reduces data loss by catching malfunctions more quickly than checks conducted on a six-month frequency.

- The standard operating procedures should include examples of the data sheets used for recording the audits of each different piece of equipment.

XVIII. Data Recording System

The plan should state which data-logging system is being used, and provide a specification sheet for the system in the equipment specification sheet appendix . The following items should also be addressed in the plan.

- The plan should include a table listing each parameter the logger records, the units data are recorded in, and the significant figures used (e.g., delta temperature is recorded to the nearest 0.01 degree Celsius).

- Examples of the calculations for certain parameters, such as vector wind direction, should be given.

- The system should record meteorological parameters in both 15-minute and one-hour averaging periods.

- Wind gust data should also be archived. Wind gusts should be reported as a "3-second peak" for each 15-minute period, computed in the same manner used by the National Weather Service: (http://www.weather.gov/ops2/Surface/documents/IFWS_BelfordWS_comparison.pdf). Figure 10 in Appendix A is a copy of this National Weather Service document.

- The data downloading, backup and storage must also be described. Any remote queries or downloading of data should also be discussed.

- The procedures for rounding or truncating data at a certain decimal place must be described. (For example, ozone readings are truncated at the parts per billion level). Consult the appendices of 40 Code of Federal Regulations 50 for a description of how to handle each air pollutant, as the rules vary.

XIX. Data Review and Quality Assurance

The plan should detail the data review process, from raw to finished data. Screenings for data should be described. Minimum requirements for quality-assured data should be developed (i.e., data is bracketed by passing calibrations or audits, daily spans are present, etc). The electronic reporting formats for data should indicate when data has been invalidated. The quarterly project reports should include the reasons for any data invalidation that occurred.

XX. Standard Operating Procedures

The plan must include standard operating procedures. Each standard operating procedure should include samples of any data sheets used. Standard operating procedures should be developed for the following activities:

- Weekly inspection/ maintenance visits for meteorological and continuous air monitoring equipment.

- Filter change-outs for particulate matter samplers. Include filter transport to the laboratory.

- Calibrations of all equipment.

- Audits of all equipment.

- All analyses conducted in the laboratory (filter weighing, chemical analysis of samples, etc).

- Data review

XXI. Equipment Specification Sheet Appendix

The plan should have an appendix with copies of manufacturer's specification sheets for each piece of meteorological and air pollution measurement equipment used. Auxiliary equipment, such as temperature sensor aspirators and precipitation wind screens, should also be covered.

XXII. Immediate Reporting of Values Greater than 90% of the Applicable National Ambient Air Quality Standard

All monitoring plans must contain provisions for immediate reporting of monitored values at 90% or greater of the appropriate National Ambient Air Quality Standard (NAAQS). For example, the PM_{10} standard for a 24-hour period is 150 ug/m^3. Therefore, the plan must contain a provision that all measured PM_{10} concentrations at 135 ug/m^3 or greater be reported to the APCD within 72 hours of their discovery.

The high pollutant value report should be sent by email to the APCD contact for the air monitoring project. The report should list the high value, as well as all 15-minute and hourly meteorological data collected during the period of high concentrations. The report should mention all routine and any unusual site activities occurring during the

period of interest. If possible, the site should try and obtain photographic evidence of the atmospheric conditions during the period of interest. For example, if smoke intrusion from a nearby forest fire is occurring, the event should be documented by photographs.

XXIII. Additional Requirements

In some cases, the APCD may have additional requirements for specific monitoring projects. For example, we have required that monitoring projects provide a real-time data link that allows the APCD to instantly access project data. This is done because the data is needed for use in our required air pollution level forecasting. The means the project will use to address any additional requirements from the APCD should be described in the plan.

XXIV. Quarterly Reports

The majority of ambient monitoring projects report data to the APCD on a quarterly basis. The report may either be based on a calendar year quarter (April, May, June), or a project-specific quarter (May, June, July). Reports are generally due to APCD 45 days after the end of the monitoring quarter. The project should send two electronic copies of the report, and two copies of the associated data disks. Hard copies of the report may also be included. If a hard copy is not sent, the APCD will print one for our records, using the electronic copy.

The quarterly report should contain:

- All meteorological data, in electronic format, for both 15-minute and one-hour intervals. This may be any format that is typically used by your organization. There should be an associated file that explains the format.

- All air pollutant data, in electronic format.

- Records of all quarterly calibrations.

- Records of all instrument audits.

- Records of precision tests (if required for the project).

- NIST-traceability records for all measurement standards used.

- Calculated percentage data recovery for all parameters monitored.

- The highest 5 values for each pollutant's National Ambient Air Quality Standards averaging periods. The highest 5 one-hour values for all continuously-monitored pollutants.

- Copies of any notices of any readings greater than 90 % of the NAAQS, sent to the APCD during the monitoring quarter.

- Records of weekly site visits.

- Data Sheets for particulate sampler filter installation and removal.

- Chain-of-Custody for samples mailed to a laboratory.

- Laboratory results, and associated laboratory quality assurance checks.

- Spreadsheet or other format, showing how filter particulate concentrations are calculated.

- Joint Frequency Distribution of Wind Speed and Direction, by stability class, for each level of winds monitored (e.g., 10 meter level, 30 meter level, 60 meter level, etc).

- A report narrative, in electronic format.

XXV. Annual Reports

The annual report should be a brief summary, on an annual basis, of the data provided in the quarterly reports. Reports are generally due to APCD 45 days after the end of the monitoring year. The project should send two electronic copies of the report, and two copies of the associated data disks. Hard copies of the report may also be included. If a hard copy is not sent, the APCD will print one for our records, using the electronic copy.

The annual report should contain:

- All meteorological data, in electronic format, for both 15-minute and one-hour intervals, for the full year. All meteorological data must be reported in an electronic format, such as an excel spreadsheet or comma-separated, columnar format. This may be any format that is typically used by your organization. There should be an associated file that explains the format.

- Additionally, the data must be processed into text strings suitable for input into the Environmental Protection Agency's Air Quality System (AQS) format. Appendix E provides additional information regarding this format. AQS text strings are provided at the end of the monitoring year, after APCD and the monitoring organization agree that all data are finalized.

- All air pollutant data, in electronic format, for the full year. All pollutant data must be reported in an electronic format, such as an excel spreadsheet or comma-separated, columnar format. This may be any format that is typically used by your organization. There should be an associated file that explains the format. Additionally, the data must be processed into text strings suitable for input into the Environmental Protection Agency's Air Quality System (AQS) format. Appendix E provides additional information regarding this format.

- AQS data format for each parameter of meteorological and air pollutant data.

- Calculated annual percentage data recovery for all parameters monitored.

- The highest 5 values for each pollutant's National Ambient Air Quality Standards averaging periods, for the monitoring year. This would be the highest 5 one-hour values for all continuously-monitored pollutants, along with other averaging periods applicable to that pollutant (e.g. five highest 8-hour values for carbon monoxide). For filter-based measurements, list the five highest 24-hour values.

- Joint Frequency Distribution of Wind Speed and Direction, by stability class, for each level of winds monitored (e.g., 10 meter level, 30 meter level, 60 meter level, etc). This is one frequency distribution for the entire year.

- A report narrative, in electronic format.

XXVI. Report Review by APCD

The APCD will review each report submitted, and send a letter with any comments and questions. After these are addressed, the APCD will approve, disapprove, or partially approve the report. It should be noted that data cannot be used for meteorological modeling, determination of pollutant levels, or satisfaction of permit monitoring requirements, unless it is approved by APCD.

Appendix A

Example Figures for Reporting Formats

Figure 1

Minimum Contents of a Monitoring Plan, PSD Format

Table 1 from the EPA document, "Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD), EPA-405/4-87-007, May 1987.

PSD Guidelines Document web address:
http://www.epa.gov/ttnamti1/archive/files/ambient/criteria/reldocs/4-87-007.pdf

TABLE 1. MINIMUM CONTENTS OF A MONITORING PLAN

I. SOURCE ENVIRONMENT DESCRIPTION (within 2 km of source)

- o topographical description
- o land-use description
- o topographical map of source and environs (including location of existing stationary sources, roadways, and monitoring sites)
- o climatological description
- o quarterly wind roses (from meteorological data collected at the source or other representative meteorological data)

II. SAMPLING PROGRAM DESCRIPTION

- o time period for which the pollutant(s) will be measured
- o rationale for location of monitors (include modeling results and analysis of existing soures in the area)
- o rationale for joint utilization of monitoring network by other PSD sources

III. MONITOR SITE DESCRIPTION

- o Universal Transverse Mercator (UTM) coordinates
- o height of sampler (air intake) above ground
- o distance from obstructions and heights of obstructions
- o distance from other sources (stationary and mobile)
- o photographs of each site (five photos: one in each cardinal direction looking out from each existing sampler or where a future sampler will be located, and one closeup of each existing sampler or where a future sampler will be located. Ground cover should be included in the closeup photograph.)

IV. MONITOR DESCRIPTION

- o name of manufacturer
- o description of calibration system to be used
- o type of flow control and flow recorder

V. DATA REPORTING

- o format of data submission
- o frequency of data reporting

VI. QUALITY ASSURANCE PROGRAM

- o calibration frequency
- o independent audit program
- o internal quality control procedures
- o data precision and accuracy calculation procedures

Figure 2

Minimum Contents of a Monitoring Plan, QA/R-5 Format

The EPA document, "EPA Requirements for Quality Assurance Project Plans", EPA QA/R-5, EPA/240/B-01/003, March 2001, gives project elements required in a monitoring plan. A companion document, "EPA Guidance for Quality Assurance Project Plans", EPA QA/G-5, EPA/240/R-02/009, December 2002, gives more details. Table 1 of EPA QA/G-5 summarizes these elements, and is reproduced below.

QA/R-5 EPA Requirements for Quality Assurance Project Plans web address:
http://www.epa.gov/quality/qs-docs/r5-final.pdf

QA/G-5 EPA Guidance for Quality Assurance Project Plans web address:
http://www.epa.gov/quality/qs-docs/g5-final.pdf

CHAPTER 2

QA PROJECT PLAN ELEMENTS

QA Project Plan specifications are detailed in EPA's Quality Manual and in *EPA Requirements for QA Project Plans (QA/R-5)* (EPA, 2001a). These documents describe the QA Project Plan as divided into four basic element groups covering project management, data generation and acquisition, assessment and oversight, and data validation and usability activities. Each element group is subsequently divided into elements covering different topics; there are 24 elements (Table 1). Not all elements will pertain to every project. In addition, the extent or level of detail written in the QA Project Plan for each element will depend on the type of project, the data to be obtained, the decisions to be made, and the consequences of potential decision errors. For example, for a modeling project or a project using existing information, the elements concerning collecting samples may not pertain. For a basic research project, complete information for many elements may not be available at the start of the project and the plan will be revised as needed.

Table 1. List of QA Project Plan Elements

Group A. Project Management	Group B. Data Generation and Acquisition	Group C. Assessment and Oversight
A1 Title and Approval Sheet	B1 Sampling Process Design (Experimental Design)	C1 Assessments and Response Actions
A2 Table of Contents	B2 Sampling Methods	C2 Reports to Management
A3 Distribution List	B3 Sample Handling and Custody	
A4 Project/Task Organization	B4 Analytical Methods	**Group D. Data Validation and Usability**
A5 Problem Definition and Background	B5 Quality Control	D1 Data Review, Verification, and Validation
A6 Project/Task Description	B6 Instrument/Equipment Testing, Inspection, and Maintenance	D2 Verification and Validation Methods
A7 Quality Objectives and Criteria	B7 Instrument/Equipment Calibration and Frequency	D3 Reconciliation with User Requirements
A8 Special Training/ Certifications	B8 Inspection/Acceptance of Supplies and Consumables	
A9 Documentation and Records	B9 Non-direct Measurements	
	B10 Data Management	

It is not necessary to follow the sequence of elements listed herein. However, some organizations may choose to mandate this format.

Figure 3

Example of Document Control Format

Project #/Name _____
Revision No. _____
Date _____
Page ____ of ____

This figure is taken from Figure 2 in the document, "EPA Guidance for Quality Assurance Project Plans", EPA QA/G-5, EPA/240/R-02/009, December 2002.

QA/G-5 EPA Guidance for Quality Assurance Project Plans web address:
http://www.epa.gov/quality/qs-docs/g5-final.pdf

Figure 4

Minimum Meteorological Parameters for Monitoring

Meteorological Monitoring

The specifications of the meteorological tower and sensors should follow the recommendations in the most recent version of "Meteorological Monitoring Guidance for Regulatory Modeling Applications" (currently EPA-454/R-99-005, February 2000).

For sources with mainly low-level releases, a 10-meter meteorological tower is sufficient. For a source with elevated and low-level releases, a taller meteorological tower may be necessary with additional data levels.

Meteorological instrumentation and measurements for a 10-meter meteorological tower:

- Wind speed, scalar mean (10m)
- Wind direction, scalar mean or unit vector, and sigma-theta (10m)
- Wind gust measurements (10m)
- Temperature difference between 10m and 2m w/matched aspirated radiation shields
- Temperature at 2m
- Solar radiation
- Precipitation (e.g., heated tipping rain gauge)
- Barometric pressure
- Relative humidity
- Additional turbulence measurements (optional)

Projects should be prepared to collect both 15-minute and 60-minute averages for all parameters, and to report them to APCD in electronic format.

Wind Gust Measurements

Wind gust data should also be archived. Wind gusts should be reported as a "3-second peak" for each 15-minute period, computed in the same manner used by the National Weather Service (http://www.weather.gov/ops2/Surface/documents/IFWS_BelfordWS_comparison.pdf). A copy of the document at the previous http hot link is in Appendix A as Figure 9.

Figure 5
Sample Format for Plan Signature Page

ABC Natural Gas Company

DEF Compressor Project
Air Quality and Meteorological Monitoring Plan

For ABC Natural Gas:

Approved By:

Date:

John Smith, Environmental Compliance Officer

For the Colorado Air Pollution Control Division:

Approved By:

Date:

Colorado Air Pollution Control Division,
Technical Services Program

Figure 6
Sample Format for Personnel Organizational Chart

This figure is taken from Figure 3 in the document, "EPA Guidance for Quality Assurance Project Plans", EPA QA/G-5, EPA/240/R-02/009, December 2002.

QA/G-5 EPA Guidance for Quality Assurance Project Plans web address:
http://www.epa.gov/quality/qs-docs/g5-final.pdf

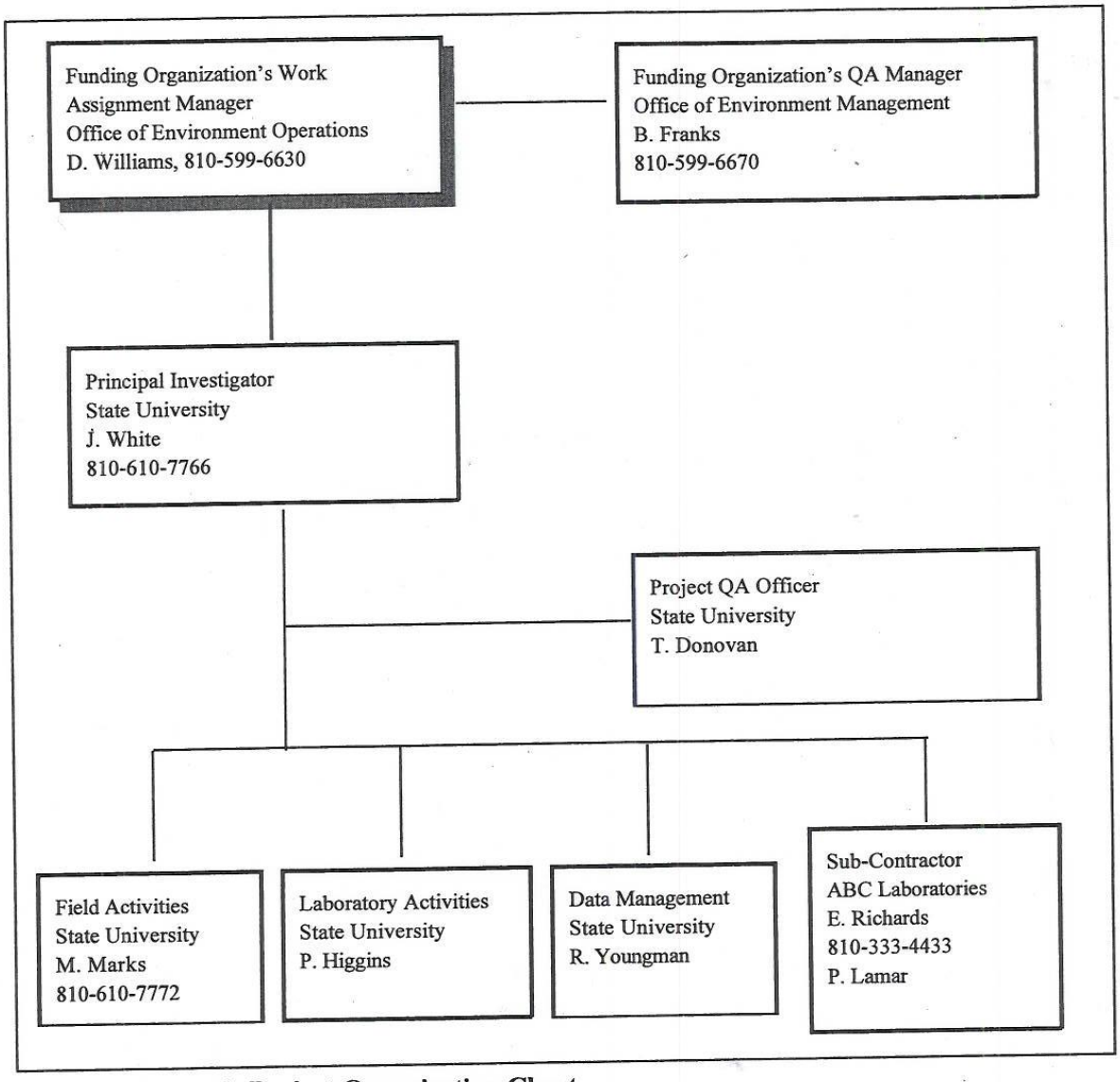


Figure 3. Example Project Organization Chart

Figure 7
Sample Format for Continuous Meteorological and Pollutant Data

ABC Company Air Pollutant and Meteorological Monitoring													
Quarter 1, 2012													
Date	Hour	10 Meter	10 Meter	10 Meter	10 Meter	2 Meter	Delta	Solar	Barometric	Precipitation	Relative	Wind Gust	Wind Gust
	Beginning	Wind	Wind	Sigma Theta	Temperature	Temperature	Temperature	Radiation	Pressure		Humidity		Time
		Speed	Direction	Wind Direction			(10 m - 2 m)						
		meter/sec	Degrees	Degrees	Degrees C	Degrees C	Degrees C	watts/m2	mm Hg	in	Percentage	meter/sec	Hour:Min
1/1/2012	0:00	1.2	236.1	22.8	2.50	2.30	0.20	0	628.7	0	21.3	2.2	23:58
1/1/2012	1:00	1.4	245.8	21.7	2.40	2.35	0.05	0	625.4	0	22.8	2.3	0:27
1/1/2012	2:00	2.8	275.0	3.4	3.30	3.10	0.20	0	622.3	0	23.7	2.5	1:32
1/1/2012	3:00	3.7	276.0	4.5	0.20	0.10	0.10	0	625.8	0	24.1	3.1	2:48
1/1/2012	4:00	8.6	225.0	8.7	0.06	0.05	0.01	0	625.1	0	33.9	1.8	3:19
1/1/2012	5:00	5.6	238.0	9.8	0.03	0.01	0.02	0	624.7	0	32.8	1.6	4:22
1/1/2012	6:00	2.3	355.0	15.0	0.01	0.00	0.01	28	624.8	0	48.9	2.5	5:31
1/1/2012	7:00	1.1	345.0	19.5	0.01	0.00	0.01	157	623.0	0	55.0	3.1	6:54
1/1/2012	8:00	1.0	92.0	45.0	5.20	5.30	-0.10	252	622.9	0	66.8	2.8	7:26
1/1/2012	9:00	2.4	91.0	54.0	5.30	5.45	-0.15	353	621.0	0	79.2	3.5	8:03
1/1/2012	10:00	2.6	107.0	13.7	6.50	6.72	-0.22	487	628.0	0	88.6	2.4	9:14
1/1/2012	11:00	8.8	11.0	18.5	6.10	6.40	-0.30	522	629.0	0.01	98.0	8.7	10:43
1/1/2012	12:00	9.8	98.0	23.8	8.30	9.00	-0.70	689	627.0	0.02	99.4	9.8	11:05
1/1/2012	13:00	11.1	97.0	24.6	8.10	8.90	-0.80	789	632.0	0.05	99.8	12.5	12:58
1/1/2012	14:00	3.3	135.0	13.2	7.40	7.80	-0.40	882	634.0	0	35.5	11.9	13:36
1/1/2012	15:00	3.6	145.0	12.0	7.10	7.20	-0.10	564	635.0	0	36.8	10.3	14:27
1/1/2012	16:00	4.7	184.0	11.9	6.80	6.60	0.20	352	629.0	0	46.7	8.7	15:11
1/1/2012	17:00	2.1	355.0	12.3	6.10	5.95	0.15	221	628.0	0	55.2	2.1	16:25
1/1/2012	18:00	4.1	345.0	57.0	3.00	2.87	0.13	56	628.4	0	68.9	2.6	17:09
1/1/2012	19:00	4.2	272.0	29.7	2.90	2.88	0.02	0	623.1	0	45.0	2.4	18:22
1/1/2012	20:00	4.3	245.6	32.1	2.20	1.10	1.10	0	629.2	0	54.0	3.1	19:39
1/1/2012	21:00	5.5	255.5	5.4	2.30	1.10	1.20	0	623.2	0	64.0	1.8	20:48
1/1/2012	22:00	6.4	275.3	9.8	1.80	1.65	0.15	0	624.9	0	32.3	1.6	21:59
1/1/2012	23:00	2.0	270.1	4.6	1.70	1.62	0.08	0	622.1	0	12.7	1.4	22:33
1/2/2012	0:00	1.0	268.9	2.3	1.60	1.40	0.20	0	623.6	0	11.2	2.2	23:14
1/2/2012	1:00	2.4	261.0	10.8	1.56	1.32	0.24	0	623.1	0	9.8	2.1	0:57
1/2/2012	2:00	2.2	298.0	12.2	1.32	1.23	0.09	0	622.9	0	15.9	1.9	1:51

Figure 8
Joint Frequency Distribution of Wind Speed and Wind Direction by Stability Class

The following example STAR Deck (Joint Frequency Distribution of Wind Speed and Wind Direction by Stability Class), is taken from the document,

"ARAMS/FRAMES JOINT FREQUENCY DATA (JFD) GENERATOR:
An Interface Based on a Revised Version of the EPA STAR Meteorological Joint Frequency Program." Prepared for Engineer Research and Development Center, U.S. Army Corps of Engineers, Vicksburg, MS, under Contract DE-AC05-76RL01830. By J. G. Droppo and M. A. Pelton, Pacific Northwest National Laboratory Richland, Washington 99352, Document PNNL-16149, September 2006.

Web Address:
http://www.pnl.gov/main/publications/external/technical_reports/PNNL-16149.pdf

The following is an example of the sheet for B Class Stability. A full STAR Deck has 7 pages – Individual sheets for Stability Classes A-F, plus a summary page covering all six stability classes.

STATION:: 94823 YEAR: 64 RUN ID: Pittsburgh 1964 cdm2
MONTHS SELECTED: OCT NOV DEC

FREQUENCY DISTRIBUTION

SPEED(MPH)

	DIRECTION	1 - 3	4 - 7	8 - 12	13 - 18	19 - 24	GREATER THAN 24	TOTAL
0	N	.00	.00	.00	.00	.00	.00	.00
0	NNE	.00	.00	.88	.00	.00	.00	.88
0	NE	.00	.00	.38	.00	.00	.00	.38
0	ENE	.00	.00	1.75	.00	.00	.00	1.75
0	E	2.00	1.00	.00	.00	.00	.00	3.00
0	ESE	.88	2.00	.88	.00	.00	.00	3.75
0	SE	.38	.25	.13	.00	.00	.00	.75
0	SSE	1.75	2.75	.00	.00	.00	.00	4.50
0	S	.63	.00	.00	.00	.00	.00	.63
0	SSW	1.25	.00	.00	.00	.00	.00	1.25
0	SW	2.38	.13	.13	.00	.00	.00	2.63
0	WSW	2.75	1.25	.88	.00	.00	.00	4.88
0	W	.63	1.25	1.63	.00	.00	.00	3.50
0	WNW	.38	3.25	.38	.00	.00	.00	4.00
0	NW	.00	1.13	1.13	.00	.00	.00	2.25
0	NNW	.00	.00	.88	.00	.00	.00	.88
	TOTAL	13.00	13.00	9.00	.00	.00	.00	

NUMBER OF OCCURENCES OF B STABILITY = 42

NUMBER OF CALMS WITH B STABILITY = 7.00

Figure 9
National Weather Service 3-Second Gust Data Processing

Cup & Vane Wind Data Processing Within ASOS

Cup & Vane Wind Sensor

At the sensor:

1) Every 1 second, the wind direction and speed are sampled

2 Every 5 seconds, the average of the most recent 5 seconds of data is computed*, producing a discrete "5 second average"

** To the nearest degree and tenth of a knot*

DCP

At the Data Collection Package (DCP):

1) Every 5 seconds, the 5 second average is collected from the sensor and sent to the ACU. NOTE: The DCP acts as a "pass through", i.e. data is not altered by the DCP.

ACU

At the Acquisition Control Unit (ACU):

1) Every 5 seconds, the 5 second average is received from the DCP. Wind speed data are received to the nearest tenth of a knot and are truncated by the ACU to the nearest knot (i.e. 22.8 kts becomes 22 kts).

At this point, the algorithm to compute the observed wind (average direction, speed and peak wind direction and speed) will begin

2) Every 5 seconds, the average speed and direction is computed using the most recent 24 (i.e. 2 minutes) 5 second samples. The peak wind is the 5 second sample with the highest speed.

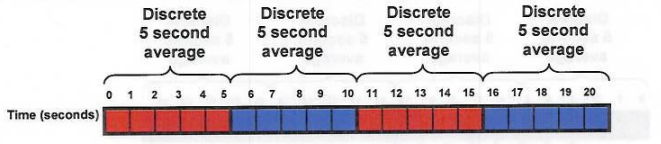
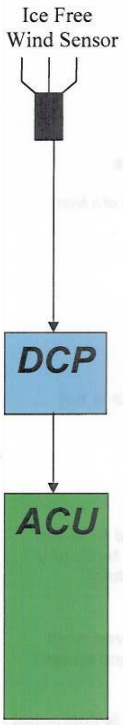


Figure 1

IFWS Wind Data Processing Within ASOS



At the sensor:

1) Every 1 second, the wind direction and speed are sampled

2) Every 1 second, a running average of the most recent 3 seconds of data is computed*, producing the "3 second peak"**

3) Every 5 seconds, the average of the most recent 5 seconds of data is computed*, producing a discrete "5 second average"

** To the nearest degree and tenth of a knot*

*** The running 3 second average is assigned to the 5 second block in which it ends*

At the Data Collection Package (DCP):

1) Every 5 seconds, the 5 second average and the highest 3 second peak collected during the past 5 seconds are collected from the sensor and sent to the ACU.
NOTE: The DCP acts as a "pass through", i.e. data is not altered by the DCP.

At the Acquisition Control Unit (ACU):

1) Every 5 seconds, the 5 second average and the 3 second peak are received from the DCP. Wind speed data are received to the nearest tenth of a knot and are truncated by the ACU to the nearest knot (i.e. 22.8 kts becomes 22 kts).

At this point, the algorithm to compute the observed wind (average direction, speed and peak wind direction and speed) will begin

2) Every 5 seconds, the average speed and direction is computed using the most recent 24 (i.e. 2 minutes) 5 second samples. The peak wind is the 3 second peak wind value from the 5 second sample with the highest 3 second peak wind speed.

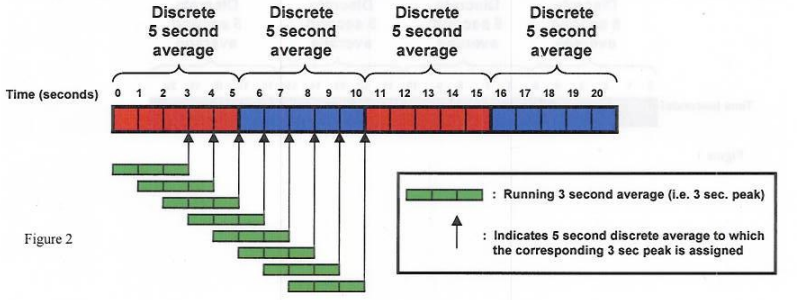


Figure 2

Comparison of IFWS Algorithm to Cup & Vane Algorithm:

***Note: This is a comparison of the algorithms only, not the sensors.**

- **Both algorithms compute the 2 minute average exactly the same way: by averaging 24 discrete 5 second samples.**
- **The 2 minute peak wind using the cup & vane configuration is the 5 second sample within the 24 used to compute the 2 minute average with the highest speed.**
- **The 2 minute peak wind using the IFWS (i.e. sonic) configuration is the value of the 3 second peak from the 5 second sample containing the highest 3 second peak wind speed.**
- **Since the 3 second peak is a running mean, in many cases the 1 second samples that went into it have occurred towards the end of the previous discrete 5 second sample (figure 2). Therefore, it is possible to have a 3 second peak wind value lower than the 5 second average speed.**

NOUS41 KWBC 252021
PNSWSH
PUBLIC INFO. STATEMENT...TECHNICAL IMPLEMENTATION NOTICE 02-30A
NATIONAL WEATHER SERVICE HEADQUARTERS WASHINGTON DC
420 PM EST MONDAY MARCH 10 2003

TO: FAMILY OF SERVICES */FOS/* SUBSCRIBERS...NOAA WEATHER
WIRE SERVICE */NWWS/* SUBSCRIBERS...EMERGENCY MANAGERS
WEATHER INFORMATION NETWORK */EMWIN/* SUBSCRIBERS...
OTHER NATIONAL WEATHER SERVICE */NWS/* CUSTOMERS OF
AVIATION DATA AND FORECASTS...NWS EMPLOYEES

FROM: RAINER DOMBROWSKY
CHIEF...OBSERVING SERVICES DIVISION

SUBJECT: AUTOMATED SURFACE OBSERVING SYSTEM WIND SENSOR
REPLACEMENT

THE FOLLOWING CHANGES HAVE NO DIRECT IMPACT ON NOAA WEATHER WIRE
SERVICE SUBSCRIBERS
THE AUTOMATED SURFACE OBSERVING SYSTEM */ASOS/* PRODUCT IMPROVEMENT
PROGRAM WILL SOON DEPLOY A REPLACEMENT WIND SENSOR. THE NEW SENSOR
WILL REPORT WIND INFORMATION USING THE 3-SECOND WORLD METEOROLOGICAL
ORGANIZATION */WMO/* GUST STANDARD.
THE CURRENT ASOS WIND SENSOR /BELFORT 2000 / USES ROTATING CUPS
TO MEASURE WIND SPEED AND A VANE TO MEASURE WIND DIRECTION. OVER
A 2-MINUTE PERIOD...ASOS USES TWENTY-FOUR 5-SECOND AVERAGES TO
DETERMINE THE 2-MINUTE AVERAGE WIND SPEED AND DIRECTION. EVERY
MINUTE ASOS STORES THE HIGHEST 5-SECOND AVERAGE SPEED FOR THE
PAST MINUTE... ALONG WITH ITS DIRECTION... IN THE 12-HOUR ARCHIVE
FOR ADDITIONAL PROCESSING. THIS HIGHEST SPEED VALUE IS USED TO
DETERMINE IF A GUST AND/OR A PEAK WIND REMARK WILL BE REPORTED.
THE NEW ASOS WIND SENSOR /VAISALA 425NWS / IS A SONIC ANEMOMETER.

IT HAS NO MOVING PARTS AND WILL OPERATE BETTER IN WINTER WEATHER CONDITIONS. AS WITH THE BELFORT SENSOR...OVER A 2-MINUTE PERIOD...ASOS USES TWENTY-FOUR 5-SECOND AVERAGES TO DETERMINE THE 2-MINUTE AVERAGE WIND SPEED AND DIRECTION. BUT THE HIGHEST 3-SECOND RUNNING AVERAGE SPEED IS STORED FOR GUST AND PEAK WIND PROCESSING.

WHILE THERE WILL BE LITTLE DIFFERENCE IN 2-MINUTE AVERAGE WIND SPEED AND DIRECTION REPORTING...THE CHANGES IN GUST AND PEAK WIND REPORTING MAY BE SIGNIFICANT. WE CAN EXPECT TO SEE MORE GUSTS AND PEAK WINDS REPORTED WITH THE NEW SENSOR. THE MASS OF THE MOVING PARTS IN EXISTING SENSORS LIMITS RESPONSIVENESS. THE NEW SENSOR WILL BE MORE RESPONSIVE TO SHORT TERM GUSTS.

Appendix B

Check List for Monitoring Plans

Colorado Air Pollution Control Division

Check List for Air Pollution and Meteorological Monitoring Plans APCD Comments

Project Identity

Company Name	

Project Name	

Description of Facility	

Date Plan Submitted	
Revisions Submitted	

Date APCD Approved Plan	

Colorado Air Pollution Control Division

Check List for Air Pollution and Meteorological Monitoring Plans Yes No APCD Comments

Scope Of Project

Reasons for Monitoring Project (Check all that apply)			
Meteorological Data for Modeling?			
Background Concentrations of Air Pollutants?			
NAAQS Status of the Area?			
PSD Pre-Construction?			
PSD Post-Construction?			
For APCD Permit?			
For Hazardous Waste Division Permit?			
For EIS or EA?			
For Planning Document?			
For Neighbors / Local Government?			
To Indicate Source Compliance with NAAQS?			

Meteorological Parameters Monitored			
Minimum Parameters for AERMOD?			
Height of Parameters Monitored			
10 meters?			
30 meters?			
60 meters?			
Other Levels?			

Air Pollution Parameters Monitored			
CO?			
Ozone?			
NO_2?			
SO_2?			
PM_{10}?			
$PM_{2.5}$?			
Other?			

Colorado Air Pollution Control Division

Check List for Air Pollution and Meteorological Monitoring Plans	Yes	No	APCD Comments
Plan Elements			
Clear and Understandable Organization for Plan?			
In Document Control Format?			
Monitoring Location(s)			
Reason for this Location Described?			
UTMS or Lat-Long and Datum Given?			
Colorado Map?			
Close-In Local Map?			
Site Photographs? (4 Directions Plus Ground Cover)			
Direction and Height of Obstructions?			
Height of Sampling Inlets and Probes Given?			
Meets Federal Siting Guidance?			
APCD Approves of Monitoring Location(s)?			
Signature Page?			
Personnel Described?			
Organizational Chart of Personnel?			
Equipment Description			
Air Pollutant Equipment Has EPA Ref. or Equivalence?			
Air Pollution Measurements have NIST traceability?			
Air Pollution Equipment Listed in Table Giving Specs?			
Met Equipment Meets PSD Guidelines?			
Met Equipment Meets Met Monitoring Guid. for Reg Models?			
Met Equipment Listed in Table Giving Specs?			
Auxiliary Equipment listed? (Aspirator fans, Precip screens, etc).			
Plan Has Appendix with Manufacturer's Spec Sheets for Equipment?			

Colorado Air Pollution Control Division

Check List for Air Pollution and Meteorological Monitoring Plans

Meteorology

	Yes	No	APCD Comments
All Meteorological Parameters Listed in Tables?			
Tables Describe Scanning, Recording, and Significant Figures?			
Meteorological Data Reporting Electronic Format Described?			
3-Second Gusts Recorded?			
15-Minute Averages Reported?			
60-Minute Averages Reported?			
Meteorological Equipment Calibrated 2 Times or More per Year?			
Includes Standard Operating Procedures for calibrations?			
Meteorological Equipment Audited 2 Times or More per Year?			
Auditor is independent of routine operations?			
Auditor has independent equipment?			
Plan includes Standard Operating Procedures for audits?			
Meteorological Equipment Checked Every 3 Months?			
Met Data Recovery To Be 90% or Better for All parameters jointly?			
Project Will Report Joint Frequency Distributions (STAR Decks)?			

Colorado Air Pollution Control Division

Check List for Air Pollution and Meteorological Monitoring Plans	Yes	No	APCD Comments

Gaseous Monitoring

All Gaseous Parameters Listed in Tables?			
Tables Describe Scanning, Recording, and Significant Figures?			

Gaseous Data Reporting Electronic Format Described?			
Data Reported in AQS Format?			
15-Minute Averages Reported?			
60-Minute Averages Reported?			

Gaseous Equipment Calibrated Quarterly?			
Plan includes Standard Operating Procedures for calibrations?			

Gaseous Equipment Audited Quarterly?			
Auditor is independent of routine operations?			
Auditor has independent equipment?			
Plan includes Standard Operating Procedures for audits?			

Gaseous Equipment undergoes daily zero-span check?			
Gaseous Equipment undergoes biweekly precision check?			

Ozone Traceabilty to Regional Standard Reference Photometer?			

Gaseous Recovery To Be 80% or Better for All parameters?			

Project Will Report Highest Concentrations For Quarter in Tables?			
5 Highest Hourly Averages Reported for each pollutant?			
5 Highest Averages for each NAAQS standard reported?			

Colorado Air Pollution Control Division

Check List for Air Pollution and Meteorological Monitoring Plans	Yes	No	APCD Comments

Continuous Particulate Monitoring

All Continuously-Monitored Particulate Parameters Listed in Tables?			
Tables Describe Scanning, Recording, and Significant Figures?			

Continuous Particulate Data Reporting Electronic Format Described?			
Data Reported in AQS Format?			
60-Minute Averages Reported?			
15-Minute Averages Reported?			
24-Hour Averages Reported?			

Continuous Particulate Equipment Calibrated Quarterly?			
Plan includes Standard Operating Procedures for calibrations?			

Continuous Particulate Equipment Audited Quarterly?			
Auditor is independent of routine operations?			
Auditor has independent equipment?			
Plan includes Standard Operating Procedures for audits?			

PM_{10} Data Reported at Standard Flow Rate Conditions?			
$PM_{2.5}$ Data Reported at Actual Flow Rate Conditions?			

Monthly Flow Rate Checks for Instruments?			
NIST Traceabilty for Flow Rate, Temperature, and Pressure?			

Continuous Particulate Recovery To Be 80% or Better for All parameters?			

Project Will Report Highest Concentrations For Quarter in Tables?			
5 Highest Hourly Averages Reported for each pollutant?			
5 Highest Averages for each NAAQS standard reported?			

Colorado Air Pollution Control Division

Check List for Air Pollution and Meteorological Monitoring Plans	Yes	No	APCD Comments

Filter-Based Sampling of Particulate Matter

All Filter-Based Particulate Parameters Listed in Tables?			
Tables Describe Operating Parameters Recorded by Sampler?			
Tables Describe Operating Parameters Recorded Manually?			

Filter-Based Particulate Matter Sampling Frequency Described?			

Filter-Based Particulate Data Reporting Electronic Format Described?			
Data Reported in AQS Format?			
24-Hour Averages Reported?			

Filter-Based Particulate Sampling Equipment Calibrated Quarterly?			
Plan includes Standard Operating Procedures for calibrations?			

Filter-Based Particulate Sampling Equipment Audited Quarterly?			
Auditor is independent of routine operations?			
Auditor has independent equipment?			
Plan includes Standard Operating Procedures for audits?			

PM_{10} Data Reported at Standard Flow Rate Conditions?			
$PM_{2.5}$ Data Reported at Actual Flow Rate Conditions?			

Monthly Flow Rate Checks for Instruments?			
NIST Traceabilty for Flow Rate, Temperature, and Pressure?			

Filter-Based Particulate Sampler Data Recovery To Be 80% or Better?			

Project Will Report Highest Concentrations For Quarter in Tables?			
Quarterly and Annual Arithmetic Mean reported for each pollutant?			
5 Highest Averages for each NAAQS standard reported?			

Colorado Air Pollution Control Division

Check List for Air Pollution and Meteorological Monitoring Plans	Yes	No	APCD Comments

Air Toxics

All Air Toxics Parameters Listed in Tables?			
Lists Air Toxics Sampling Equipment Used?			
Tables Describe How Operating Parameters Recorded?			

Air Toxics Sampling Frequency Described?			

Air Toxics Data Electronic Reporting Format Described?			
Data Reported in AQS Format?			
Time Averaging for Data Reported? (Hourly and/or Daily averages)			

Air Toxics Sampling Equipment Calibrated Quarterly?			
Plan includes Standard Operating Procedures for calibrations?			

Air Toxics Sampling Equipment Audited Quarterly?			
Auditor is independent of routine operations?			
Auditor has independent equipment?			
Plan includes Standard Operating Procedures for audits?			

Air Toxics Data Reported at Standard Flow Rate Conditions?			
Air Toxics Data Reported at Actual Flow Rate Conditions?			

How is Flow Rate Determined for Air Toxics Instruments?			
NIST Traceabilty for Flow Rate, Temperature, and Pressure?			

Air Toxics Sample Data Recovery To Be 80% or Better?			

Project Will Report Highest Concentrations For Quarter in Tables?			
Quarterly and Annual Arithmetic Mean reported for each Air Toxic?			
5 Highest Averages for each Air Toxic reported?			

Colorado Air Pollution Control Division

Check List for Air Pollution and Meteorological Monitoring Plans	Yes	No	APCD Comments

Quality Assurance

Equipment Maintenance Requirements Described?			
For Met Equipment?			
For Gaseous Equipment?			
For Continuous Particulate Monitoring Equipment?			
For Particulate Sampling Equipment?			
Spare Parts Inventory Maintained?			

Standard Operating Procedures Included?			
For Operator Site Visit for Meteorology?			
For Operator Site Visit for Gaseous Pollutants?			
For Operator Site Visit for Continuous Particulate Monitors?			
For Operator Site Visit for Filter-Based Particulate Samplers?			
For Sample Filter Transport to Laboratory?			
Chain-of-Custody Form Included?			
$PM_{2.5}$ or low-volume PM_{10} filters transported on ice?			
For Sample Filter Weighing at Laboratory?			
For Sample Filter Chemical Analyses at Laboratory?			
Data Recording System (Logger / Computer) Described?			
Examples of Data Logger Calculations included?			
For Standard Deviation of Horizontal Wind Direction?			
For Vector / Scalar Wind Data?			
Data Downloading, Backup, and Storage Described?			
Is there capability to access data remotely?			

Data Validation and Verification Described?			
Data Screening Criteria Used?			
Standard Operating Procedure for Data Review Included?			

Colorado Air Pollution Control Division

Check List for Air Pollution and Meteorological Monitoring Plans	Yes	No	APCD Comments

Reporting

Immediate Reporting of Values >/= to 90% of the NAAQS Included?			

Additional Requirements			
APCD Link for Immediate Access to Data Included?			
Data to be Provided in EPA AQS Format?			
List Any Additional Requirements for Project			

Quarterly Reports Described?			

Annual Reports Described?			

Miscellaneous Review Issues			

Any Other Comments			

Appendix C

SODAR Procedures

SODAR Quality Assurance

A good example of SODAR quality assurance measures is found in:

Colorado Power Project Ambient Monitoring Plan
ENSR \ AECOM Corporation
December 2006
Document No.: 06808-017-210

This document was prepared for the Tri-State Generation and Transmission Association Site at Holly, Colorado, which ran from 2007 - 2008.

Measures this plan addresses include the following.

1. **Siting.**

   Document that the following were addressed in the initial siting decision.

   Check site noise levels by using a sound meter.

   Document sources of ambient noise (roadways, nearby objects, etc).

   Inspect land use in the area, to look for structures that could interfere with the sending and return of audio signals. (These could include: trees, telephone lines, fences, berms, local topography etc).

   Avoid electric or magnetic interferences

   Follow manufacturer's guidance concerning installation of antennas, data cables, alignment to true north, etc.

2. **Sodar Measurements**

   Horizontal wind speed, wind direction, and sigma theta

   Vertical wind speed and sigma-w

   Measured every 50 meters, from a height of 50 meters up to 400 meters or more.

3. **Sodar Description**

   Verbal description of the sodar measurement principle, the individual equipment being used, and the data acquisition system.

4. **Standard Operating Procedures**

   The plan should include standard operating procedures describing installation, operation, maintenance, weekly site checks, audit comparisons to a collocated fixed tower, and data quality assurance / data processing / data validation.

5. Weekly Site Checks

The weekly site visit should address the following:

- Proper operation
- Clearing snow, leaves, etc. from the antenna
- Use level to check that the antenna base is horizontal
- Check antenna orientation
- Siting (Look for any changes that could interfere with signals, or cause echoes. Check local noise level).
- Electronic Status Checks
- Check status of paper and electronic data storage media
- Check pulses by listening for echoes, or weakening of signal
- Check heater
- Check if data are reasonable by comparing to the current meteorological conditions, and to data from a similar level on a fixed tower.

6. Sodar Audits

- Audit Frequency is:

  At installation
  Every 6 months
  At close-out of station

- Address Site Evaluation (obstructions, potential for other noise or interference). Re-check some of the items discussed in Number one, above).
- Conduct electronic status checks (see manufacturer's recommendations)
- Audit is done by comparing hourly sodar data for one level with a similar level on a fixed tower system. Two – three days of data are compared.

7. System Audits

The system audits should include procedures to re-check siting, including the potential for echoes or noise interference.

8. **Acceptability Standards for Sodar Data**

   Describe how many minutes are needed for a valid hourly average.

   Describe how many height levels should be valid for acceptable operation.

   Check data to see if nearby objects are causing interference.

   Periodic comparisons to similar level on fixed meteorological tower.

Important Guidance Documents

Meteorological Monitoring Guidance for Regulatory Modeling Applications, EPA-454/R-99-005. February 2000.
United States Environmental Protection Agency
Office of Air and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711.

Web Address: http://www.epa.gov/scram001/guidance/met/mmgrma.pdf

Quality Assurance Handbook for Air Pollution Measurement Systems
Volume IV: Meteorological Measurements Version 2.0 (Final)
EPA-454/B-08-002. March 2008.
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Air Quality Analysis Division
Measurement Technology and
Ambient Air Monitoring Groups
Research Triangle Park, North Carolina, 27711

Web Address:
http://www.epa.gov/ttnamti1/files/ambient/met/Volume%20IV_Meteorological_Measurements.pdf

Appendix D

References and Monitoring Resources

References and Monitoring Resources

Regulations

Web Link for All Code of Federal Regulations (CFR) citations:

CFR Web Link: http://www.gpo.gov/fdsys/

40 Code of Federal Regulations (CFR) 50 (National Primary and Secondary Ambient Air Quality Standards).

This section lists the National Ambient Air Quality Standards (NAAQS), describes how they are calculated, and defines the accepted methods for monitoring these air pollutants.

40 Code of Federal Regulations (CFR) 58 (Ambient Air Quality Surveillance), Appendix A, Quality Assurance Requirements for SLAMS, SPMs and PSD Air Monitoring.

40 Code of Federal Regulations (CFR) 58 (Ambient Air Quality Surveillance), Appendix C, Ambient Air Quality Monitoring Methodology.

40 Code of Federal Regulations (CFR) 58 (Ambient Air Quality Surveillance), Appendix D, Network Design for State and Local Air Monitoring Stations (SLAMS), National Air Monitoring Stations (NAMS), and Photochemical Assessment Monitoring Stations (PAMS).

40 Code of Federal Regulations (CFR) 58 (Ambient Air Quality Surveillance), Appendix E, Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring.

Guidance

Prevention of Significant Deterioration

"Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD), EPA-405/4-87-007, May 1987.

PSD Guidelines Document web address:
http://www.epa.gov/ttnamti1/archive/files/ambient/criteria/reldocs/4-87-007.pdf

EPA Quality Assurance Project Plan (QAPP) Guidance

"EPA Requirements for Quality Assurance Project Plans", EPA QA/R-5, EPA/240/B-01/003, March 2001.

QA/R-5 EPA Requirements for Quality Assurance Project Plans web address: http://www.epa.gov/quality/qs-docs/r5-final.pdf

"EPA Guidance for Quality Assurance Project Plans", EPA QA/G-5, EPA/240/R-02/009, December 2002.

QA/G-5 EPA Guidance for Quality Assurance Project Plans web address: http://www.epa.gov/quality/qs-docs/g5-final.pdf

"EPA Guidance for Preparing Standard Operating Procedures (SOPs)", EPA QA/G-6, EPA/600/B-07/001, April 2007.

QA/G-6 EPA Guidance for Preparing Standard Operating Procedures web address: http://www.epa.gov/quality/qs-docs/g6-final.pdf

EPA Meteorological Monitoring Guidance for Regulatory Modeling Applications

"Meteorological Monitoring Guidance for Regulatory Modeling Applications", EPA-454/R-99-005, February 2000.

Meteorological Monitoring Guidelines web address: http://www.epa.gov/scram001/guidance/met/mmgrma.pdf

National Weather Service Three- Second Wind Gust Guidance

Wind gusts should be reported as a "3-second peak" for each 15-minute period, computed in the same manner used by the National Weather Service.

Web Address: http://www.weather.gov/ops2/Surface/documents/IFWS_BelfordWS_comparison.pdf

EPA Quality Assurance Handbook (Red book) Guidance

Quality Assurance Handbook for Air Pollution Measurement Systems Volume I: A Field Guide to Environmental Quality Assurance, EPAI600/R·94/038a, April 1994.

Web Address: http://www.epa.gov/ttnamti1/files/ambient/qaqc/r94-038a.pdf

Quality Assurance Handbook for Air Pollution Measurement Systems Volume II: Ambient Air Quality Monitoring Program, EPA-454/B-08-003, December, 2008.

Web Address: http://www.epa.gov/ttnamti1/files/ambient/pm25/qa/QA-Handbook-Vol-II.pdf

Quality Assurance Handbook for Air Pollution Measurement Systems Volume IV: Meteorological Measurements, Version 2.0 (Final), EPA-454/B-08-002, March 2008.

Web Address:
http://www.epa.gov/ttnamti1/files/ambient/met/Volume%20IV_Meteorological_Measurements.pdf

Quality Assurance Handbook for Air Pollution Measurement Systems Volume V: Precipitation Measurement Systems (Interim Edition), EPA-600/R-94/038e, April 1994.

Web Address For Indirect Link: http://www.epa.gov/ttnamti1/qalist.html

EPA Guidance for Ozone Standards Traceability

"Transfer Standards For The Calibration of Ambient Air Monitoring Analyzers For Ozone", Technical Assistance Document, EPA-454/B-10-001, November, 2010.

Ozone Transfer Standards Guidance web address:
http://www.epa.gov/ttnamti1/files/ambient/qaqc/OzoneTransferStandardGuidance.pdf

EPA Guidance on Air Toxics Monitoring

"Compendium of Methods for the Determination of Inorganic Compounds in Ambient Air", United States Environmental Protection Agency, Washington, DC 20460, Office of Research and Development, EPA/625/R-96/010a, June 1999.

Web Address: http://www.epa.gov/ttnamti1/files/ambient/inorganic/iocompen.pdf

"Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air - Second Edition", United States Environmental Protection Agency, Center for Environmental Research Information, EPA/625/R-96/010b, January 1999.

Web Address: http://www.epa.gov/ttnamti1/files/ambient/airtox/tocomp99.pdf

EPA $PM_{2.5}$ Guidance and Policy

Web Address: http://www.epa.gov/ttnamti1/pmpolgud.html

Air Toxics Ambient Levels Guidance

California EPA standards.
Web Address: http://www.arb.ca.gov/toxics/cattable.htm)

Agency for Toxic Substances and Disease Registry Minimal Risk Levels.
Web Address: http://www.atsdr.cdc.gov/mrls/index.asp

Joint Frequency Distribution Information

"ARAMS/FRAMES JOINT FREQUENCY DATA (JFD) GENERATOR:
An Interface Based on a Revised Version of the EPA STAR Meteorological Joint Frequency Program." Prepared for Engineer Research and Development Center, U.S. Army Corps of Engineers, Vicksburg, MS, under Contract DE-AC05-76RL01830.
By J. G. Droppo and M. A. Pelton, Pacific Northwest National Laboratory
Richland, Washington 99352, Document PNNL-16149, September 2006.

Web Address:
http://www.pnl.gov/main/publications/external/technical_reports/PNNL-16149.pdf

Appendix E

Information Concerning
EPA Air Quality System Data Format

General Information about EPA's AQS Data Format

The Environmental Protection Agency maintains a nation-wide database of air pollutant and meteorological data. This database is primarily for use by state agencies and Indian tribes, to enter air pollutant data collected within their borders. The Colorado Air Pollution Control Division wishes to obtain all air and meteorological data in a consistent format. We have chosen the AQS format because it is in use nation-wide.

AQS is an Oracle database based on Structured Query Language (SQL). Data may be entered in the database by setting up formatted text strings. There are text strings for entering sampling site information, for individual pieces of data (hourly or 24 hour average pollutant concentrations), and for quality assurance information such as sampler precision and audit data. The EPA has numerous documents available on-line to explain these formats. Figures 10 and 11 also serve as examples of text entry strings.

Each site in the database is set up via one AA text string, and a number of AB data strings. The AA string sets up the site information. The AB strings give information regarding nearby roads. There should be one AB string of text for each nearby road. Therefore, each site may have a different number of AB data strings. There are several MA – MK text strings which are used to set up each parameter monitored at the site. A "parameter" is a monitored pollutant or meteorological variable. For example, ozone is a "parameter", as are 10 meter wind speed, and 10 meter wind direction. The AQS Data Coding Manual explains each required text string in detail.

Figure 10 shows example AQS text strings setting up a site (AA) near two roads (AB), with one parameter, an ozone monitor. Figure 11 shows example text strings for entering Raw Data (RD format).

There are also AQS strings for entering precision and accuracy information (pollutant instrument audits and precision test results). These are described in the AQS Data Coding Manual.

Figure 10
Sample AQS Site Setup Data Strings for an Example Monitoring Site

Statements that Explain the Formatting of Each Pipe-delimited text file. Each string is a record to be entered in the AQS database tables. The letter designation (AA, etc) indicates the table into which data will be entered.

AA Format Sets up Site

AB Format Sets up Each Road Near Site

MA – MK Sets up the files for a parameter, in this case 44201 (Ozone)
You will need these M –type files for every parameter monitored at the site (For example, ozone, carbon monoxide, 10 meter wind speed, 10 meter wind direction, relative humidity, etc).

The Site Number consists of codes for the State (08- Colorado), the County, and the Site Number. The Air Pollution Control Division will issue a site number for each site. The last 4 digits (Site Number) may be different from the AQS format of four numerical digits. Please use the site number provided by the APCD.

```
# AA|Action Code|State Code|County Code|Site ID|Latitude|Longitude|UTM Zone|UTM Easting|UTM Northing|LDP Method of Collection|LDP
Horizontal Datum|LDP Source Scale|LDP Measurement Accuracy Value|LDP Vertical Measure|Time Zone|Support Agency|Street Address|City
Code|Urban Area Code|AQCR|Land Use|Location Setting|Date Site Established|Date Site Terminated|Zip Code|Congressional
District|Block|Block Group|Census Tract|Class I Area|Local Region|Local Site Name|HQ Evaluation Date|Regional Evaluation Date|Compass
Sector|Distance to City|Type Meteorological Site|Meteorological Site ID|Distance to Meteorological|Direction to Meteorological
Site|State or Local ID|LDP Vertical Method|LDP Vertical Datum|LDP Vertical Accuracy Value
# AB|Action Code|State Code|County Code|Site ID|Tangent Street Number|Street Name|Type Road|Traffic Count|Year of Traffic
Count|Direction to Street|Source of Traffic Count
# MA|Action Code|State Code|County Code|Site ID|Parameter|POC|Project Class|Dominant Source|Measurement Scale|Open Path Number|Probe
Location Code|Probe Height|Horizontal Distance|Vertical Distance|Surrogate Flag Indicator|Unrestricted Airflow Indicator|Sample
Residence Time|Worst Site Type|Applicable NAAQS Indicator|Spatial Average Indicator|Schedule Exemption Indicator|Community Monitoring
Zone|Pollutant Area Code - 1|Pollutant Area Code - 2|Pollutant Area Code - 3|Pollutant Area Code - 4|Pollutant Area Code - 5|Close
Date
# MB|Action Code|State Code|County Code|Site ID|Parameter|POC|Date Sampling Began|Date Sampling Ended
# MC|Action Code|State Code|County Code|Site ID|Parameter|POC|Monitor Type|Monitor Type Begin Date|Monitor Type End Date
# MD|Action Code|State Code|County Code|Site ID|Parameter|POC|Agency Role Name|Agency Code|Begin Date|End Date
# ME|Action Code|State Code|County Code|Site ID|Parameter|POC|Monitor Objective|Urban Area Represented|MSA Represented|CMSA
Represented|CBSA Represented|CSA Represented
# MF|Action Code|State Code|County Code|Site ID|Parameter|POC|RCF Code|RCF Begin Date|RCF End Date|Number of Samples - January|Number
of Samples - February|Number of Samples - March|Number of Samples - April|Number of Samples - May|Number of Samples - June|Number of
Samples - July|Number of Samples - August|Number of Samples - September|Number of Samples - October|Number of Samples -
November|Number of Samples - December
# MG|Action Code|State Code|County Code|Site ID|Parameter|POC|Tangent Road Number|Distance From Monitor
# MK|Action Code|State Code|County Code|Site ID|Parameter|POC|Monitor Protocol (MP) ID|Sample Duration|Unit|Method|Sampling
Frequency|Composite Type|Alternate Method Detectable Limit
AA|I|08|083|0006|+37.350054|-108.592334||||103|WGS84||10|1890|MOUNTAIN|0240|106 W. North Street|17375|0000|014|RESIDENTIAL|URBAN AND
CENTER CITY|20080610||81321|3|7013||96930|||Cortez - Health Dept|||||AIRPORT||5800|SSW||001|MEAN SEA-LEVEL|10
AB|I|08|083|0006|1|North Street|LOCAL ST OR HY|2000|2007|S|
AB|I|08|083|0006|2|N. Chestnut Avenue|LOCAL ST OR HY|2000|2007|E|
MA|I|08|083|0006|44201|1|01|AREA|NEIGHBORHOOD||TOP OF BUILDING|5|0|1||Y|||||||||||
MB|I|08|083|0006|44201|1|20080617|
MC|I|08|083|0006|44201|1|SPECIAL PURPOSE|20080617|
MD|I|08|083|0006|44201|1|REPORTING|0240|20080617|
MD|I|08|083|0006|44201|1|PQAO|0009|20080617|
MD|I|08|083|0006|44201|1|COLLECTING|0009|20080617|
MD|I|08|083|0006|44201|1|ANALYZING|0009|20080617|
ME|I|08|083|0006|44201|1|POPULATION EXPOSURE|0000||||
MF|I|08|083|0006|44201|1|1|20080617|||||||||||||
MG|I|08|083|0006|44201|1|1|19
MG|I|08|083|0006|44201|1|2|44
MK|I|08|083|0006|44201|1|1|1|007|087|||
MK|I|08|083|0006|44201|1|2|1|007|053|||
MK|I|08|083|0006|44201|1|3|1|008|087|||
```

Figure 11
Data Entry Data Strings for an Example Monitoring Site

Figure 11 is an example of an Excel spreadsheet used to develop text strings to enter hourly TEOM data from the Welby site into AQS. Each hour of data is one RD string.
Columns 1 – 14 list out the codes to be concatenated in Column 16.

RD – This transaction enters Raw Data.

U – This transaction is Updating (in this case, deleting) previously-entered data. Normally, you would use I (Insert) here.

Note that Column 11, the Date, is in YYYYMMDD (20110101 – January 1, 2011) format.
The Date must always be in this format.

Note that Column 12, the Time, is in HH:MM format (01:00 is 1 am).
The time must always be in this format.

Column 13 is the hourly PM_{10} value for this time. Note that here it is blank, because the data is being invalidated.

Column 14 is the column used to explain why the data in Column 13 is null. AQS has special codes for this. If there is data in Column 13, then Column 14 is blank. If there is no data in Column 13, a null data code is required for Column 14.

Column 16 is concatenating the previous Columns, to create a data string. There are some optional fields into which we are not entering data. For these fields, there is a vertical pipe followed by a blank. There must be enough field data entries or vertical pipes to cover all the portions of the RD data entry format.

Column 18 has copied Column 16, AS A TEXT STRING, with all variables as text. Column 18 is the text string that will actually be entered into AQS. Column 18 is the format that should be supplied to APCD – you will not actually be entering data into AQS.

RD	U	08	001	3001	81102	3	1	001	079	20100715	11:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100715|11:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100715|11:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100715	12:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100715|12:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100715|12:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100715	13:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100715|13:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100715|13:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100715	14:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100715|14:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100715|14:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100715	15:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100715|15:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100715|15:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100715	16:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100715|16:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100715|16:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100715	17:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100715|17:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100715|17:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100715	18:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100715|18:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100715|18:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100715	19:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100715|19:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100715|19:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100715	20:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100715|20:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100715|20:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100715	21:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100715|21:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100715|21:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100715	22:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100715|22:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100715|22:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100715	23:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100715|23:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100715|23:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	00:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|00:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|00:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	01:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|01:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|01:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	02:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|02:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|02:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	03:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|03:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|03:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	04:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|04:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|04:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	05:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|05:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|05:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	06:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|06:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|06:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	07:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|07:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|07:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	08:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|08:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|08:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	09:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|09:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|09:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	10:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|10:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|10:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	11:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|11:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|11:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	12:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|12:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|12:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	13:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|13:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|13:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	14:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|14:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|14:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	15:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|15:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|15:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	16:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|16:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|16:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	17:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|17:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|17:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	18:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|18:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|18:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	19:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|19:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|19:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	20:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|20:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|20:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	21:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|21:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|21:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	22:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|22:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|22:00||AN||||||||||||||
RD	U	08	001	3001	81102	3	1	001	079	20100716	23:00	AN	RD|U|08|001|3001|81102|3|1|001|079|20100716|23:00||AN||||||||||||||	RD|U|08|001|3001|81102|3|1|001|079|20100716|23:00||AN||||||||||||||

Blown-Up Version of Example RD Text String:

RD|I|08|087|5001|44201|1|1|008|087|20090516|00:00|30|||||||||||||||

Transaction|Insert|State|County|Site Number|Parameter|Parameter Occurrence Code|Duration|Units|Method Code|Date|Time|Reported Sample Value|Qualifier Code – Null Data|Collection Frequency|Monitor Protocol|
Qualifier 1|Qualifier 2|Qualifier 3|Qualifier 4|Qualifier 5|Qualifier 6|Qualifier 7|Qualifier 8|Qualifier 9|Qualifier 10|Alternate Method Detection Limit|Uncertainty Value

EPA AQS Data Resources

The following are EPA Documents that describe AQS and its Data Formats:

AQS Web Site Address:

http://www.epa.gov/ttn/airs/airsaqs/

AQS User Guide, May 2009 Version:

http://www.epa.gov/ttn/airs/airsaqs/manuals/AQSUserGuide(2009%20update).pdf

AQS Data Coding Manual, February 2010 Version:

http://www.epa.gov/ttn/airs/airsaqs/manuals/AQS%20Data%20Coding%20Manual.pdf

AQS Data Dictionary, April 2011 Version:

http://www.epa.gov/ttn/airs/airsaqs/manuals/AQS%20Data%20Dictionary.pdf

AQS Input Transaction Formats, April 2011 Version:

http://www.epa.gov/ttn/airs/airsaqs/manuals/AQS%20Input%20Transaction%20Formats%20v2_17.pdf

Where to Find Codes for AQS Data Entry – Web Links

Link to Main AQS Codes Page:

http://www.epa.gov/ttn/airs/airsaqs/manuals/codedescs.htm

Meteorological Site Types Table:

http://www.epa.gov/aqspubl1/met_site_type.html

Locational Reference Tables:

http://www.epa.gov/enviro/html/locational/lrt/lrt_table.html

"Non-Regulatory" Monitor Type:

http://www.epa.gov/ttnairs1/airsaqs/memos/Non%20Regulatory%20Monitor%20Type%20Guidance.pdf

Monitor Types:

http://www.epa.gov/aqspubl1/monitor_type_code.html

Agency Types, Time Zones, Units, Urbanized Areas, Audit Types, Local Primary Standards, Accuracy Types, Road Types – See Appendices in:

http://www.epa.gov/ttnairs1/airsaqs-o/manuals/Data%20Coding%20and%20Data%20Dictionary%20Appendices.pdf

Link to Vertical (elevation) data codes:

http://www.epa.gov/enviro/html/locational/lrt/lrt_return.html

LDP Collection Methods:

http://www.epa.gov/aqspubl1/ldp_collection_methods.html

Air Quality Control Regions:

See Code of Federal Regulations (CFR) – Look in 40 CFR 81 Appendix A

Code of Federal Regulations at:
http://www.gpo.gov/fdsys/search/submitcitation.action?publication=CFR

Null Data Codes in Old Format:

http://www.epa.gov/ttn/airs/airsaqs/manuals/OldNullCodes.htm

Precision and Accuracy Completeness Report in AQS:

http://www.epa.gov/ttnairs1/airsaqs/manuals/AMP255%20Guide.PDF

NEW Audit Levels in AQS:

http://www.epa.gov/ttn/airs/airsaqs/memos/expanded%20audit.pdf

AQS Memos:

http://www.epa.gov/ttn/airs/airsaqs/memos/expanded%20audit.pdf

Local Primary Standard Codes Memo:

http://www.epa.gov/ttnairs1/airsaqs-o/memos/Email_%20Retrieval%20Problem%20&%20Inactivated%20Local%20Primary%20Standard%20Codes.pdf

AQS Data Mart Direct User Instructions:

http://www.epa.gov/ttnairs1/aqsdatamart/documentation/AQS%20Data%20Mart%20Direct%20Interface%20User%20Instructions.pdf

AQS on DataFed:

http://datafedwiki.wustl.edu/index.php/AQS_D

Colorado Department
of Public Health
and Environment