Standard Operating Procedures
Data Management

Air Quality Division

Air Monitoring
&
Quality Assurance
Program

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Disclaimer

Any mention of equipment manufacturers, instrument or equipment model numbers, commercial vendors or suppliers does not represent an endorsement by the State of Alaska or the Department of Environmental Conservation.

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1. PURPOSE & SCOPE

This document shall establish standard operating procedures (SOP) for the data management of continuous and filter based monitoring data, either collected by the Alaska Department of Environmental Conservation (DEC) or subject to a regulatory review by DEC.

2. APPLICABILITY

This document describes the basic components of data management including the basic procedures to review, validate, report and archive ambient air quality data in accordance with federal regulations and EPA quality assurance/quality control (QA/QC) requirements. This document is specific to the Department's use of the DR DAS data acquisition system and the DEC AirTools Data Warehouse developed in house. This document is generic in that it does not address pollutant specific data validation tables and procedure, since those are spelled out in the separate instrument/pollutant SOPs.

This document shall serve as:

- the SOP document for data management of all State and Local Air Monitoring Station (SLAMS) and National Core site (NCore) data
- the SOP document for data management of all special purpose monitoring stations (SPMS) performed by DEC or other local air pollution control agencies.
- the SOP document for data management of all special studies performed by DEC.

This SOP document, at the date of issuance, represents the latest information on data management in regards to federal regulations as published in *Title 40 of the Code of Federal Regulations (Parts 50, 52, 53, and 58)* and EPA requirements as listed in the *EPA Quality Assurance Handbook for Air Pollution Measurements, Volume II, Ambient Air Monitoring Program, March 2017,* https://www3.epa.gov/ttn/amtic/qalist.html.

3. DATA ACQUISITION COMPONENTS

3.1 DR DAS

DEC uses a commercially available data acquisition system (DAS) to collect and store data from continuous monitoring instruments located around the state. Currently, the system accesses sites in Anchorage, the Matanuska-Susitna Valley, Juneau, Bethel and Fairbanks. A central server is located in the Juneau DEC office. The central server houses the database in which collected data are stored and hosts the specialized applications which "oversee" the data loggers located at each site.

To collect, manage and distribute increasing volumes of Alaska's continuous air monitoring data, the Municipality of Anchorage (MOA) elected to enter into an intergovernmental agreement with the Washington Department of Ecology (DOE), and DEC in 2006. DOE

already was working with the Envista data acquisition system and received additional EPA grant funding by extending their network. MOA transferred the financial liability for the Envista DAS to DEC in 2012. Envitech Ltd (http://www.envitech.co.il/) developed Envista DAS and DR DAS Ltd (http://dr-das.com/) distributes and supports it for North America. The Envista DAS consists of field data loggers (also referred to as site servers), a central SQL database, services (that run continually), and several software programs. Because Envista DAS does not adequately handle all the metadata for particulate monitoring and other monitoring data (like particulate monitor QC checks, mobile monitoring data or wet deposition mercury analyses), DEC Air Quality Division programmers added a monitoring module to DEC's in-house AirTools database already in use for air quality monitoring, State Implementation Plans (SIP), permitting and compliance documents and data. A schematic diagram of the components of the Alaska DAS system is shown in Figure 3-1. Monitoring data are distributed to the public via near real-time websites, emailed responses to data requests, and reports and data summaries (see Data Validation and Verification SOP).

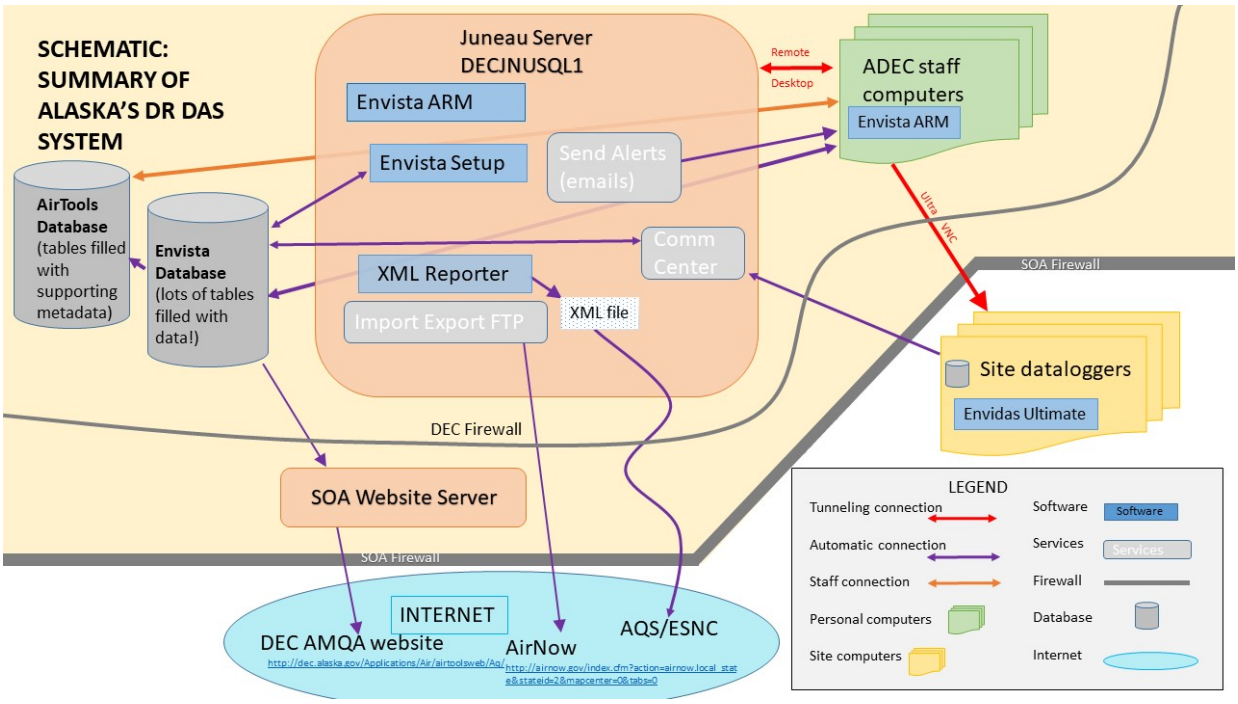


Figure 3-1: Schematic of Alaska's DR DAS data acquisition system

3.2 Envidas Ultimate

Envista Ultimate and a local SQL database reside on each monitoring site's computer. Tunneling software, Comet, and sometimes Thermo iPort and Excel (sites with gaseous monitors) are also on each site computer. There are four components of Envidas Ultimate: Service Manager, Ultimate Setup, Viewer and Reporter. The following is a brief overview of the roles of the four components (also see Figure 3-2). All but two State of Alaska sites have a

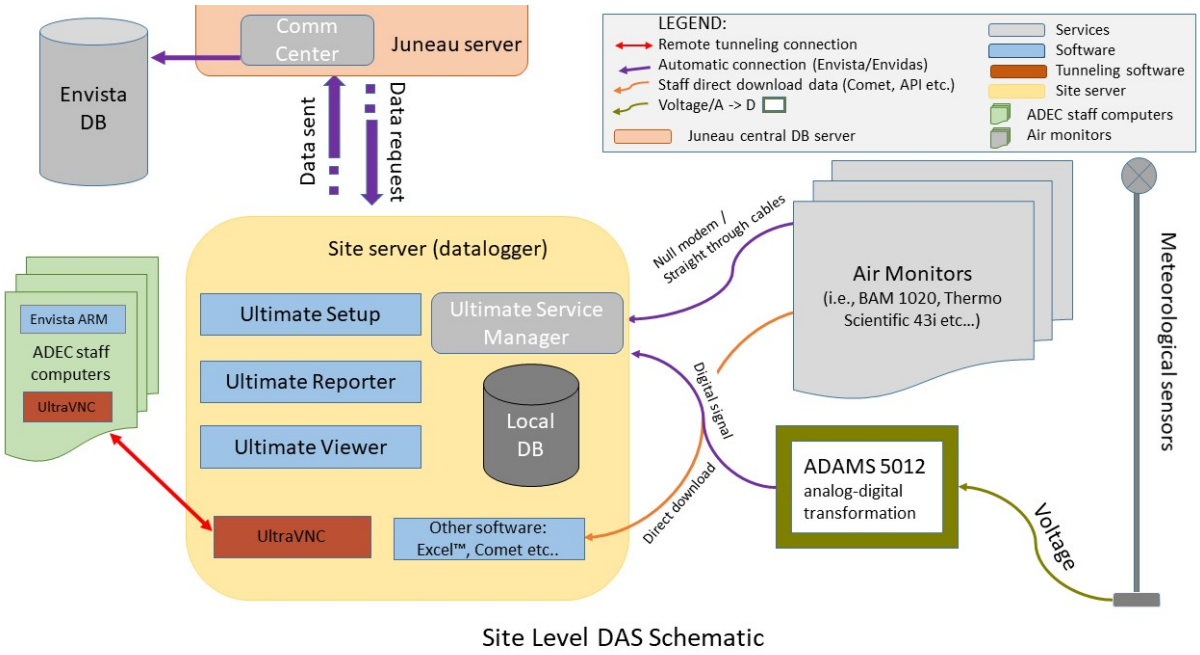
maximum 32 channels. The NCore and Hurst Road sites are equipped with 64 channel so additional instruments and parameters can be added to the site when necessary.

The Envidas Service Manager must be running in order for the Envidas EnvidasPoll service to collect data from the site instruments. EnvidasPoll service acts as a data logger, retrieving data from the analyzers and loading them to the site computer's Envidas database. The Envidas Service manager is an application that lets operators start and stop EnvidasPoll. The site time bases are set at the site level. All sites store 1, 5 and 60 minute averages of the instantaneous data collected from the analyzers. The polling times for each pollutant are set individually in Ultimate Setup. The Service Manager is set to automatically start when the operating system starts, thus it will always turn back on when the site server reboots.

Envidas Ultimate Setup is the program which stores channel and instrument configurations. Timebases, calculation methods, clock syncing, sample rates, calibrations are all set in Envidas Ultimate Setup. Instrument digital status and/or diagnostics can be specified. DR DAS will assist with a new configurations if a new analyzer is not available in the pulldown menu. Meteorological parameters can be set to record as vector, scalar or both as necessary. Individual analyzer sequences are created. Communication protocols with the air monitoring analyzers are set. The settings in Envidas Ultimate Setup must be the same as the settings for Envista Setup in order for the central database to poll the site server.

Envidas Reporter is the graphical user interface for the Envidas Ultimate database. Users can make logbook entries, edit data and graph and chart data much as in Envista Air Resource Manager (ARM). All raw data, edits and entries are polled by the Communications Center every minute to the central Envista database along with the raw data and errors. The DR DAS SOP (still in progress) lays out specific instructions on how to use Envidas Reporter at a field site.

Envidas Viewer is an application to look at the raw data in real time as it is polled by the Service Manager. It shows diagnostics, raw data (in tabular or chart form), traces of the data streams and communications occurring in real time.



Site Level DAS Schematic

Figure 3-2: DR DAS Site level Envidas data acquisition system schematic

3.3 Envista ARM

Envista ARM (Air Resource Manager) is an application installed on staff computers that allows users to interface with the Envista database. ARM allows users to access, analyze, review, and validate data stored in the database. Multiple reports provide options for viewing and analyzing data for individual monitoring parameters from specific stations. Data reviewers use ARM to review and edit data during the data validation process and must validate the data before it can be submitted to AQS using the XML Reporter application.[1]

3.4 XML Reporter

XML Reporter was developed by DR DAS to allow the direct transfer of air quality data to EPA. The software acts as a conduit between the Envista ARM data database and the EPA Exchange Network Services Center (ENSC). XML Reporter supports automatic submission of some raw particulate and gaseous data directly to the Air Quality System (AQS) via the ENSC. See section 3.9 for additional AQS information.

3.5 Data Warehouse

The data warehouse is an Air Online Service (AOS) module built into DEC's in-house AirTools database to augment the Envista ARM database for air monitoring. Currently it

[1] Quality Assurance Project Plan for the State of Alaska Air Monitoring and Quality Assurance Program, DEC April 20, 2018: http://dec.alaska.gov/air/air-monitoring/quality-assurance-plans link : Statewide QAPP - 2018

contains QC attachments that do not ‘fit’ into the Envista database. These include: site photos, audit reports, flow check reports, data narratives, and reference device information including NIST certifications among others (see Figure 3-3). AQS required metadata, Exceptional Events Waiver Requests (EEWR) and unusually formatted data that will not load into Envista easily (Table 1-1) are stored in the warehouse for archiving. The Envista database is backed up to the AirTools data warehouse nightly and backups are retained for 5 days. The AirTools database is backed up nightly with the backups being retained for 5 days.

Table 1: Categories in AirTools database

Type	Category	Relevant instruments	Description
Data management, validation and verification	QC Audit	all particulate analyzers	done in Excel
	Gaseous audit	all gaseous analyzers	done in Excel
	Pb strip audit	TSP or Hi-Vol	done in Excel
	QC check	all particulate analyzers	done in Excel
	Zero Air	Met-One BAM	done in Excel
	Configuration	Met-One BAM	not in use
	TEOM configuration	TEOM	not in use
	Calibration	all analyzers	done in Excel
	Reference Device Certification	all	From manufacturer, CARB
	ZPS	all gaseous	currently automating (into Envista), will be phased out
	Met audit	all meteorological parameters	done in Excel
	Site Log	all sites	handwritten on-site logbook
	Filter field log	all Partisol 2000i and 2025i	
	DAS download comparison	all	done in Excel now included in 2nd level review
	1st level data narrative	all	Archived; not in current use 2019 forward
	2nd level review	all	includes data narrative, validation tables, etc
	Filter Lab QC	all Partisol 2000i and 2025i	Juneau filter lab, Chester Labs & Fairbanks automated weighing system
	Corrective Action	all	Phased out; now included in 2nd level review
	Shelter Temperature	all	Phased out; now included in 2nd level review
	Speciation: Chain of Custody	URG and SASS	copies of all relevant paperwork
Reports	Exceptional Events Waiver Request	submitted to EPA	EEWR box checked
	Letters	to and from EPA	EEWR box checked
	Annual Report	all	Site data reports
	Network Plan	all	annual
	Network Assessment	all	5-year
Photos	Site		
	East In		
	East Out		
	North In		
	North Out		
	West In		
	West Out		
	South In		
	South Out		

3.6 Lab LIMS

DEC uses a commercial Laboratory Information Management System (LIMS) from Measurement Technologies Laboratory (MTL). The MTL Filter Weighing System (FWS) is a comprehensive set of hardware and software components which automates the weighing of filter media and handling of associated data. The Fairbanks lab is using version 4.9.2- 10 APR 2019 currently (October 2019). The software and hardware will be updated as suggested by MTL. The hardware includes the MTL's robotic auto handler, microbalance, environmental monitor, barcode reader, and optional static meter.

The software includes data collection, statistical process controls, and quality assurance measures. Balance readings and environmental conditions are automatically collected and stored by the software, eliminating human effort and error. The analytical microbalance is linked to a computer and acquires filter weights, continuous weighing chamber temperature and percent relative humidity (RH) electronically through the MTL LIMS. All out-of-tolerance conditions are flagged and reported by the software.

Filter sampling metadata is downloaded from particulate monitors on-site, and sent to the lab with the appropriate sample filter paperwork. Site operators work closely with the lab staff to schedule shipments of pre- and post-weighed filters in order to meet or exceed validation table requirements.

Gravimetric laboratory staff export directly from the LIMS system and send data to site operators for further review. Site operators will work with the gravimetric laboratory staff to resolve any irregularities or issues that arise. The QA Officer and data analysts are available for consultation during this process (see Data Validation SOP for more detail, in progress). The analyst uses a laboratory QC notebook in addition to the LIMS electronic database to record all QC data including the microbalance calibration and maintenance information, routine internal QC checks of mass reference standards, laboratory, field and lot filter blanks, and external QA audits. The gravimetric laboratory SOP (http://dec.alaska.gov/air/air-monitoring/standard-operating-procedures/) includes details.

3.7 Websites

DEC's Envista database is the source of near real-time data for several websites including AirNow, and the Fairbanks North Star Borough (FNSB) and DEC websites. Envista's service, FTP Import/Export, sends the data to AirNow Tech for conversion to the air quality index (AQI) and then the AirNow web display (see DR DAS and AirTools SOP for details). AirNow uses the NowCast for calculating the pollutant-normalized AQI. Different acquisition timing for state and local distribution methods causes AirNow to refresh data at 40 minutes past the hour to include the entire United States. ADEC's AQ near real-time monitoring website requests raw data from the Envista database via a service written by an in-house programmer. FNSB uses the service to populate their website. For ADEC's real-time website, ADEC chose

to use AirNow's NowCast formula (see Appendix A) for calculating the AQI to minimize public confusion. The site is compatible with mobile devices, includes site information and pictures. It refreshes at 3 to 5 minutes past the hour and charts the most recent 72 hourly concentrations and calculates the AQI. DEC has not opted to use AirNow's forecast capabilities. Instead, a DEC contractor has developed a model specific to the Fairbanks/North Pole $PM_{2.5}$ serious nonattainment area. It is updated yearly to keep up with changes to the monitoring network. The 'AQ Model' as it's called is being transitioned over to in-house programming starting in 2019. The DEC meteorologist has worked closely with the contractor and FNSB staff to provide timely advisories coordinated with DEC compliance actions.

DEC: http://dec.alaska.gov/Applications/Air/airtoolsweb/Aq/

AirNow: https://www.airnow.gov/index.cfm?action=airnow.local_state

FNSB: http://data.fnsb.us/airquality/AQNearRealTime

Import/Export FTP is part of DR DAS's data acquisition suite. This service resides on the central Juneau Server (DECJNUAQMON). Left running continuously it sends a comma delimited file every hour (10 minutes after the hour) to AirNowTech for the AirNow update (approximately 40 minutes after the hour).

3.8 DART

Chemical Speciation Network sampling occurs at the NCore site in Fairbanks, Alaska (02-090-0034) and the Hurst Road site in North Pole, Alaska (02-090-0035). EPA-contracted laboratories upload analytical results and field instrument data in batches for review before submission to AQS. Currently the University of California Davis (UCD) has been contracted for the speciation analysis and data management. They developed a platform called the Data Analysis Reporting Tool (DART) that is housed on the Sonoma Technology AirNowTech website (https://dart.airnowtech.org/). DEC reviews batch data for accuracy and reasonableness in the AirNow Tech DART database using Approval Mode. Comments are submitted to the laboratory using DART before the end of a set review period and considered by UCD for incorporation into the dataset before final posting to AQS. DART staff load the raw data while DEC is responsible for loading flow check, blank and audit results to AQS.

3.9 Air Quality System (AQS)

AQS is the final repository for data that has completed the data review process and has been certified for submission to EPA. Staff input validated data by upload of pipe-delimited flat files generated from the LIMS system for filter-based data and by using XML Reporter for continuous data (see section 3.4 for detail on XML Reporter). Audits and QC check data are also uploaded by flat file. The Program AQS coordinator or a data analyst also documents Exceptional Events in AQS and subsequently links them to the appropriately flagged exceptional event data.

4. DATA REQUESTS

4.1 Preliminary Data

Self-retrieval of raw monitoring data is available for the public back three months from the current date on the AMQA real-time monitoring data website: http://dec.alaska.gov/Applications/Air/airtoolsweb/Aq/. However, final data that has been through the QC process should be used whenever possible and must always be used for peer review published research and white papers.

4.2 Final Data

Data requests for longer periods and data that have been validated are submitted to the AMQA Program via email or written request with a 5 business day turnaround. EPA's website API is now only in JSON format. Loading JSON data into Excel is a convoluted process that is difficult for the general public. For this reason ADEC staff will download AQS data for most data requests. All legislative data requests are routed through the DEC Commissioner's office and forwarded to the AQ Division Director. These data are prepared by AMQA staff to provide flagging information and other metadata.

5. DR DAS UPDATES

To assure the continuity and continued utility and expected growth of DEC's data management system all software and hardware need periodic backing up. For the foreseeable future, DEC will continue to work with DR DAS, Ltd. to upgrade their system. The AirTools Data Warehouse is maintained in-house by DEC programmers in conjunction with Alaska Office of Information Technology (OIT).

5.1 Envidas Ultimate

Envidas Ultimate is updated once per year on all the site computers. The AMQA database coordinator downloads the update from DR DAS's FTP site via FileZilla®, backs up the configurations at each site and applies the update.

5.2 Envista ARM

On a quarterly basis, the AMQA database coordinator obtains most recent SmartUpdate for Envista ARM from DR DAS's FTP site using FileZilla and copies it to the Fairbanks, Anchorage and Juneau SmartUpdates folders. EnvistaARM updates automatically the next time any user opens the program.

5.3 Envista SQL Database & Services

Envista database updates are currently done annually between April 1 and September 30. AMQA intends to move to updates semiannually in the future. An overview of the process is

shown in Figure 5-1 and the full update process is codified in the Alaska Update Process (DEC 2017, Appendix A). Personnel involved include the DEC AMQA database coordinator, DEC AQ programming staff, OIT database managers and DR DAS Ltd staff. Prior notification is given to all personnel involved as well as AMQA managers and staff.

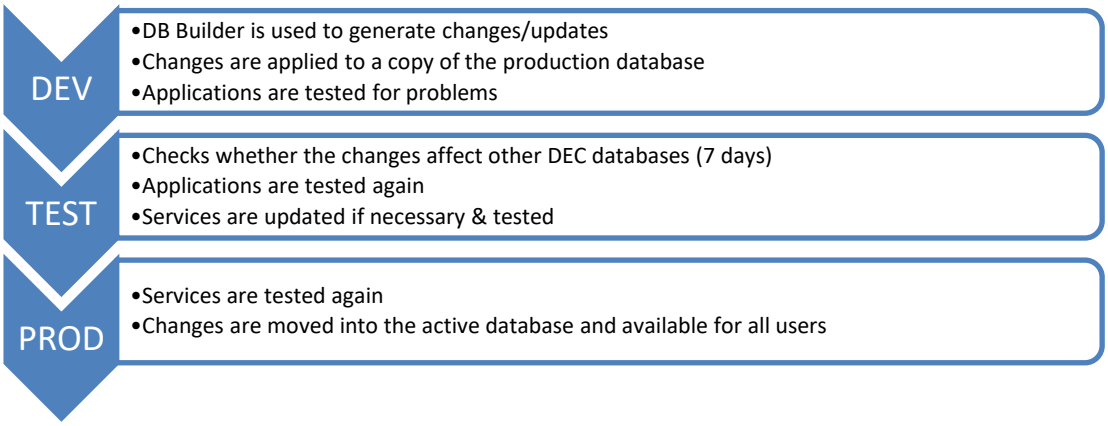


Figure 5-1: Schematic of Envista database update process (DEV refers to DEC's development instance, TEST refers to DEC's test instance and PROD refers to the active production database)

The DEC database manager (DBM) backs up the Envista database on several schedules. The DEC DBM records server and database activity and uses the backups to rebuild the database in the event of a server crash. Daily backups are automatically made to AirTools and retained for five days. Tape backups are made yearly.

5.4 Data Warehouse (AirTools)

The Air Quality programming staff has developed and maintains the AirTools database for the AQ Division. AirTools updates are done in-house and rollouts are scheduled with the DEC database manager.

5.5 Hardware

To assure on-going data quality and avoid unnecessary data losses DEC updates air quality analyzers when new technology prompts or as instruments begin to fail as funding becomes available. The site server computers are replaced on a 5 year rotating schedule.

6. DEFINITIONS OF ACRONYMS

AMQA	Air Monitoring & Quality Assurance program within the Alaska Department of Environmental Conservation, Air Quality Division
ARM	Air Resources Manager
AQ	Air Quality
AQS	Air Quality System EPA database stores ambient air quality data
CDX	EPA's Central Data eXchange for states without their own node for AQS submittal
AOS	Air Online System is part of AQ's in-house web-based database
CFR	government abbreviation for "Code of Federal Regulation," which is used to reference federal regulations for example, 40 CFR 58 is the reference for Title 40, Code of Federal Regulations, Part 58
DAS	common abbreviation for "data acquisition system," which for the purposes of this manual, represents a computer-based system that records and stores electronic signals from gaseous analyzers, and provides programmed functions to perform automated quality control checks
DBM	database manager
DEC	Alaska Department of Environmental Conservation
ENSC	Exchange Network Services Center
EEWR	Exceptional Events Waiver Request
FNSB	Fairbanks North Star Borough
JSON	JavaScript Object Notation
LIMS	Laboratory Information Management System
MOA	Municipality of Anchorage
MTL FWS	Measurement Technologies Laboratory Filter Weighing System
NAAQS	government abbreviation for "National Ambient Air Quality Standards," which are air quality standards established in regulation under 40 CFR 50 to protect human health and the environment

NCore	an EPA program to establish a national multi pollutant monitoring network that integrates several advanced measurement systems for particles, pollutant gases and meteorology
NIST	National Institute of Standards and Technology
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
SLAMS	State and Local Air Monitoring Station
SOP	Standard Operating Procedure
SPM	Special Purpose Monitoring Station
EPA	United States Environmental Protection Agency

Appendix A: NowCast Formula

Computing the NowCast with the New Method

1. Compute the concentration range (max-min) over the last 12 hours. This tells us how much the air has changed.

Example 12-hour period

50 80 75 90 82 53 64 74 21 10 16 13

Range = 90-10 = 80 ug/m3

2. Divide the range by the maximum concentration in the 12-hour period

Scaled rate of change is 80/90.

3. Compute the weight factor by subtracting the scaled rate of change from 1. The weight factor must be between .5 and 1. The minimum limit approximates a 3-hour average. If the weight factor is less than .5 then set it equal to .5.

Weight factor is 1 – 80/90 = .11 → less than .5, so use .5

4. Multiply each hourly concentration by the weight factor raised to the power of how many hours ago the concentration was measured (for the current hour, the factor is raised to the zero power)

$13*(.5)^0 + 16*(.5)^1 + 10*(.5)^2 + 21*(.5)^3 + 74*(.5)^4 + \ldots$

5. Compute the NowCast by summing these products and dividing by the sum of the weight factors raised to the power of how many hours ago the concentration was measured.

$$\frac{13*(.5)^0 + 16*(.5)^1 + 10*(.5)^2 + 21*(.5)^3 + 74*(.5)^4 + \ldots}{(.5)^0 + (.5)^1 + (.5)^2 + (.5)^3 + (.5)^4 + \ldots}$$