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Secretary
MICHAEL A. ABRACZINSKAS
Director

NORTH CAROLINA
Environmental Quality

North Carolina Department of Environmental Quality
Division of Air Quality
Standard Operating Procedure 2.63.4
Section 4:
Standard Operating Procedures for Validation of Particulate Matter

Version 0.0

North Carolina Department of Environmental Quality
Division of Air Quality
1641 Mail Service Center
Raleigh, North Carolina 27699

NORTH CAROLINA
Department of Environmental Quality

Sign Off Page

I certify that I have read and approve of the contents of the Standard Operating Procedure for Validation of Particulate Matter with an effective date of August 1, 2020.

Director, Air Quality Division

Michael Abraczinskas

Signature: Michael A. Abraczinskas Date: Aug 12, 2020

Ambient Monitoring Section Chief

Patrick Butler, Section Chief

Signature: Patrick Butler
Patrick Butler (Aug 12, 2020 13:22 EDT) Date: Aug 12, 2020

Laboratory Analysis Branch Supervisor

Dr. Jim Bowyer, Environmental Program Supervisor

Signature: Jim Bowyer Date: Aug 12, 2020

Projects and Procedures Branch Supervisor

Joette Steger, Environmental Program Supervisor

Signature: Joette Steger Date: Aug 12, 2020

Primary SOP Author

Travis Funderburk, Environmental Chemist

Signature: Travis D. Funderburk
Travis D. Funderburk (Aug 12, 2020 13:06 EDT) Date: Aug 12, 2020

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2.63.4.1 Scope and Purpose

This document serves as a guide for the Raleigh Central Office (RCO) PM Chemist to review, document and validate particulate matter (PM) data in the North Carolina Division of Air Quality (NC DAQ) Monitoring Network. It provides routine operating procedures to achieve uniformity and ensure a high level of quality data produced in the course of operations. Several other documents are encouraged to be used in this review, including but not limited to:

- The Code of Federal Regulations (CFR),
- The EPA (Environmental Protection Agency) Quality Assurance Handbook for Air Pollution Measurement Systems Volume II,
- The Quality Assurance Project Plan for the North Carolina Division of Air Quality Particulate Matter Monitoring Program (QAPP),
- Operator's Standard Operating Procedures (SOP) and
- Manufacturer's operator's manual.

2.63.4.2 Personnel Qualifications

The user of this document should have a general working knowledge of Air Quality regulations, be familiar with software NC DAQ may use regularly such as Envidas, Envista, IBEAM, MS Office and EPA-AQS (Air Quality Systems).

2.63.4.3 Description of the PM Monitor Network

The NC DAQ PM monitoring network uses only EPA-approved FRM (Federal Reference Method) or FEM (Federal Equivalent Method) instrumentation for determining pollutant concentrations for NAAQS (National Ambient Air Quality Standard) compliance. Listed in table 1 are the types of instrumentation in the NC DAQ PM Monitoring Network. Note: The NC DAQ may use alternative non-FEM or non-FRM methods for Air Quality Index (AQI) reporting.

Table 1- Instrumentation in the NC DAQ PM Monitoring Network

Pollutant	Analyzer/Monitor/Sampler	AQS Method Codes	EPA Reference/ Equivalence
$PM_{2.5}$ local conditions, filter based	Rupprecht and Patashnick Partisol-Plus Model 2025 Sequential Air Sampler (with PM_{10} head and VSCC) Thermo Model 2025 i Sequential Air Sampler (with PM_{10} head and VSCC)	145	RFPS-1006-145
$PM_{2.5}$ local conditions, continuous	Met One BAM 1020 (with PM10 head and VSCC) Met One BAM 1022 (with PM10 head and VSCC) Teledyne T640X (with PM10 head)	170 209 236	EQPM-0308-170 EQPM-1013-209 EQPM-0516-236

Table 1- Instrumentation in the NC DAQ PM Monitoring Network

Pollutant	Analyzer/Monitor/Sampler	AQS Method Codes	EPA Reference/ Equivalence
PM_{10} local conditions, continuous	Met One Instruments BAM 1020 (with PM_{10} head alone) Teledyne T640X (with PM_{10} head)	122 238	EQPM-0798-122 EQPM-0516-238
PM_{10} STP, continuous	Met One Instruments BAM 1020 (with PM_{10} head and downtube) Teledyne T640X (with PM_{10} head)	122 239	EQPM-0798-122 EQPM-0516-239
Acceptable $PM_{2.5}$ AQI	Met One BAM 1020 (with PM_{10} head and VSCC) Met One BAM 1022 (with PM_{10} head and VSCC Met One BAM 1022 (with PM_{10} head and SCC)	733 733 171	Not a reference method
$PM_{10-2.5}$, local conditions continuous	Met One BAM 1020 (one unit with PM_{10} head and VSCC paired with a unit with PM_{10} head alone) Teledyne T640X (with PM_{10} head)	185 238	EQPM-0709-185 EQPM-0516-238
$PM_{2.5}$ speciation carbon compounds local conditions, filter based	CSN(Chemical Speciation Network) URG	838	Not a reference method
$PM_{2.5}$ speciation cations and anions local conditions, filter based	CSN-MetOne SASS	812	Not a reference method
$PM_{2.5}$ speciation metals local conditions, filter based	CSN-MetOne SASS	811	Not a reference method

Data collected from the NC DAQ PM monitoring network are categorized into two general categories:

- Intermittent sample collection (non-continuous or static) – Where a physical sample is collected using a monitoring device that passes ambient air through a filter, collects a sample in a container, or exposes a sample collection media to a sample stream. The sample containing media (i.e., filter) is then removed and analyzed via laboratory methods to identify and/or quantify the pollutant of interest.

- Real-time or near real-time sample analysis (continuous) – Where physical samples are not collected. Instead, the analyzer itself performs "In situ" analysis of the composition of the sample using a specific methodology. The next subsections describe the process of how non-continuous and continuous PM data are validated.

2.63.4.4 Validation of Non-Continuous PM Data

1) Site Validation Checklist Set-Up: Validation of non-continuous PM data begins with obtaining a copy of the latest version of the FRM Validation Template. The most current version of the template is stored in IBEAM (**>Documents General:Work, >Search General Documents: Doc. Category:**Ambient Work, **Doc. Group:** Templates**, Doc. Type:** Logbook Templates) or SharePoint (FRM Validation Template). Note: The template contains the same directions outlined in this SOP.

2) Save a copy of the validation template as FRM Validation XQ20XX (e.g. FRM Validation 4Q2017). Make a copy of the original Site Validation Checklist tab and rename it for the site you are reviewing (e.g. Spruce Pine). Fill out the Site Information section. Enter the first run day of the quarter for the sampling schedule needed.

Figure 1-Screen Shot of Site Information

Site Information	
Region:	WSRO
Site Name:	Lexington
AIRS #:	37-057-0002
Site ID2 #:	409
Reviewer(s):	PJC
Passed QA Date:	

1:3 first run day of quarter:	
1:6 first run day of quarter:	1/4/20

3) Filter Sheet and IBEAM Completeness Review
As part of NC DAQs chain of custody procedure, every EPA sampling date and field blank must have:
   a) A filter sheet for that day,
   b) An IBEAM site data record for that run day with the corresponding filter number,
   c) And a lab data record for the filter that ran.

4) Using the 3-day or 6-day schedule generator in the checklist, ensure that there is a filter sheet for every EPA run date. While performing this task, confirm that a field

blank was run during each month of the quarter for the sampler, and that a site trip blank was run once during the quarter for the site. Record these dates on the checklist.

Figure 2-Screen Shot of 6-Day Schedule

6 - Day Schedule	Ran
1/4/20	☑
1/10/20	☑
1/16/20	☑
1/22/20	☑
1/28/20	☑
2/3/20	☑

Figure 3-Screen Shot of Filter Sheet and I-BEAM Completeness Review

Filter Sheet and I-BEAM Completeness Review							Yes	No
Filter # and date on data sheet agrees with the field data in I-BEAM?							☑	☐
All sampling occured on a 1:3 or 1:6 schedule? *If not, see Misses Samples section.*							☑	☐
Field blanks: 1/month/sampler		1/23/20	2/28/20	3/29/20			☑	☐
Trip blanks: 1/quarter/site		1/6/20	3/3/20				☑	☑
Blanks net mass are within ± 30 µg? *If greater, reweigh filter and review data.*							☐	☐

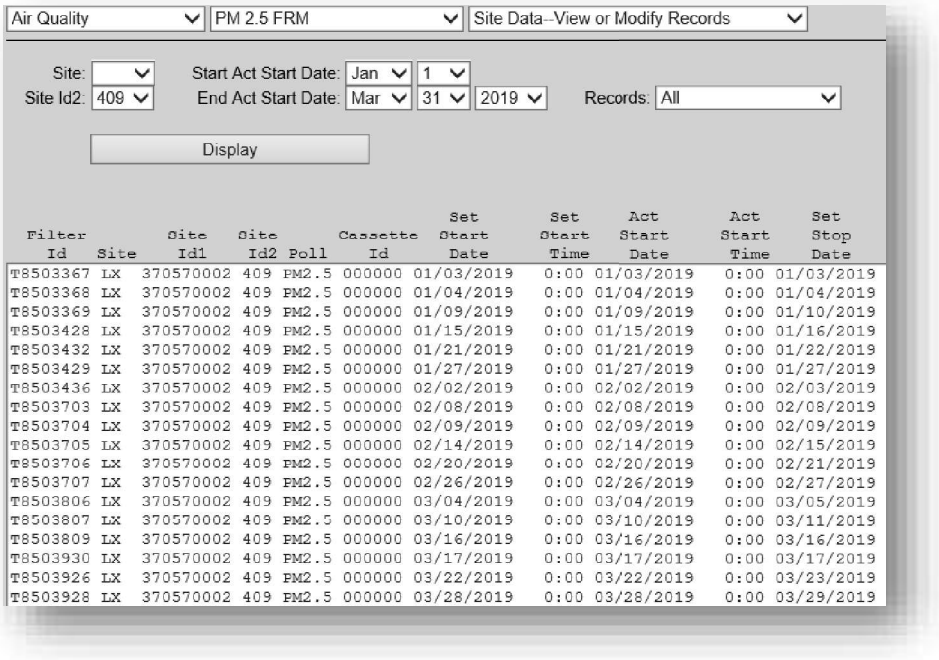
1) If a filter is missing for an EPA sample date, make sure the operator filled out a missing filter sheet for that day, or make one yourself using information from the site's e-log, and record the missed sample date, reason for missing, null code and make-up date in the Missed Samples and Sample Make-Ups section of the checklist.

Figure 4-Screen Shot of Missed Samples and Sample Make-Ups

Missed Samples and Sample Make-Ups			
Sample Date	Reason	Code	Make-up Date

2) In IBEAM, go to **>PM 2.5 FRM, >Site Data - View or Modify Records.** Select the appropriate site specific two letter code, ID2, start sample date and the end sample date of the quarter you are reviewing. Select **>Display**.
3) Reconcile the filter sheets to the filter data in IBEAM. Trip blanks will not be seen in this screen. Remedy any conflicts with run date and filter number by highlighting the record and selecting **>Update selected record**.

Figure 5-Screen Shot of IBEAM Update Selected Record



Filter Id	Site	Site Id1	Site Id2	Poll	Cassette Id	Set Start Date	Set Start Time	Act Start Date	Act Start Time	Set Stop Date
T8503367	LX	370570002	409	PM2.5	000000	01/03/2019	0:00	01/03/2019	0:00	01/03/2019
T8503368	LX	370570002	409	PM2.5	000000	01/04/2019	0:00	01/04/2019	0:00	01/04/2019
T8503369	LX	370570002	409	PM2.5	000000	01/09/2019	0:00	01/09/2019	0:00	01/10/2019
T8503428	LX	370570002	409	PM2.5	000000	01/15/2019	0:00	01/15/2019	0:00	01/16/2019
T8503432	LX	370570002	409	PM2.5	000000	01/21/2019	0:00	01/21/2019	0:00	01/22/2019
T8503429	LX	370570002	409	PM2.5	000000	01/27/2019	0:00	01/27/2019	0:00	01/27/2019
T8503436	LX	370570002	409	PM2.5	000000	02/02/2019	0:00	02/02/2019	0:00	02/03/2019
T8503703	LX	370570002	409	PM2.5	000000	02/08/2019	0:00	02/08/2019	0:00	02/08/2019
T8503704	LX	370570002	409	PM2.5	000000	02/09/2019	0:00	02/09/2019	0:00	02/09/2019
T8503705	LX	370570002	409	PM2.5	000000	02/14/2019	0:00	02/14/2019	0:00	02/15/2019
T8503706	LX	370570002	409	PM2.5	000000	02/20/2019	0:00	02/20/2019	0:00	02/21/2019
T8503707	LX	370570002	409	PM2.5	000000	02/26/2019	0:00	02/26/2019	0:00	02/27/2019
T8503806	LX	370570002	409	PM2.5	000000	03/04/2019	0:00	03/04/2019	0:00	03/05/2019
T8503807	LX	370570002	409	PM2.5	000000	03/10/2019	0:00	03/10/2019	0:00	03/11/2019
T8503809	LX	370570002	409	PM2.5	000000	03/16/2019	0:00	03/16/2019	0:00	03/16/2019
T8503930	LX	370570002	409	PM2.5	000000	03/17/2019	0:00	03/17/2019	0:00	03/17/2019
T8503926	LX	370570002	409	PM2.5	000000	03/22/2019	0:00	03/22/2019	0:00	03/23/2019
T8503928	LX	370570002	409	PM2.5	000000	03/28/2019	0:00	03/28/2019	0:00	03/29/2019

4) Insert a missed day into I-BEAM by selecting **>Insert missed day record**. Input the make-up date, appropriate null code and comment from the Missed Samples and Sample Make-Ups section.

5) Delete any erroneous filters by highlighting the record and selecting **>Delete selected record**.

6) If a sample is missing in IBEAM, but occurs in the lab data and has a filter sheet, the field data can be uploaded via FTP (see below) or by selecting **>Insert complete record**.

7) In IBEAM, select **>Reports, >Ambient Monitoring and run a "Noncontinuous Field and Trip Blanks"**. Select the region, start sample date and the end sample date of the quarter you are reviewing. Select **>Run Report**. Copy and paste the data from the Excel spreadsheet into the Blank Data Review tab of the template. Review to confirm that all field and trip filter blanks have not exceeded ± 30 µg. If an exceedance occurs, call the lab to have the blank reweighed. After the lab has reweighed the blank and it proves to be unacceptable, contamination during

transportation or at the sampling site may be occurring. Notify parties involved to take appropriate troubleshooting and corrective actions. Report the blank to AQS and apply the appropriate Qualifier Code to the data as needed. Use the **LB**-Lab blank value above acceptable limit, **FB**-Field blank value above acceptable limit, or **TB**-Trip blank value above acceptable limit, depending upon which blank has failed the acceptance criteria. The raw data must be flagged from the last passing blank to the next passing blank (usually for 2 months). Note: Blanks may be listed as runs by mistake in the lab data. Contact the lab for changes to the data. Run the report again. Blank data for the WNC program can be found on the **"Noncontinuous Lab Data"** report in IBEAM. .

8) File Transfer Protocol (FTP) to IBEAM
   a) To upload a field data file into IBEAM, open Filezilla.
   b) Enter the following and click **>Quickconnect**:

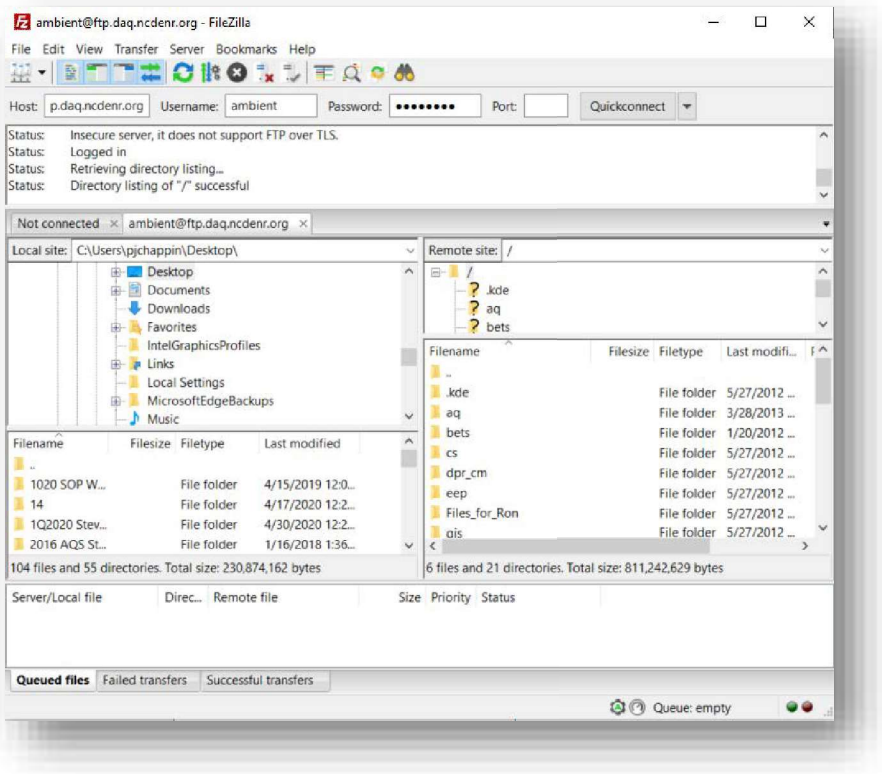
      Host: [redacted]

      Username: [redacted]

      Password: [redacted]

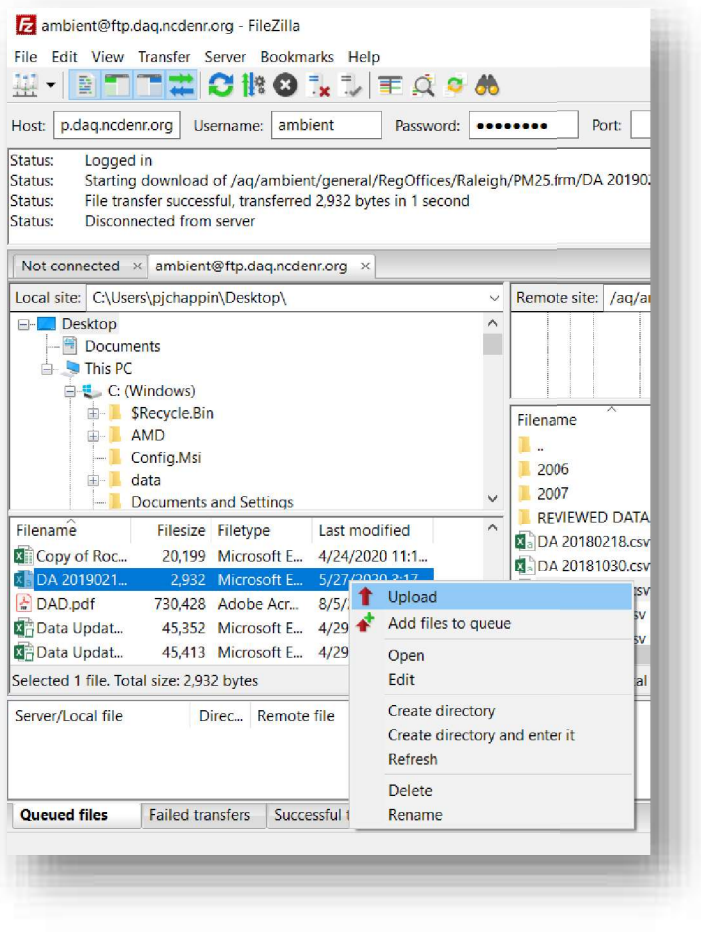
9) The following screen should appear. Under Remote Site, in the Filename window, select >aq>ambient>general>RegOffices>(Regional Office Name)>PM2.5frm.

Figure 6-Screen Shot of FileZilla



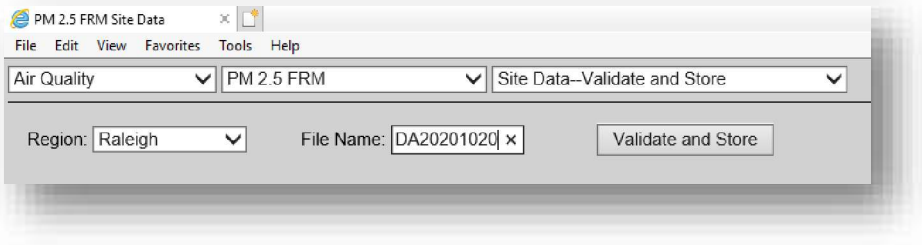
10) Under the **Local site**, in the **Filename** window, highlight the files to be uploaded. Click **>Upload**.

Figure 7-Screen Shot of FileZilla Upload



11) Return to IBEAM and select **>PM 2.5 FRM>Site Data – Validate and Store**. Select the proper Regional Office and enter the file name you uploaded. Click **>Validate and Store**. IBEAM will either tell you the files have been successfully uploaded or that there is an error, and what the errors are so you can fix them.

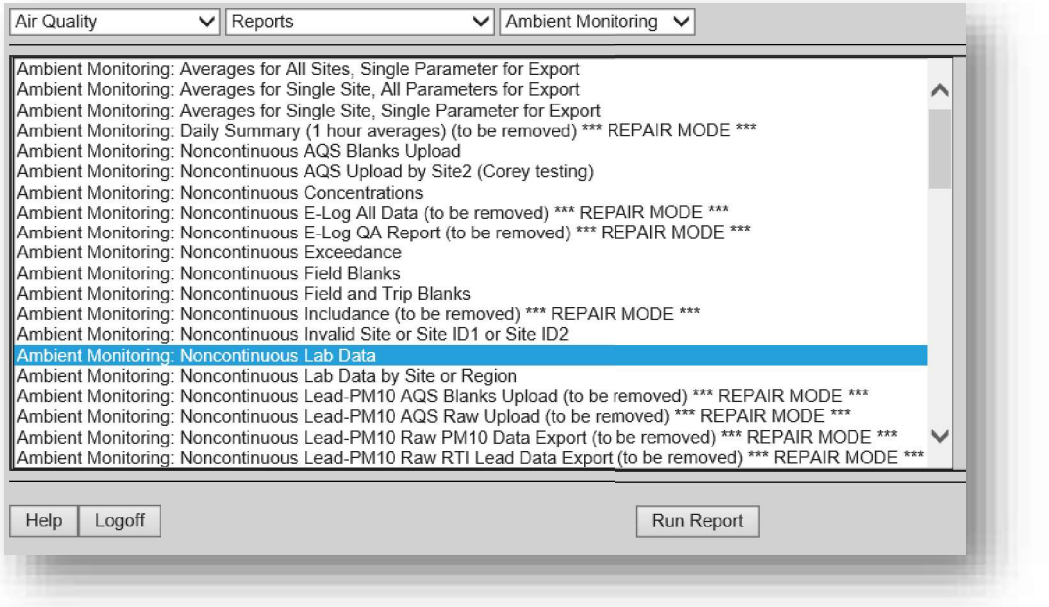
Figure 8-Screen Shot of IBEAM Validate and Store



12) Lab Data Review

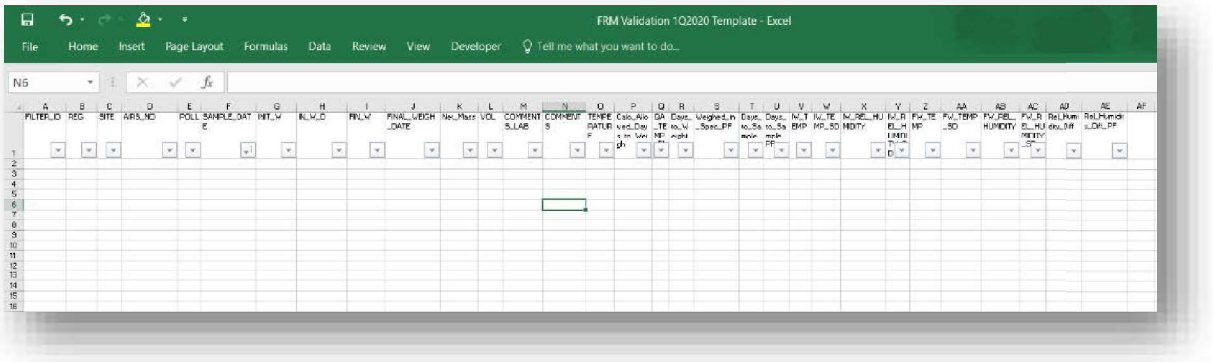
In IBEAM, select **>Reports, >Ambient Monitoring and run a "Noncontinuous Lab Data" report**. Select the start sample date and the end sample date of the quarter you are reviewing. Select **>Run Report**.

Figure 9-Screen Shot o IBEAM Reports Ambient Monitoring



13) Copy, paste and save the data from the Excel spreadsheet into the Lab Data Review tab of the template.

Figure 10-Screen Shot of the Lab Data Review tab



14) Sort and filter the data by site. The sheet will automatically flag all of the failing criteria.
15) Record the results of the lab data review in the Site Validation Checklist for the site you are reviewing. Blanks that are labeled as EPA runs will be easy to spot in this spreadsheet.

Figure 11-Screen Shot of Lab Data Review

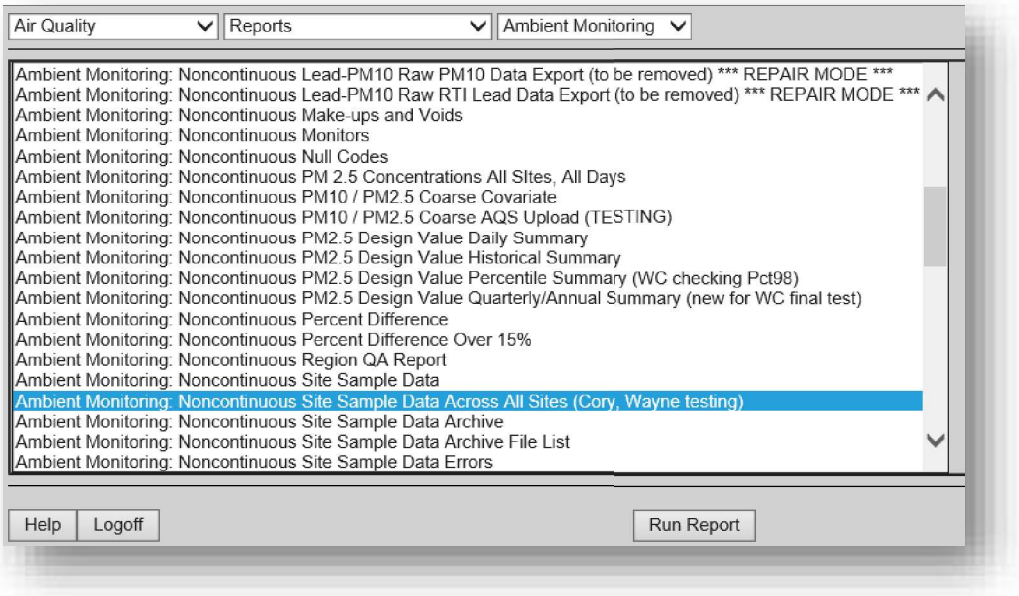
Lab Data Review	Yes	No
≤ 30 days from initial weighing date to sampling date?	☐	☐
≤ 30 days (or days calculated by lab) from sampling date to final weighing date?	☐	☐
Arrival filter temperature less than 25° C?	☐	☐
Initial weighing %RH within 5% of final weighing %RH?	☐	☐

16) Field Data Review

In IBEAM select **>Reports, >Ambient Monitoring and run a "Noncontinuous Site Sample Data Across All Sites (Cory, Wayne testing)** report. Select **>Run Report.**

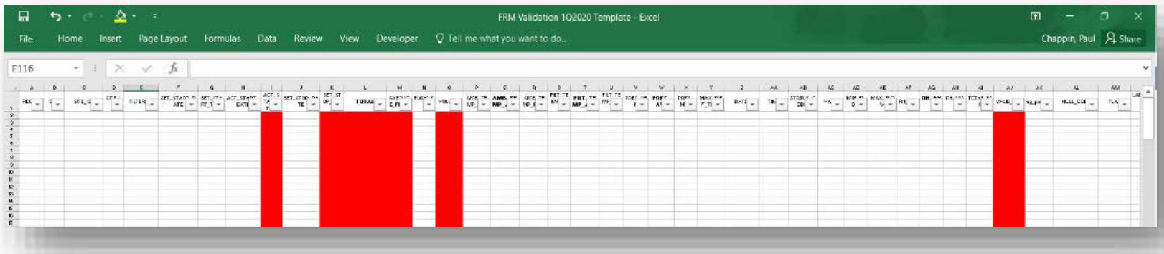
17) Select the pollutant (PM2.5 or PM10), the start sample date and the end sample date of the quarter you are reviewing. Select **>Run Report**.

Figure 12-Screen Shot of IBEAM Reports Ambient Monitoring



18) In the report, cut and paste the lab comments to the end. Delete the cassette numbers and all the associated columns. Copy, paste and save the data from the Excel spreadsheet into the Field Data Review tab of the template. You will do this for both the $PM_{2.5}$ and PM_{10} data reports.

Figure 13-Screen Shot of Field Data Review Tab



19) Sort and filter the data by site. The sheet will automatically flag all failing criteria.

20) Record the results of the field data review in the Site Validation Checklist for the site you are reviewing.

Figure 14- Screen Shot of Field Data Review

Field Data Review	Yes	No
Run time 0:00 to 0:00; 23 to 25 hours / 1380 to 1500 minutes? *Otherwise void.*	☐	☐
Flow CV less than 2.0? *Otherwise void.*	☐	☐
Average flow rate 16.7 l/min? *15.9 to 17.5 is acceptable.*	☐	☐
Sample volume in 23 m^3 to 25 m^3?	☐	☐
Maximum temperature difference is < 5° C for no more than 30 minutes?	☐	☐
Average temperature and relative humidity between minimun and maximum values?	☐	☐
Site ID1 and site ID 2 agree?	☐	☐

21) Electronic Logbook Review

22) From the Incoming file on the P drive, retrieve the appropriate e-log for the monitor being reviewed and time span.

23) Record the results of the electronic logbook review in the Site Validation Checklist for the site you are reviewing.

Figure 15-Screen Shot of Electronic Logbook Review

Electronic Logbook Review	Yes	No
Flow verifications and audits passed?	☐	☐
Leak checks passed?	☐	☐
Prescribed maintenance and cleaning performed?	☐	☑
Filter removed from sampler less than 7 days and 9 hours (177 hours) after sampling?	☐	☐

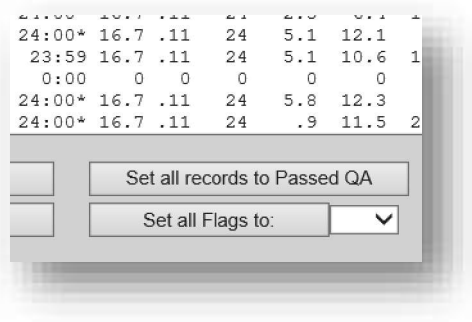
24) Make comments/notes of anything you find of interest. Copy and paste text from emails, e-logs or instant messages that pertain to events affecting air monitoring at this site. Paste hyperlinks to web articles, weather data or government information that can be used for exceptional events.

25) Pass the Data in IBEAM

a) In IBEAM, go to **>PM 2.5 FRM, >Site Data - View or Modify Records**. Select the appropriate site specific two letter code, ID2, start sample date and the end sample date of the quarter you are reviewing. Select **>Display**.

b) Select "Set all records to Passed QA". Fix or address all records that have issues (e.g. extreme temperature change, concentrations below -5 µg/m3, etc.)

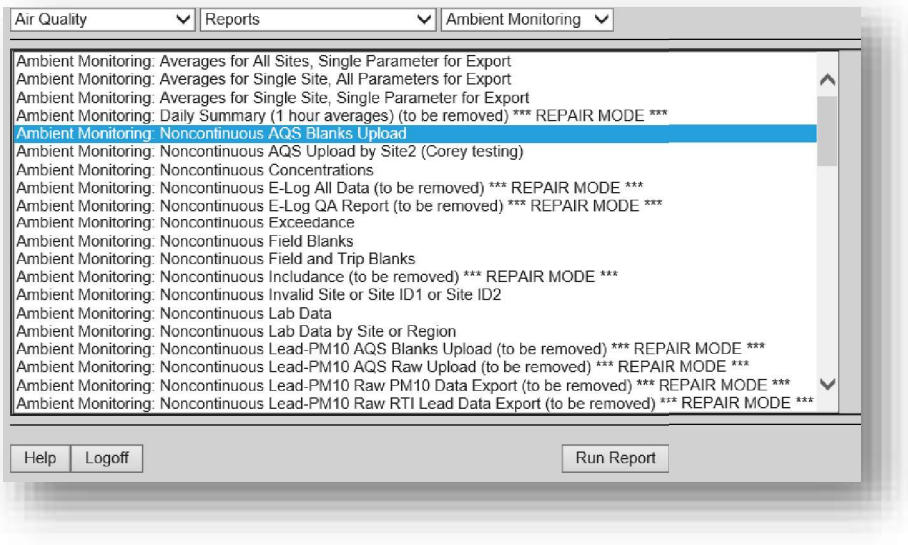
Figure 16-Screen Shot of Set all records to Passed QA



26) Create Blank Files for AQS

In IBEAM, select **>Reports, >Ambient Monitoring** and run a **"Noncontinuous AQS Blanks Upload"**. Select **>Run Report**.

Figure 17-IBEAM Screen Shot of IBEAM Reports Ambient Monitoring



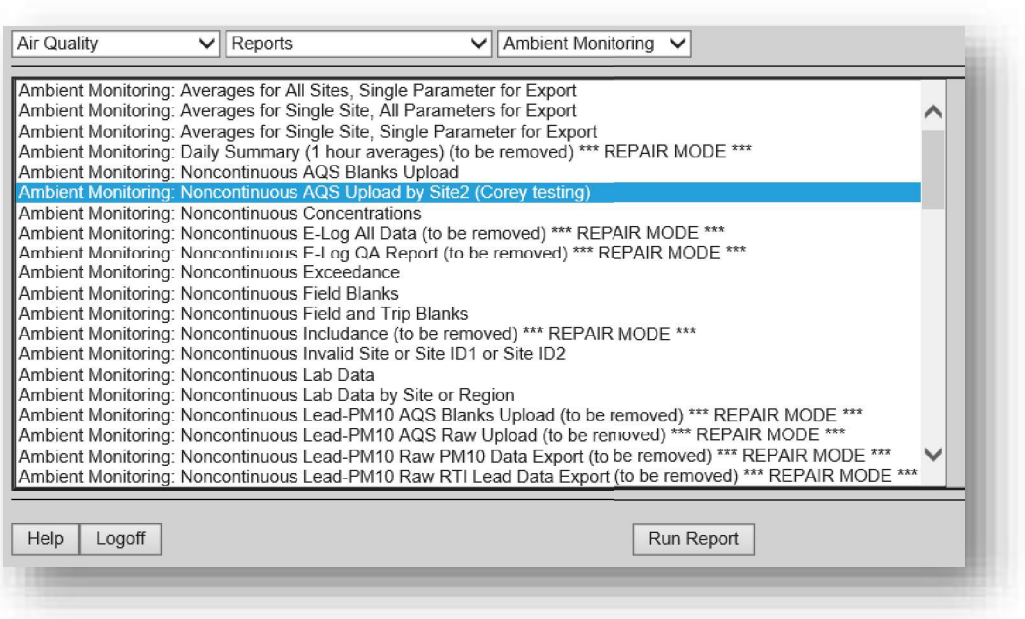
a) Select a regional office, start sample date and the end sample date of the quarter you are reviewing. Select >Run Report. Open Notepad and copy the Excel data into a text file. Save the file as RB_XXX_XQ20XX.txt (e.g. RB_MRO_2Q2017). RB is for field and trip blanks.

b) Place the file on the P drive at **P:\Ambient\PUB\RegOffices.NC\AQS\Manual Upload Files**. Do this for each regional office that has FRMs.

27) Create Data AQS Files

In IBEAM, select **>Reports, >Ambient Monitoring** and run a **"Noncontinuous AQS by Site2 (Corey testing)"**. Select **>Run Report**.

Figure 18-Screen Shot of IBEAM Reports Ambient Monitoring



28) Select a monitoring site, start sample date and the end sample date of the quarter you are reviewing. Select **>Run Report**. Open Notepad and copy the Excel data into a text file. Save the file as RD_XX_XQ20XX.txt (e.g. RD_HC_2Q2017). RD is for PM data. Do this for each site that has FRMs, placing each monitors' data in a separate file.

29) Do this for each site that has FRMs running as PM_{10}s as well.

30) Create QA Files for AQS

In the back of all FRM e-logs, there is an AQS file generator page. Copy all the Excel data strings for the quarter. Open Notepad and paste the data into a text file. Save the file as RP_XXX_XQ20XX.txt (e.g. RP_MRO_2Q2017). RP is for verification data.

Figure 19- Screen Shot of Excel Data Strings for the Quarter

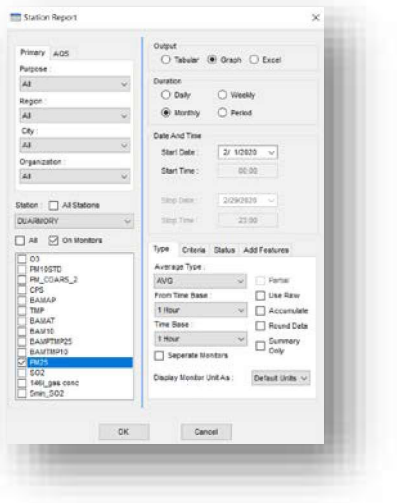
Visit Type	AQS QA Transaction Record
Monthly Verification	QA|I|Flow Rate Verification|0776|37|035|0004|88101|1|20180109|1|145|118|16.67|16.57|
Mid-Month Verification	QA|I|Flow Rate Verification|0776|37|035|0004|88101|1|20180125|1|145|118|16.7|16.75|
Monthly Verification	QA|I|Flow Rate Verification|0776|37|035|0004|88101|1|20180209|1|145|118|16.69|16.9|
Quarterly Audit	QA|I|Semi-Annual Flow Rate Audit|0776|37|035|0004|88101|1|20180223|1|145|118|16.69|16.7|
Monthly Verification	QA|I|Flow Rate Verification|0776|37|035|0004|88101|1|20180305|1|145|118|16.7|16.65|
Mid-Month Verification	QA|I|Flow Rate Verification|0776|37|035|0004|88101|1|20180323|1|145|118|16.69|16.59|
Monthly Verification	QA|I|Flow Rate Verification|0776|37|035|0004|88101|1|20180409|1|145|118|16.69|16.49|
Mid-Month Verification	QA|I|Flow Rate Verification|0776|37|035|0004|88101|1|20180424|1|145|118|16.67|16.48|
Monthly Verification	QA|I|Flow Rate Verification|0776|37|035|0004|88101|1|20180509|1|145|118|16.68|16.62|
Quarterly Audit	QA|I|Semi-Annual Flow Rate Audit|0776|37|035|0004|88101|1|20180525|1|145|118|16.67|16.75|
Monthly Verification	QA|I|Flow Rate Verification|0776|37|035|0004|88101|1|20180605|1|145|118|16.68|16.6|
Mid-Month Verification	QA|I|Flow Rate Verification|0776|37|035|0004|88101|1|20180620|1|145|118|16.69|16.67|
Monthly Verification	QA|I|Flow Rate Verification|0776|37|035|0004|88101|1|20180710|1|145|118|16.68|16.48|
Mid-Month Verification	QA|I|Flow Rate Verification|0776|37|035|0004|88101|1|20180723|1|145|118|16.69|16.51|

31) Do this for each regional office that has FRMs, placing all the data strings in the same file. Place the file on the P drive at P:\Ambient\PUB\RegOffices.NC\AQS\Manual Upload Files. Notify the Database Manager when the file is complete and ready for upload.

2.63.4.5 Validation of Continuous PM BAM 1020 ($PM_{2.5}$, PM_{10} and Coarse) Data

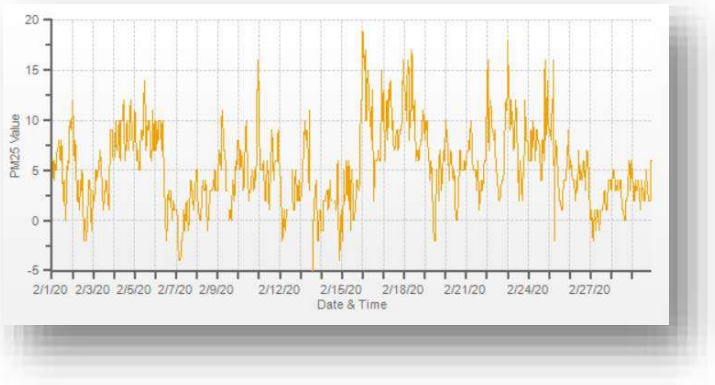
1) Make a monthly graph of the data to be validated in Envista ARM**.** Select the station name (e.g. Durham Armory), the monitoring parameter (in this case $PM_{2.5}$), output set as graph, monthly set as the duration and then set the start date (start date will automatically be the first of the month selected). The type of report will be average, made from an hourly time base, to an hourly time base. Click OK. With a Coarse setup, like Durham Armory, you may or may not want to do this for every parameter (PM_{10} STP, $PM_{10-2.5}$). Maybe just stick with $PM_{2.5}$ and PM_{10}.

Figure 20-Screen Shot of Envista Station Report



2) Review the graph for unusual spikes or drops in the data and readings that are missing all together. Readings that show no change over a span of time are also of importance. Make note of these irregularities for future use in validation.

Figure 21-Screen Shot of Envidas Graph



3) Run the same report again, but this time select the PM parameter ($PM_{2.5}$ or PM_{10}) and the BAM 1020 temperature parameter. Select Excel as the Output. Select OK.

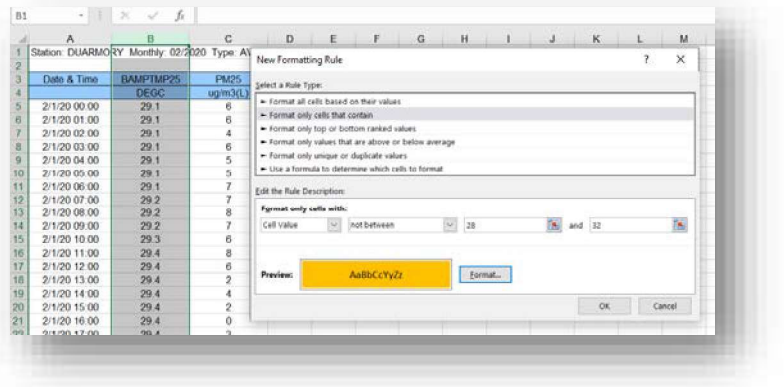
Figure 22-Screen Shot of Excel Output Statistical Information

701	Minimum	28.5	-5
702	MinDate	2/14/20 13:00	2/13/20 13:00
703	Maximum	31.4	19
704	MaxDate	2/3/20 15:00	2/16/20 00:00
705	Avg	29.398	5.2
706	Num	692	684
707	Data[%]	99.4	98.2
708	STD	0.4	3.9

4) Check out the monthly synopsis at the bottom of the report for min/max readings and other statistics. Take note if the minimum reading is less than -5 µg/m3 (we will run a report and highlight these later in the process). Take note of any max reading larger than 35 µg/m3 (if you have not already using the graph report). Take note if the min/max temp readings are outside the 28 to 32-degree window of operation (we will run a report and highlight these later in the process).

5) Use conditional formatting in Excel to highlight any values less than -5 µg/m3 (if you have them) in the data set. Use conditional formatting in Excel to highlight any values not between 28 and 32 degrees (if you have them) in the data set. Save this for future validation use.

Figure 23-Screen Shot of Excel Conditional Formatting



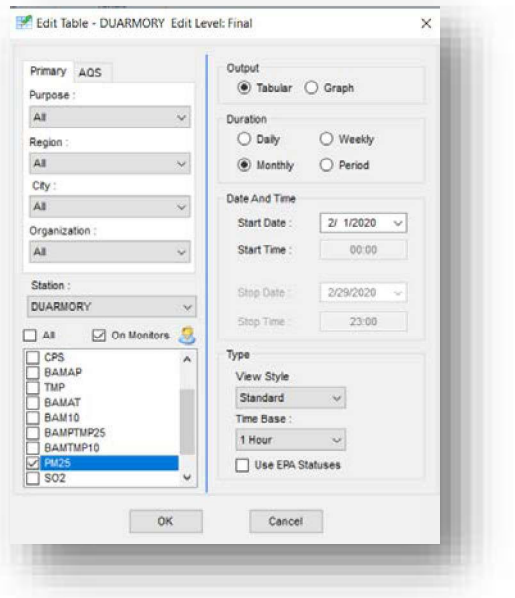
6) Now review the E-log for the monitor and month being considered. Go to the P:\Ambient\Incoming\RegOffices.NC. In this example, we will select the Raleigh office, Logbook Reports, year 2020, BAM, Durham Armory and February. Open the E-log.
7) Check the dates and results of all calibrations, verifications and maintenance activities. Make notes on this. Does the E-log paint a clear picture of what happened during the month? If not, contact the operator for clarification. Here are some important things to look out for during your E-log review:

    a) If a calibration was done for any reason, did a verification precede it?
    b) When was the last calibration performed?
    c) When was the last background test?
    d) Is there a verification for this month? Are there two? Three?
    e) Is this a month in which an audit should be performed (usually the month in the middle of each quarter: Feb, May, Aug, Nov)? Were different devices used for this audit and not the same devices used to calibrate or verify?
    f) Was quarterly maintenance performed (usually at the same time as the audit, but not always)?
    g) Was monthly maintenance performed?
    h) Was bi-monthly maintenance performed?
    i) Did the leak checks pass?
    j) Look behind a month and forward into the next month in the E-log (if available). Do you see any glaring problems that may invalidate data back into the month you are reviewing? Are there any problems in last month's data that need to be coded forward into the month you are reviewing?
    k) If a monitor was swapped out, was an ending verification done prior to the replacement?
    l) If a monitor up and died, were the data voided back to the last good verification?

8) Now back to Envista ARM. Select the Edit tab, then Edit Table. Choose your station, parameter(s), make the output tabular, duration will be monthly (date and time will self-

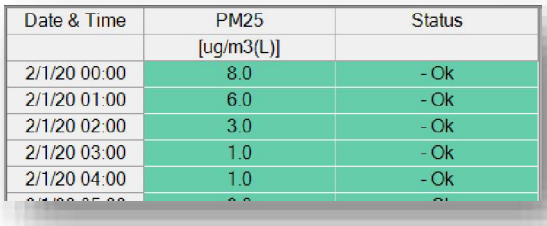
correct for the month) and report type will be standard with the time base of one hour. Click OK.

Figure 24-Screen Shot of Envista Edit Table Window



9) If the resulting report is green (see below) you are good to go. If it is light yellow, the second level review has not been performed. If it is brown, you have already signed off on this data.

Figure 25-Screen Shot of Envista Green Edit Report



Date & Time	PM25 [ug/m3(L)]	Status
2/1/20 00:00	8.0	- Ok
2/1/20 01:00	6.0	- Ok
2/1/20 02:00	3.0	- Ok
2/1/20 03:00	1.0	- Ok
2/1/20 04:00	1.0	- Ok

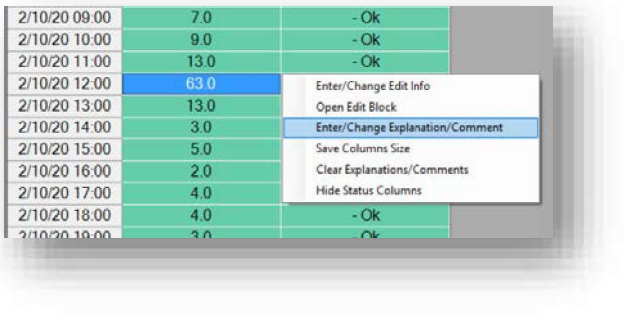
10) Another way to find the reviewing information is to use the Validation Settings option under the Edit tab, or, under the Reports tab, use the Validation report.

11) Now is when we bring all the reports together. Go through and deal with anything you found while performing the first step of graphing the data (high, low, stuck or missing). Apply codes accordingly to your review and inquiry.

12) For an example, let's use a very high reading, surrounded by low readings (a large peak on the graph). If you and the operator have done your due diligence, and the reading is deemed valid, you will need to add some flag codes. If the reading is not valid, you

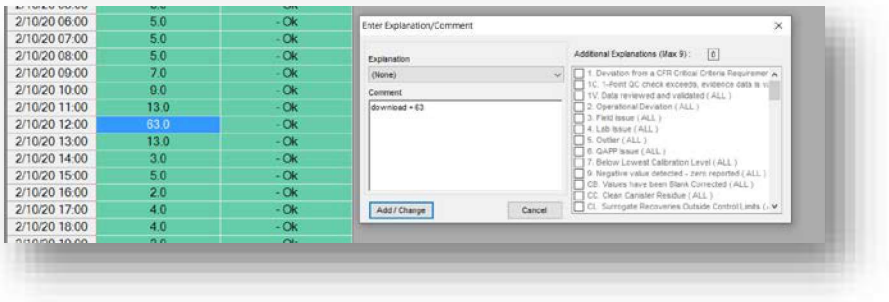
will need to use a void code. In this example, we will flag it as valid. Select the value and right click. Select Enter/Change Comment Explanation/Comment.

Figure 26- Screen Shot of Envista Green Edit Report with an Outlier



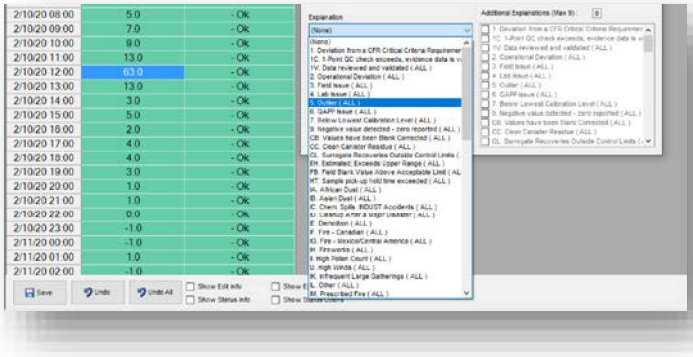
13) Next, we see that the operator or level two reviewer has inserted a comment stating that the reading was reported in the monitor's downloaded data as the same value. Be careful to not overwrite this comment.

Figure 27- Screen Shot of Envista Green Edit Report Comments



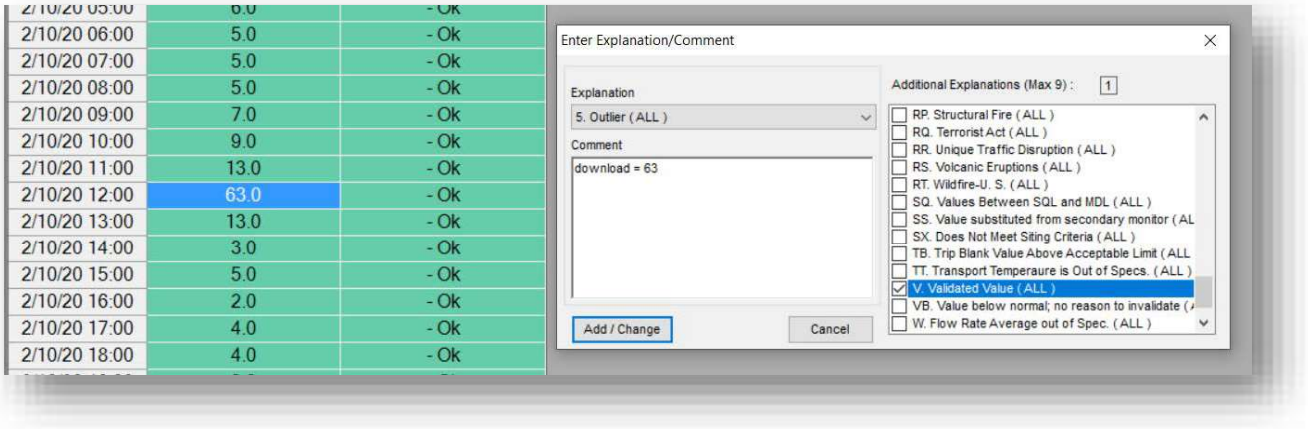
14) First, from the drop-down menu, select a flag of "5" to mark the value as an outlier.

Figure 28- Screen Shot of Envista Green Edit Report Explanation



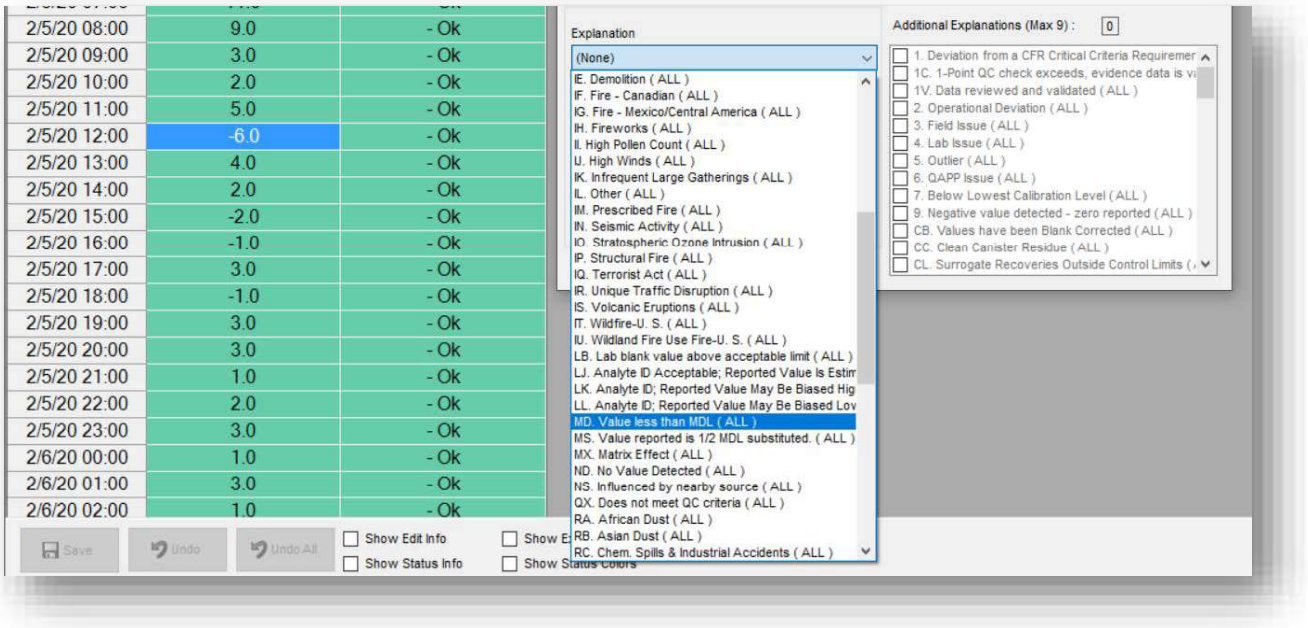
15) Second, from the additional explanation window, apply the "V" flag for validated value. This helps others know that due diligence has been used in looking into the causes or lack thereof. The value will turn blue to show that comments or flags have been applied. This value is good to go.

Figure 29- Screen Shot of Envista Green Edit Report Explanation with additional Explanation Window



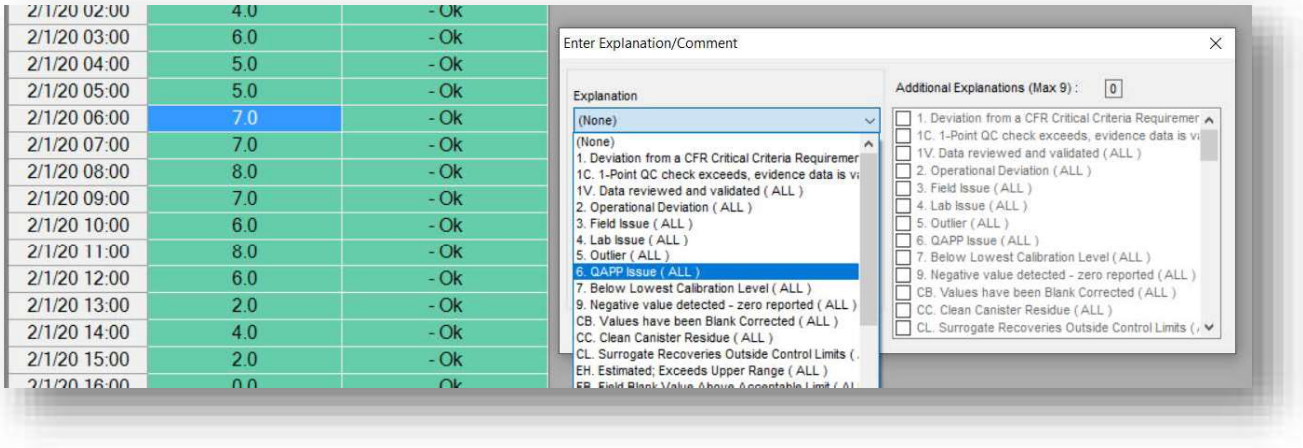
16) Now we use the less than -5 µg/m3 report that we made in the second step. Go through the edit table and apply the flag "MD" (value being less than the minimum detection limit) to all values -6 to -10. Any values less than -10 must be voided with null code "BR –Sample Value Below Acceptable Range."

Figure 30-Screen Shot of Envista Green Edit Report Explanation with MD Flag



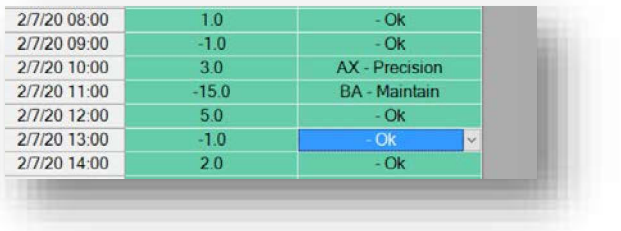
17) Now we use the 28 to 32-degree report that we made in the second step. Go through the edit table and apply the flag "6" (QAPP issue) to all PM values that have an hourly temperature not within 28 to 32 degrees. Any values that do not have a corresponding hourly temperature should be voided with "AI – Insufficient Data".

Figure 31- Screen Shot of Envista Green Edit Report Explanation with 6 Flag



18) Now, using your notes from the E-log review, apply codes to the hours in the edit table where calibrations, maintenance, verifications, zero backgrounds and other events took place. Void the appropriate number of hours to ensure the BAM has stabilized and is once again collecting valid data. If the operator performed more than one activity and voided more than one hour, be sure the operator used different null codes for the two hours so as to "tell the story" of what happened at the site. Review the list in step 6 for anything you may have missed.

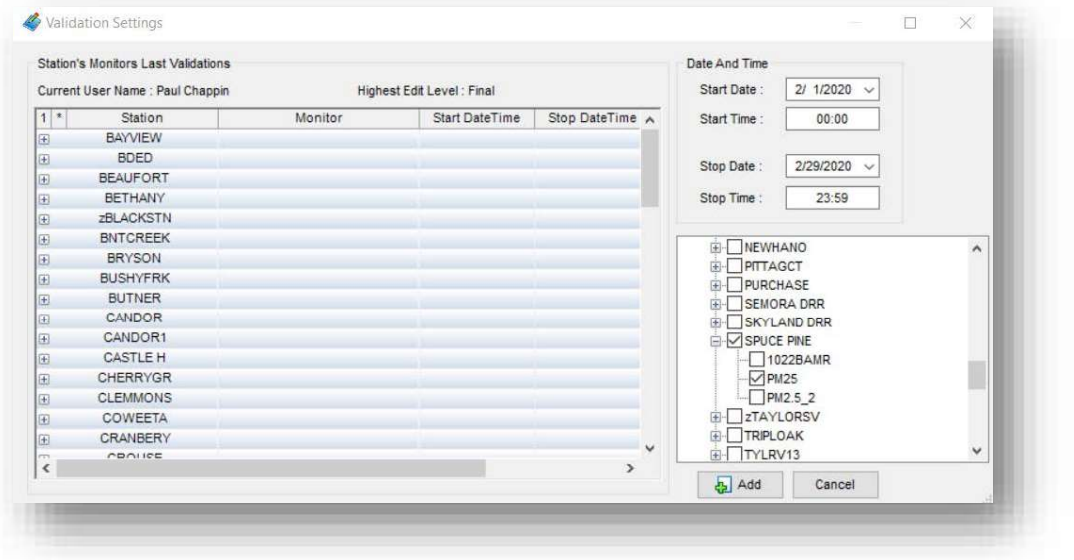
Figure 32- Screen Shot of Envista Green Edit Report "Telling the Story"



19) Continue the same process above for the PM_{10} parameter of the Coarse system. Keep in mind that the same codes will be used for PM_{10} STP as PM_{10} at local conditions. Also, the $PM_{10-2.5}$ (Coarse) reading will be influenced by the validity of <u>both</u> the $PM_{2.5}$ and PM_{10} monitors. You must have valid readings for both units for there to be a valid Coarse reading (temperatures included).

20) Once you are happy with your review, click the save icon. Now go to Validation Settings in the Edit tab. Select the time range you would like to validate (usually a whole month at a time). Select the parameter(s) at a site. Click Add. You are done.

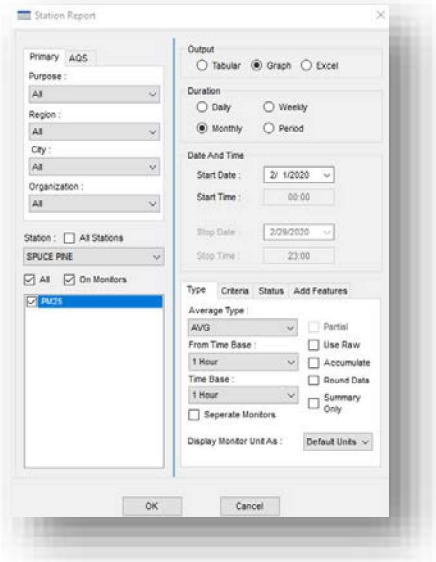
Figure 33-Screen Shot of Envidas Validation Settings



2.63.4.6 Validation of BAM 1022 Data

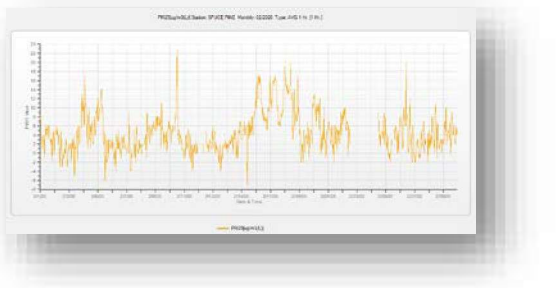
1) Make a monthly graph of the data to be validated in Envista ARM**.** Select the station name (e.g. Spruce Pine), the monitoring parameter (in this case $PM_{2.5}$), output set as graph, monthly set as the duration and then set the start date (start date will automatically be the first of the month selected). The type of report will be average, made from an hourly time base, to an hourly time base. Click OK.

Figure 34- Screen Shot of Envista Station Report



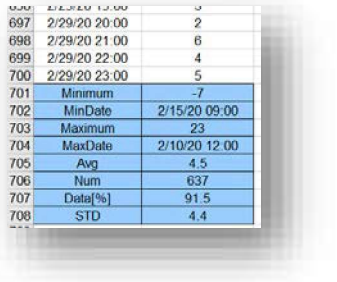
2) Review the graph for unusual spikes or drops in the data and readings that are missing all together. Readings that show no change over a span of time are also of importance. Make note of these irregularities for future use in validation.

Figure 35-Screen Shot of Envidas Graph



3) Run the same report again, but this time select Excel as the Output. Select OK. Check out the monthly synopsis at the bottom of the report for min/max readings and other statistics. Take note if the minimum reading is less than -5 µg/m3 (we will run a report and highlight these later in the process). Take note of any max reading larger than 35 µg/m3 (if you have not already using the graph report).

Figure 36-Screen Shot of Excel Output Statistical Information



697	2/29/20 20:00	2
698	2/29/20 21:00	6
699	2/29/20 22:00	4
700	2/29/20 23:00	5
701	Minimum	-7
702	MinDate	2/15/20 09:00
703	Maximum	23
704	MaxDate	2/10/20 12:00
705	Avg	4.5
706	Num	637
707	Data[%]	91.5
708	STD	4.4

4) Use conditional formatting in Excel to highlight any values less than -5 µg/m3 (if you have them) in the data set. Save this for future validation use.

Figure 37-Screen Shot of Excel Conditional Formatting

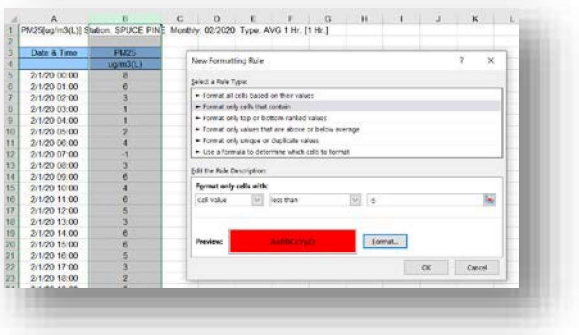
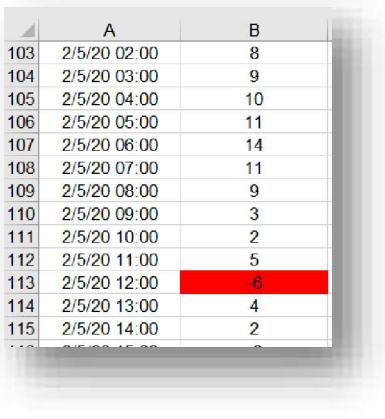


Figure 38-Screen Shot of Highlighted Data less than -5ug/m3



	A	B
103	2/5/20 02:00	8
104	2/5/20 03:00	9
105	2/5/20 04:00	10
106	2/5/20 05:00	11
107	2/5/20 06:00	14
108	2/5/20 07:00	11
109	2/5/20 08:00	9
110	2/5/20 09:00	3
111	2/5/20 10:00	2
112	2/5/20 11:00	5
113	2/5/20 12:00	-6
114	2/5/20 13:00	4
115	2/5/20 14:00	2

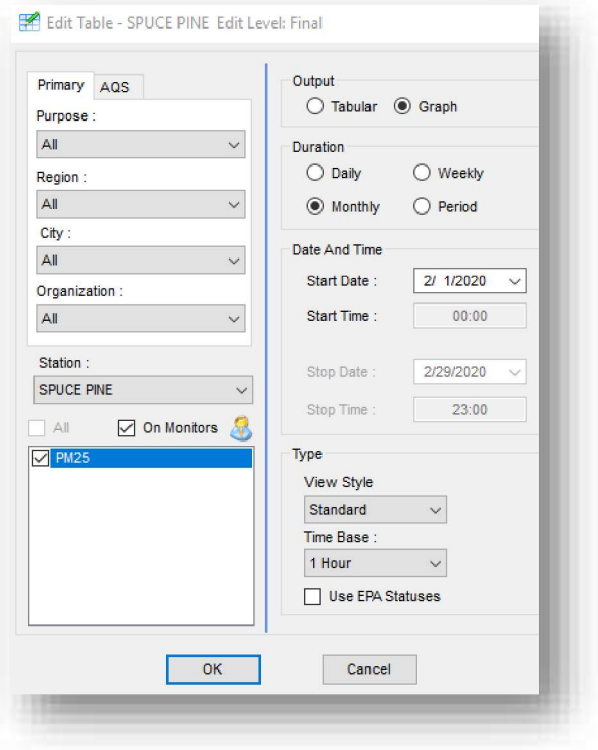
5) Now review the E-log for the monitor and month being considered. Go to the P:\Ambient\Incoming\RegOffices.NC. In this example we will select the Asheville office, Logbook Reports, year 2020, BAM, Spruce Pine and February. Open the E-log.

6) Check the dates and results of all calibrations, verifications and maintenance activities. Make notes on this. Does the E-log paint a clear picture of what happened during the month? If not, contact the operator for clarification. Here are some important things to look out for during your E-log review:

   a) If a calibration was done for any reason, did a verification precede it?
   b) When was the last calibration performed?
   c) When was the last background test?
   d) Is there a verification for this month? Are there two? Three?
   e) Is this a month in which an audit should be performed (usually the month in the middle of each quarter: Feb, May, Aug, Nov)? Were different devices used for this audit and not the same devices used to calibrate or verify?
   f) Was quarterly maintenance performed (usually at the same time as the audit, but not always)?
   g) Was monthly maintenance performed?
   h) Was bi-monthly maintenance performed?
   i) Did the leak checks pass?
   j) Look behind a month and forward into the next month in the E-log (if available). Do you see any glaring problems that may invalidate data back into the month you are reviewing? Are there any problems in last month's data that need to be coded forward into the month you are reviewing?
   k) If a monitor was swapped out, was an ending verification done prior to the replacement?
   l) If a monitor up and died, were the data voided back to the last good verification?

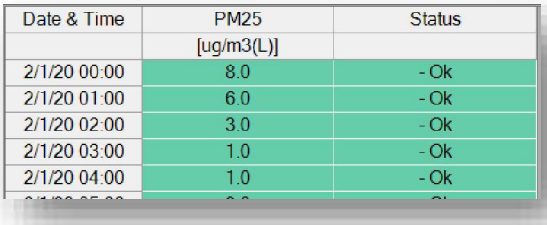
Now back to Envista ARM. Select the Edit tab, then Edit Table. Choose your station, parameter, make the output tabular, duration will be monthly (date and time will self-correct for the month) and report type will be standard with the time base of one hour. Click OK.

Figure 39-Screen Shot of Envista Edit Table Window



7) If the resulting report is green (see below) you are good to go. If it is light yellow, the second level review has not been performed. If it is brown, you have already signed off on this data.

Figure 40-Screen Shot of Envista Green Edit Report



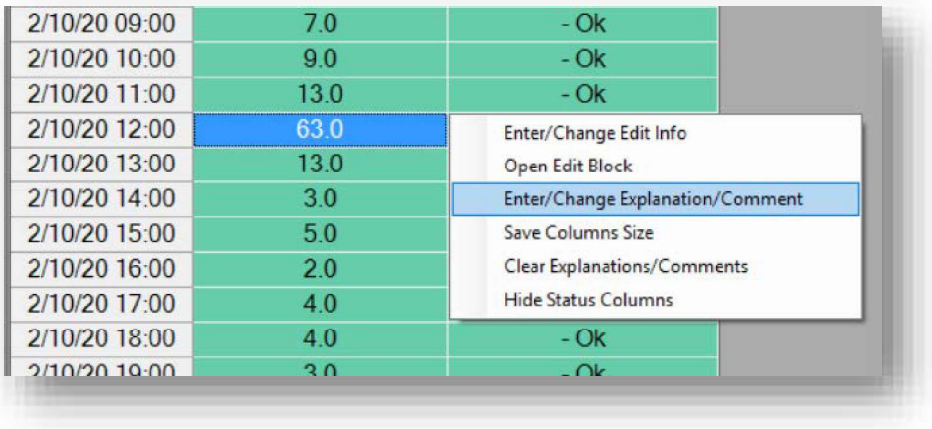
Date & Time	PM25	Status
	[ug/m3(L)]	
2/1/20 00:00	8.0	- Ok
2/1/20 01:00	6.0	- Ok
2/1/20 02:00	3.0	- Ok
2/1/20 03:00	1.0	- Ok
2/1/20 04:00	1.0	- Ok

Another way to find the reviewing information is to use the Validation Settings option under the Edit tab, or, under the Reports tab, use the Validation report.

8) Now is when we bring all the reports together. Go through and deal with anything you found while performing the first step of graphing the data (high, low, stuck or missing). Apply codes accordingly to your review and inquiry.

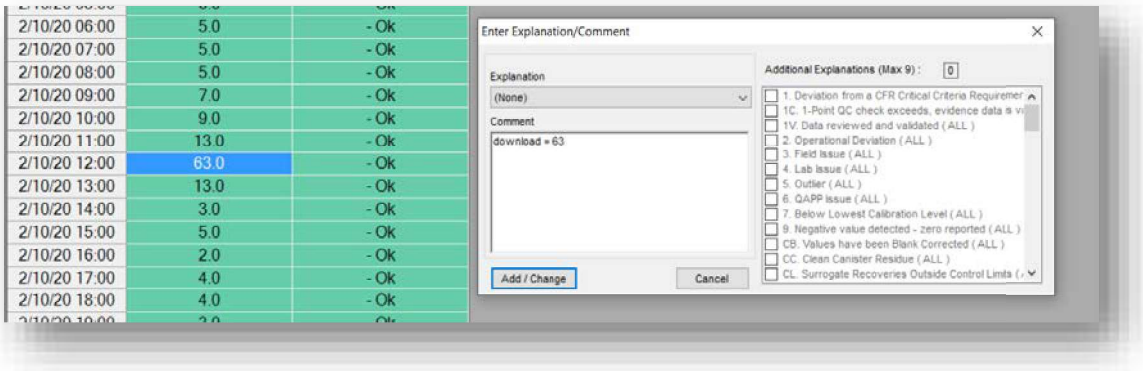
9) For an example, let's use a very high reading, surrounded by low readings (a large peak on the graph). If you and the operator have done your due diligence, and the reading is deemed valid, you will need to add some flag codes. If the reading is not valid, you will need to use a void code. In this example, we will flag it as valid. Select the value and right click. Select Enter/Change Comment Explanation/Comment.

Figure 41- Screen Shot of Envista Green Edit Report with an Outlier



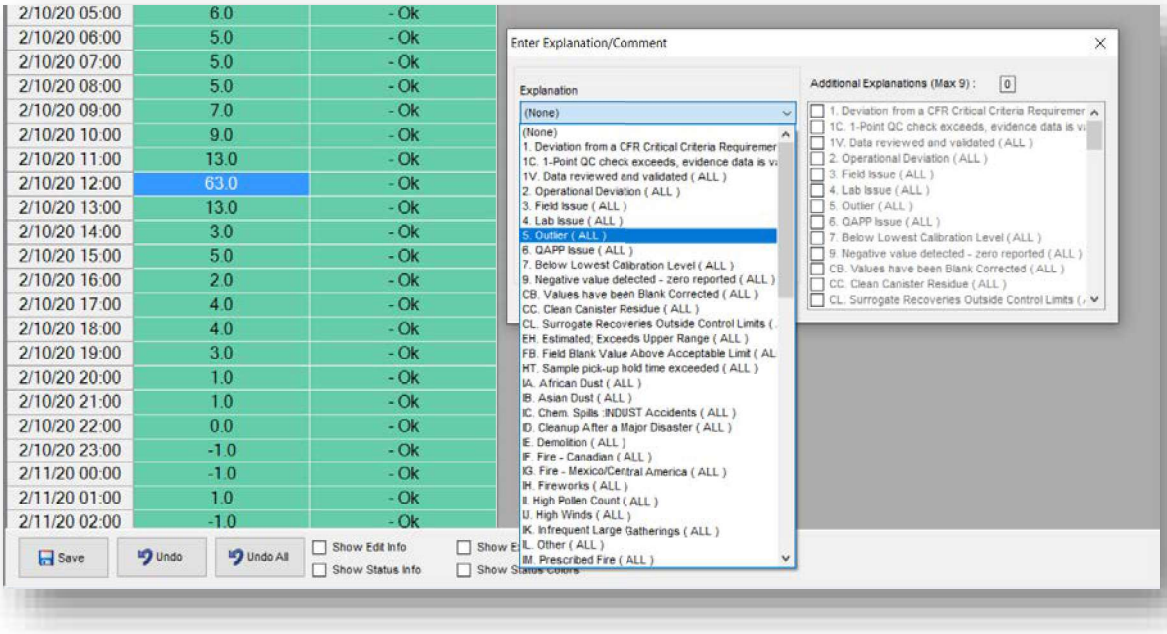
10) Next, we see that the operator or level two reviewer has inserted a comment stating that the reading was reported in the monitor's downloaded data as the same value. Be careful to not overwrite this comment.

Figure 42- Screen Shot of Envista Green Edit Report Explanation



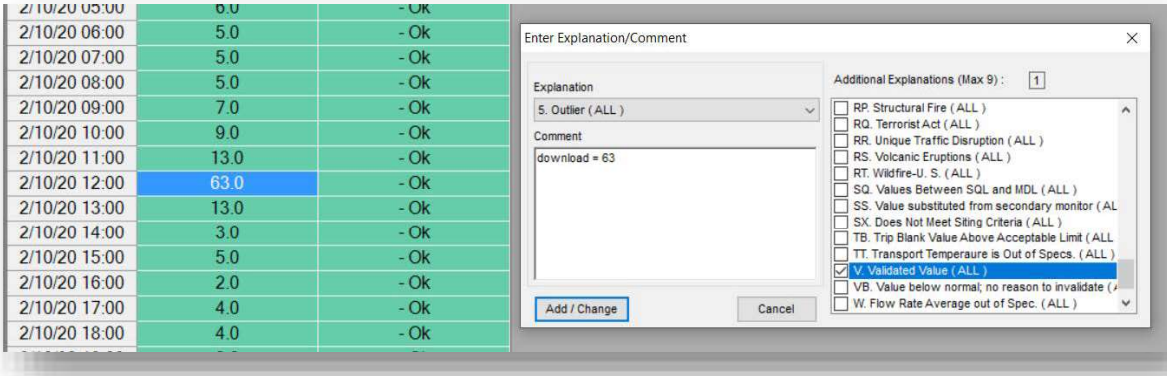
11) First, from the drop-down menu, select a flag of "5" to mark the value as an outlier.

Figure 43- Screen Shot of Envista Green Edit Report Explanation with additional Explanation Window



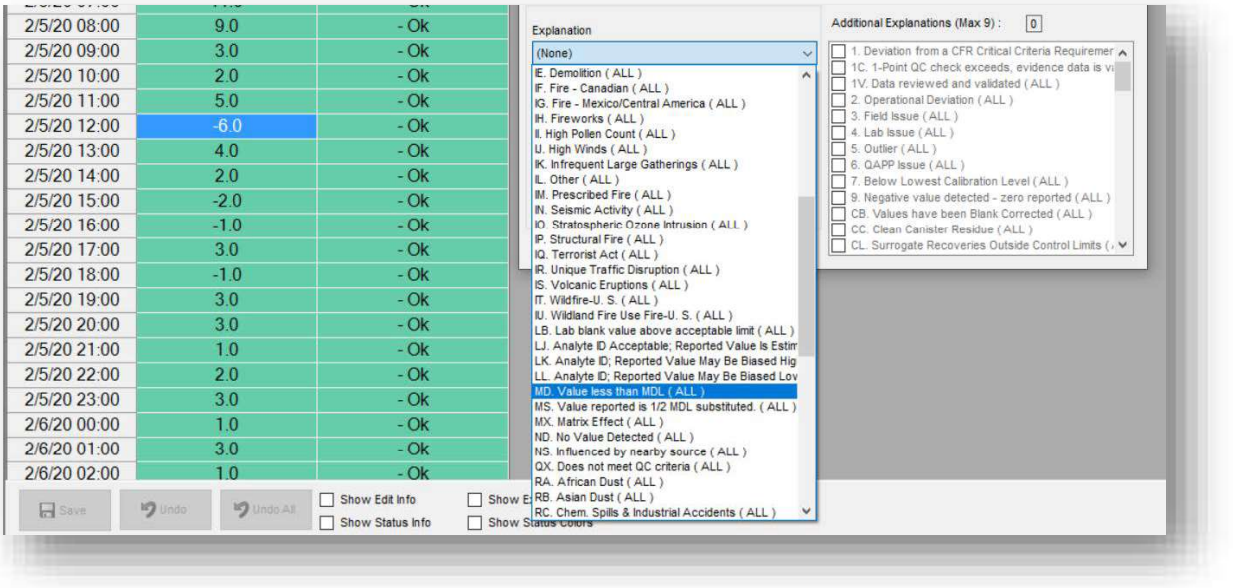
12) Second, from the additional explanation window, apply the "V" flag for validated value. This helps others know that due diligence has been used in looking into the causes or lack thereof. The value will turn blue to show that comments or flags have been applied. This value is good to go.

Figure 44- Screen Shot of Envista Green Edit Report Explanation with additional Explanation Window



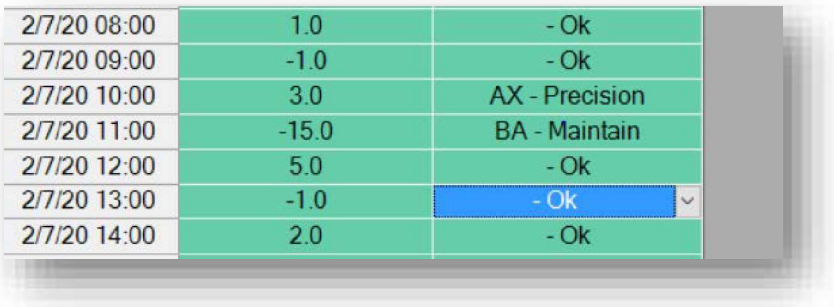
13) Now we use the less than -5 µg/m^3 report that we made in the second step. Go through the edit table and apply the flag "MD" (value being less than the minimum detection limit) to all values -6 to -10. Any values less than -10 must be voided with null code "BR –Sample Value Below Acceptable Range ".

Figure 45-Screen Shot of Envista Green Edit Report Explanation with MD Flag



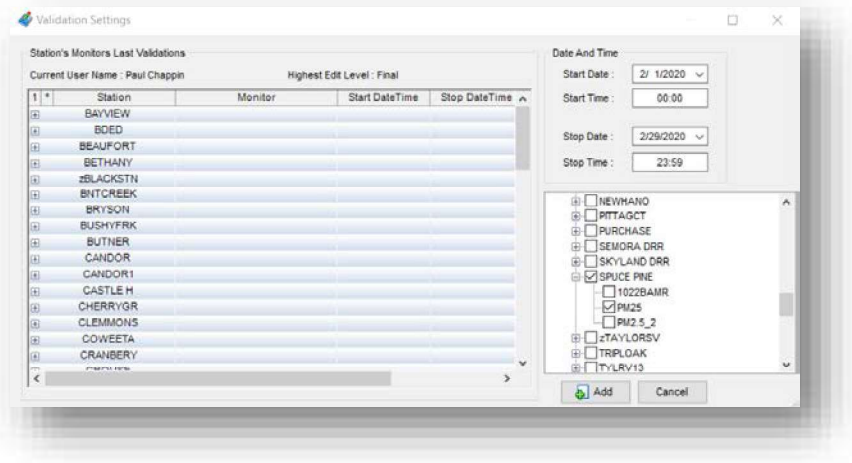
14) Now, using your notes from the E-log review, apply codes to the hours in the edit table where calibrations, maintenance, verifications, zero backgrounds and other events took place. Void the appropriate number of hours to ensure the BAM has stabilized and is once again collecting valid data. If the operator performed more than one activity and voided more than one hour, ensure the operator used different null codes for the two hours so as to "tell the story" of what happened at the site. Review the list in step 6 for anything you may have missed.

Figure 46-Screen Shot of Envista Green Edit Report "Telling the Story"



15) Once you are happy with your review, click the save icon. Now go to Validation Settings in the Edit tab. Select the time range you would like to validate (usually a whole month at a time). Select the parameter at a site. Click Add. You are done.

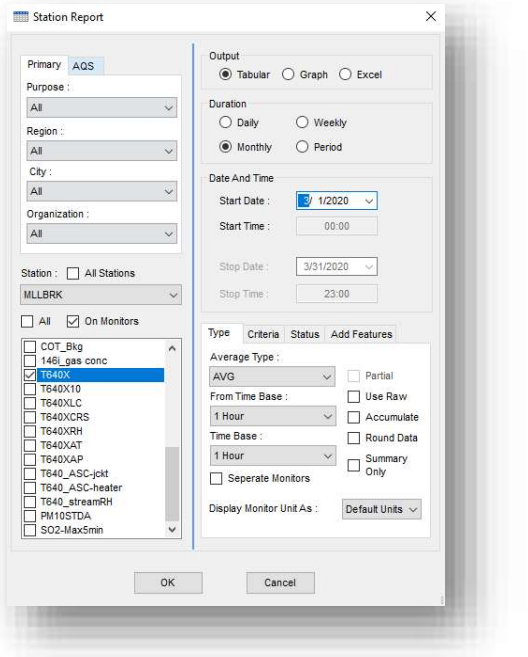
Figure 47-Screen Shot of Envidas Validation Settings



2.63.4.7Validation of T640X Data

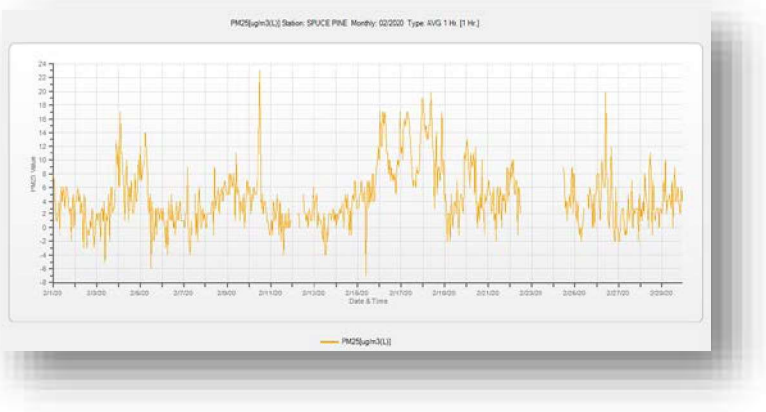
1) Make a station report of the data to be validated in Envista ARM**.** Select the station name (e.g. Millbrook), the monitoring parameter (in this case $PM_{2.5}$), output set as Tabular, monthly set as the duration and then set the start date (start date will automatically be the first of the month selected). The type of report will be average, made from an hourly time base, to an hourly time base. Click OK.

Figure 48-Screen Shot of Envista Station Report



2) Once the report generates, press the space bar to toggle between report and graphical views. Review the graph for unusual spikes or drops in the data and readings that are missing all together. Readings that show no change over a span of time are also of importance. Take note of any max reading larger than 35 µg/m^3 or negative numbers (these will never happen theoretically). Make note of these irregularities for future use in validation.

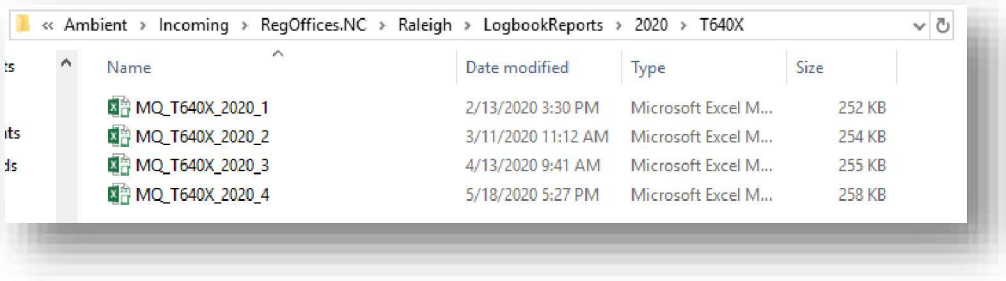
Figure 49-Screen Shot of Envidas Graph



3) Repeat steps 1 and 2 for the PM_{10}, PM_{10} STD and PM Coarse parameters of the T640X.

4) Now review the E-log for the monitor and month being considered. Go to the P:\Ambient\Incoming\RegOffices.NC. In this example, we will select the Raleigh office, Logbook Reports, year 2020, T640X, Millbrook and March. Open the E-log.

Figure 50-Screen Shot of the P: Drive Logbook Reports



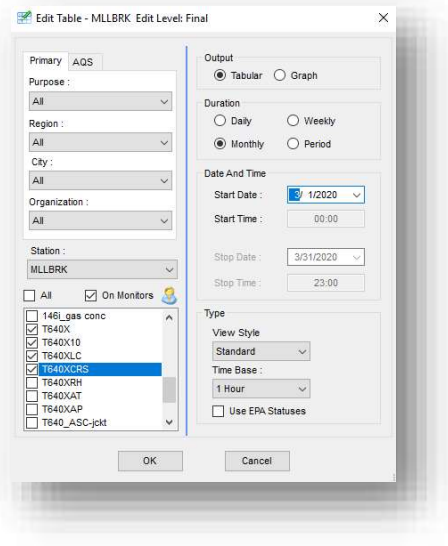
5) Check the dates and results of all calibrations, verifications and maintenance activities. Make notes on this. Does the E-log paint a clear picture of what happened during the month? If not, contact the operator for clarification. Here are some important things to look out for during your E-log review:

   a) If a calibration was done for any reason, did a verification precede it?
   b) When was the last calibration performed?
   c) When was the last span dust test?
   d) Is there a verification for this month? Are there two? Three?

e) Is this a month in which an audit should be performed (usually the month in the middle of each quarter: Feb, May, Aug, Nov)? Were different devices used for this audit and not the same ones used to calibrate or verify?
f) Was quarterly maintenance performed (usually at the same time as the audit, but not always)?
g) Was monthly maintenance performed?
h) Was quarterly maintenance performed?
i) Was bi-annual maintenance performed?
j) Was annual maintenance performed?
k) Did the leak checks pass?
l) Look behind a month and forward into the next month in the E-log (if available). Do you see any glaring problems that may invalidate data back into the month you are reviewing? Are there any problems in last month's data that need to be coded forward into the month you are reviewing?
m) If a monitor was swapped out, was an ending verification done prior to the replacement?
n) If a monitor up and died, were the data voided back to the last good verification?

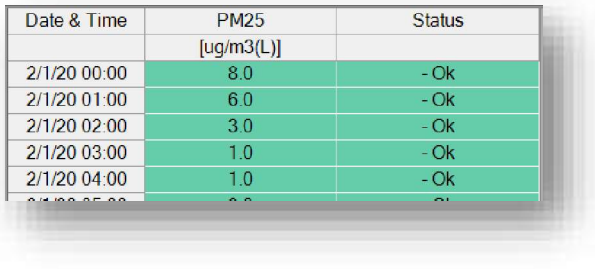
6) Now back to Envista ARM. Select the Edit tab, then Edit Table. Choose your station, parameters, make the output tabular, duration will be monthly (date and time will self-correct for the month) and report type will be standard with the time base of one hour. Click OK.

Figure 51-Screen Shot of Envista Edit Table Window



7) If the resulting report is green (see below) you are good to go. If it is light yellow, the second level review has not been performed. If it is brown, you have already signed off on these data.

Figure 52-Screen Shot of Envista Green Edit Report



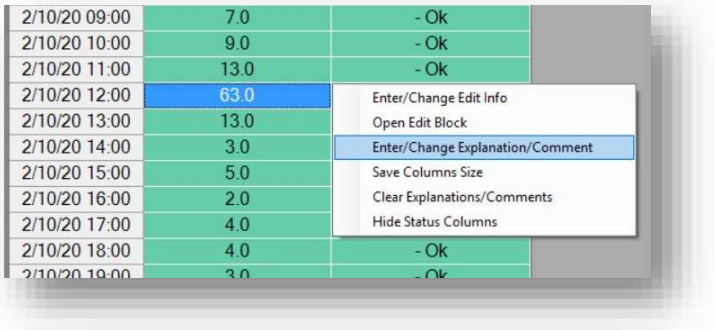
Date & Time	PM25	Status
	[ug/m3(L)]	
2/1/20 00:00	8.0	- Ok
2/1/20 01:00	6.0	- Ok
2/1/20 02:00	3.0	- Ok
2/1/20 03:00	1.0	- Ok
2/1/20 04:00	1.0	- Ok

Another way to find the reviewing information is to use the Validation Settings option under the Edit tab, or, under the Reports tab, use the Validation report.

8) Now is when we bring all the reports together. Go through and deal with anything you found while performing the first step of graphing the data (high, low, stuck or missing). Apply codes accordingly to your review and inquiry.

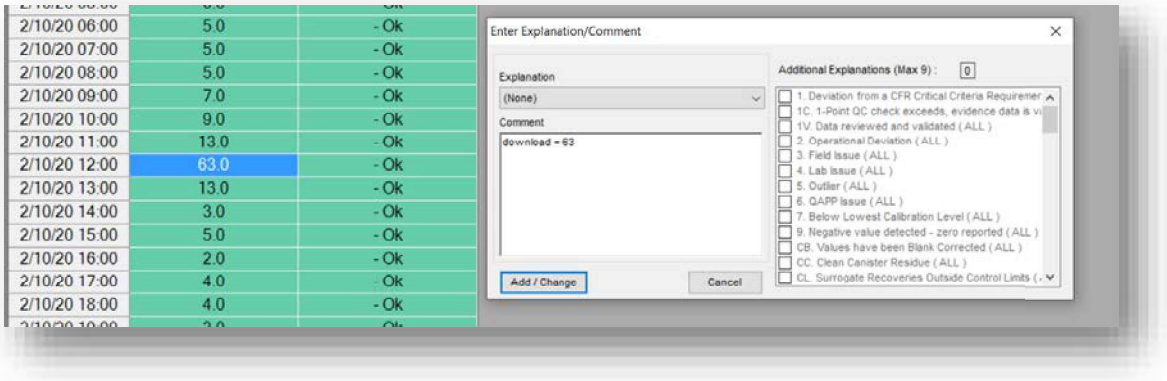
9) For an example, let's use a very high reading, surrounded by low readings (a large peak on the graph). If you and the operator have done you due diligence, and the reading is deemed valid, you will need to add some flag codes. If the reading is not valid, you will need to use a void code. In this example, we will flag it as valid. Select the value and right click. Select Enter/Change Comment Explanation/Comment.

Figure 53-Screen Shot of Envista Green Edit Report with an Outlier



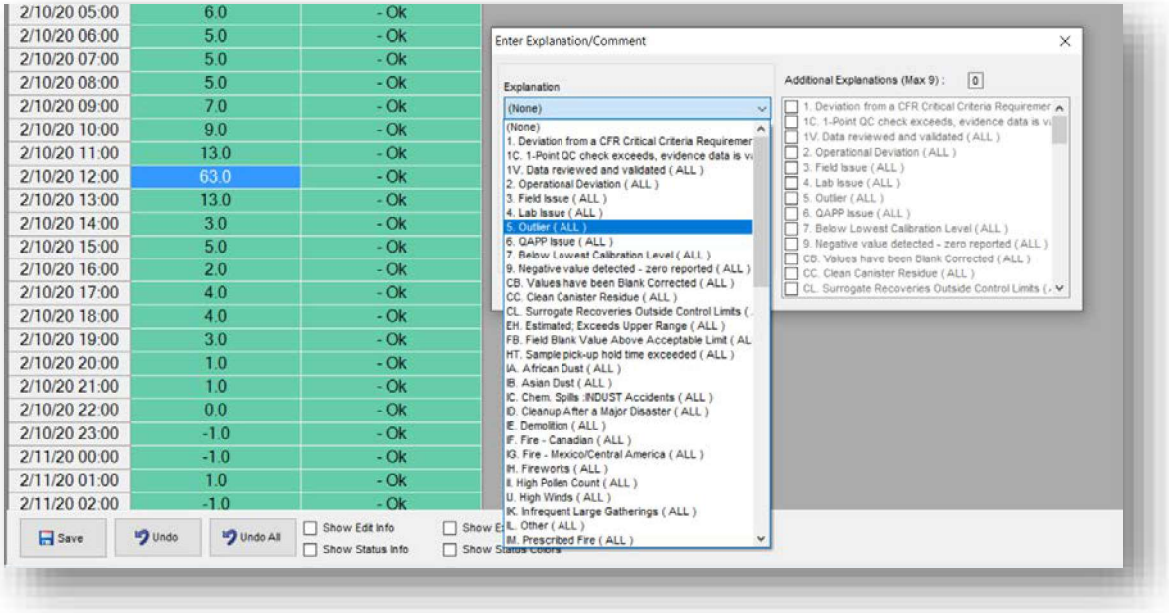
10) Next, we see that the operator or level two reviewer has inserted a comment stating that the reading was reported in the monitor's downloaded data as the same value. Be careful to not overwrite this comment.

Figure 54- Screen Shot of Envista Green Edit Report Explanation



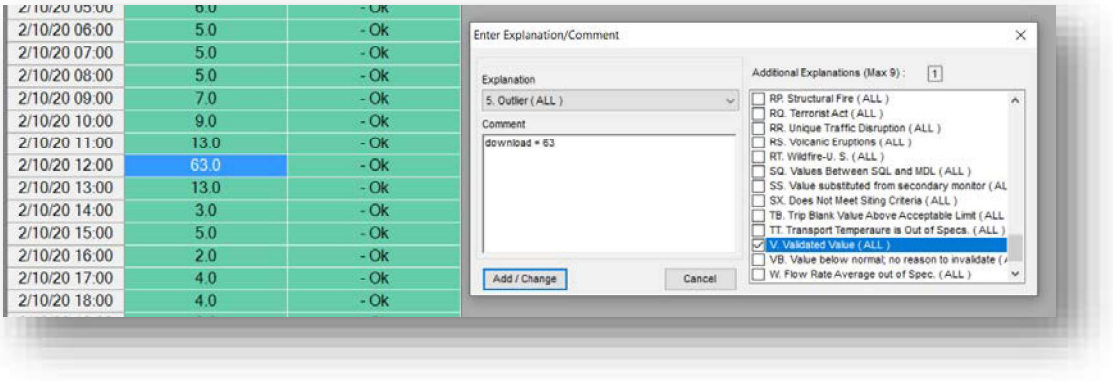
11) First, from the drop-down menu, select a flag of "5" to mark the value as an outlier.

Figure 55- Screen Shot of Envista Green Edit Report Explanation with additional Explanation Window



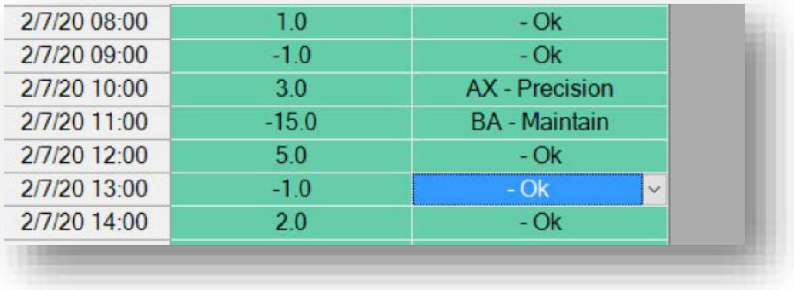
12) Second, from the additional explanation window, apply the "V" flag for validated value. This helps others know that due diligence has been used in looking into the causes or lack thereof. The value will turn blue to show that comments or flags have been applied. This value is good to go.

Figure 56- Screen Shot of Envista Green Edit Report Explanation with additional Explanation Window



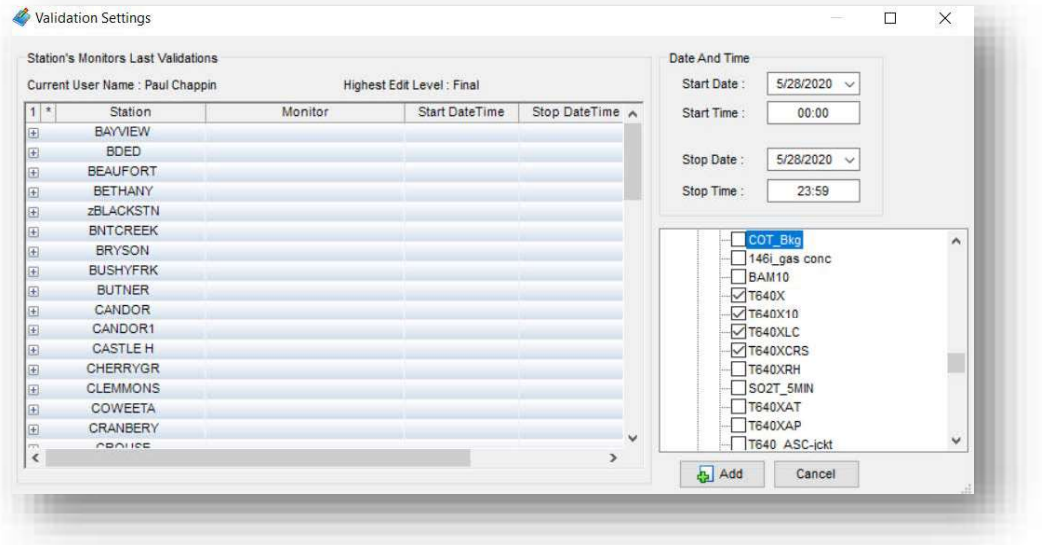
13) Now, using your notes from the E-log review, apply codes to the hours in the edit table where calibrations, maintenance, verifications, zero backgrounds and other events took place. Void the appropriate number of hours to ensure the T640X has stabilized and is once again collecting valid data. If the operator performed more than one activity and voided more than one hour, ensure the operator used different null codes for the two hours so as to "tell the story" of what happened at the site. Review the list in step 5 for anything you may have missed.

Figure 57- Screen Shot of Envista Green Edit Report "Telling the Story"



14) Once you are happy with your review, click the save icon. Now go to Validation Settings in the Edit tab. Select the time range you would like to validate (usually a whole month at a time). Select the parameter at a site. Click Add. You are done.

Figure 58-Screen Shot of Envidas Validation Settings



2.63.4.8 Validation of CSN Data

In the mid-1990s, Sonoma Technology, Inc. (STI) developed a software program, VOCDat (Volatile Organic Compound data validation and analysis software tool) for validating and analyzing PAMS (Photochemical Assessment Monitoring Station) data. Many monitoring agencies have used VOCDat to validate and analyze PAMS data and other large sets of speciated ambient data (e.g., carbonyls, air toxics, or speciated PM2.5).

Along the same lines as VOCDat, DART (Data Analysis and Reporting Tool) is an STI web-based data validation and analysis system that is integrated with AirNow-Tech. It not only provides a framework for validating and analyzing air quality data, but it will also eventually enable access to complementary data sets from different sources and web services.

In its current form, DART contains many key features for validating and analyzing data collected, such as routine air quality measurements (e.g., PM, O3, NOx), routine meteorological measurements, and VOC measurements.

1) Electronic Logbook Review

    a) Now review the E-log for the monitor and month being considered. Go to the P:\Ambient\Incoming\RegOffices.NC\Raleigh\Logbook Reports\2020\SPECIATION\Millbrook SASS and URG. Open the E-log.

    b) Check the dates and results of all calibrations, verifications and maintenance activities. Make notes on this. Does the E-log paint a clear picture of what happened during the month? If not, contact the operator for clarification. Here are some important things to look out for during your E-log review:

- If a calibration was done for any reason, did a verification precede it?
- When was the last calibration performed?
- Is there a verification for this month? Are there two? Three?
- Is this a month in which an audit should be performed (usually the month in the middle of each quarter: Feb, May, Aug, Nov)? Were different devices used for this audit and not the same devices used to calibrate or verify?
- Was quarterly maintenance performed (usually at the same time as the audit, but not always)?
- Was monthly maintenance performed?
- Did the leak checks pass?
- Look behind a month and forward into the next month in the E-log (if available). Do you see any glaring problems that may invalidate data back into the month you are reviewing? Are there any problems in last month's data that need to be coded forward into the month you are reviewing?
- If a monitor was swapped out, was an ending verification done prior to the replacement?
- If a monitor up and died, were the data voided back to the last good verification?

2) Opening Dart

a) To get started with DART, use an Internet browser to navigate to AirNow-Tech (http://airnowtech.org). Google Chrome is the preferred Internet browser; however, Firefox and Internet Explorer version 10 or above are also supported.

b) Next, log in with a new or existing account. Choose to login at the upper right corner of the main page.

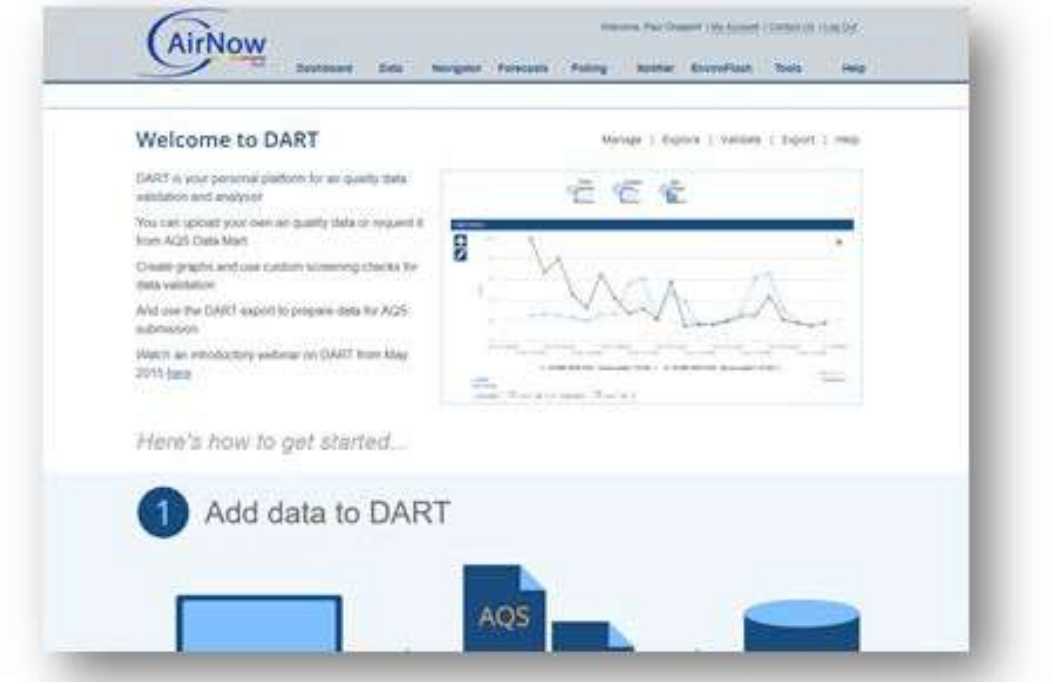
Figure 59-Screen Shot of Air Now Log In

c) Find DART under the tools tab on the AirNow-Tech home page.

Figure 60-Screen Shot of Air Now Tool Tab

d) Next, you will see the DART welcome page, which explains the three basic steps to using DART. You can return to this page at any time by clicking the DART link at the top left of the screen.

Figure 61-Screen Shot of DART Welcome Page



e) DART is organized into three general areas:
   - Data Manager – upload and manage your data sets.
   - Data Explorer – screen, validate, and explore your data using time series graphs, scatter plots, and bar charts.
   - Data Validator – build and run automated screening checks and interactively explore results and your data using linked tables and time-series graphs.
   - Data Exporter – export your data files and prepare them for submission to AQS.

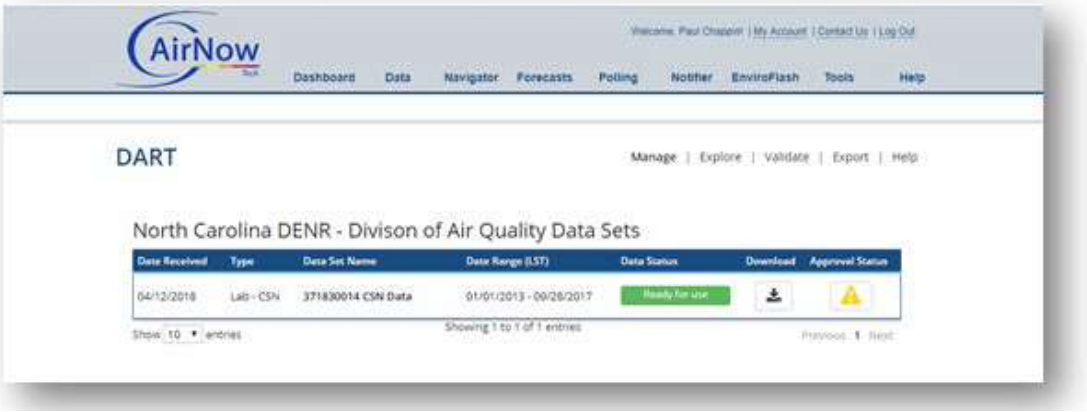
f) You can access each area by clicking on the manage, explore, validate, and export links at the top right of every screen. The help link at the top right of the screen opens the DART help guide in a separate window.

3) Validating CSN Data within DART

On the manage page, you can begin to run screening checks to automatically identify problematic data, in order to make data validation more efficient.

a) To begin, click on the approval status icon.

Figure 62-Screen Shot of DART Manage



b) DART's approval mode includes the following tools to aid in data review:
   - Description of the number of samples, date range, and "Review by" deadline for the data batch.
   - Sample summary table for each sample in the batch, describing the number of species, number of qualifier and/or null codes applied to the data, data completeness, and percent of data above the method detection limit (MDL).
   - Batch data table displaying the parameter concentration value, MDL, data uncertainty, and null or qualifier codes, for all the data in the batch.
   - Time series and fingerprint plots for visually reviewing the data.

Figure 63-DART Approval Window

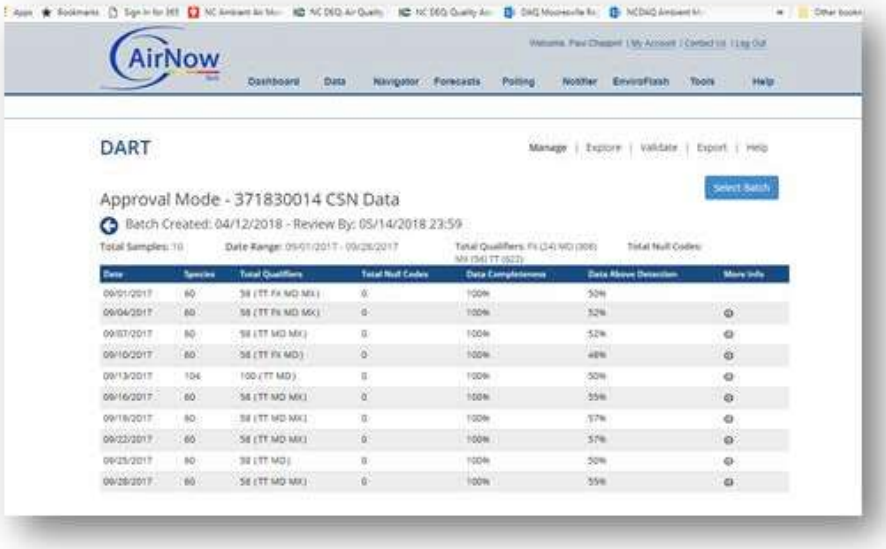


Figure 64- DART Batch Window

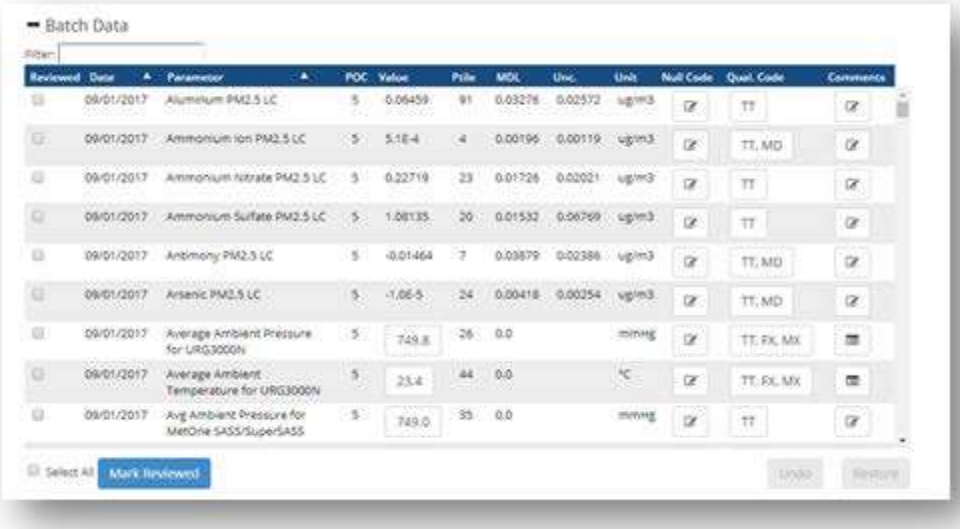
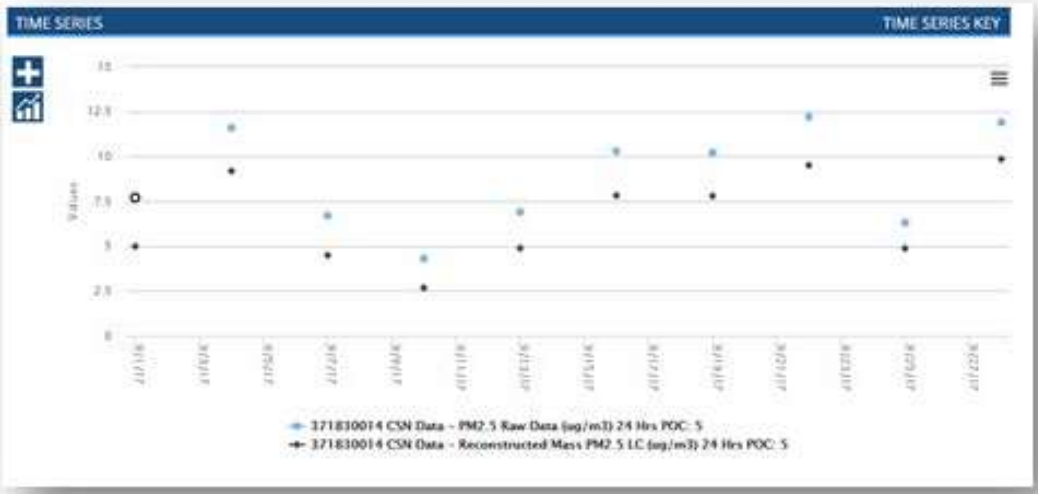


Figure 65-Time Series Window



c) In approval mode, null and/or qualifier codes can be edited using the edit batch window.
d) To access the edit batch window, click on the icon in the null code or qualifier code column in the row of the batch data table for the species that you would like to edit.
e) Choose the species or group of species that you would like to edit. The options include:

- Selected Species: Only the species selected in the batch data table will be changed. The row for the selected species in the batch data table will be highlighted in blue.
- Entire Sample: All of the species for the selected sample date will be changed. For example, if the row for the Potassium ion concentration is selected and "Apply to Entire Sample" is chosen from the drop-down menu, the null and/or qualifier code(s) for all of the species measured in the sample will be changed.
- Metal Species in Selected Sample: All of the metal species for the selected sample date will be changed. For example, if the row for the Aluminum concentration is selected and "Apply to Metal Species" is chosen from the drop-down menu, the null and/or qualifier code(s) for all of the metal species measured in the sample will be changed.
- Ions Species in Selected Sample: All of the ion species for the selected sample date will be changed. For example, if the row for the Ammonium ion concentration is selected and "Apply to Ions Species" is chosen from the drop-down menu, the null and/or qualifier code(s) for all of the ion species measured in the sample will be changed.
- Carbon Species in Selected Sample: All of the carbon species for the selected sample date will be changed. For example, if the row in the batch data table for the Elemental Carbon (EC) concentration is selected and "Apply to Carbon Species" is chosen from the drop-down menu, the null and/or qualifier code(s) for all of the carbon species measured in the sample will be changed.

f) When reviewing data, it can be tempting to remove points that do not "fit" an observed profile. However, it is critical to retain all viable data points for an unbiased dataset. Clear evidence, such as sampler malfunction or sample damage, is required for a sample or data to be invalidated. There are numerous qualifier flag options to inform the end user. Similarly, negative values are included in the final dataset as they arise from the subtraction of background signals and can be understood as "indistinguishable from zero. Censoring negative values artificially biases the dataset and can be problematic for statistics.

g) Other things to keep in mind and look for while validating data include the following:
   - Check all invalid filters. Please review the null flags and cross-check with field records.
   - Change the "AM" null flag to a more appropriate flag. The "AM" (miscellaneous void) null flag is automatically applied to data records that were not received.

- Add qualifier flags. AQS will accept up to 10 qualifier flags for each data value reported to AQS.
- Invalidate samples with a serious sampling problem. Serious sampling problems include poor flow rate (> +/-10% from specification) and inadequate sampling time (> +/-1 hour).
- Check field blank concentrations. Higher than expected concentrations could indicate sampler issues, filter set-up and run issues, or contamination.
- Check flow rates, dates and operational parameters carefully.
- Respond to questions in the comments section. UCD data analysts ask questions to the SLT validator through the DART interface. In order for these issues to be resolved, the SLT validator must leave a clear and detailed comment responding to the question.
- Write clear and detailed comments. The SLT validator must clearly indicate when action is required by the UCD data analysts, and specify the parameter(s), date(s), and describe the changes that need to be made.
- Be careful when applying flags to multiple parameters.
- Review data flagged with the "A1", "B1", and/or "C1" flags.

h) Do not perform the following:
   - Invalidate samples with the "FX" or "MX" qualifier flags unless additional information support invalidation.
   - Remove the "TT" and "MD" flags. These flags are automatically generated from measurement results. The "TT" flag is applied when samples are received with a temperature greater than 4 °C. The "MD" flag is applied when the reported value is below the corresponding detection limit.
   - Use the "Rx" Request Exclusion flags. These flags are available for use for NAAQS related data but they are not relevant to CSN data.

i) Choose the null code or qualifier code(s) that you would like to add or remove from the selected species by using the drop-down menus. A species measured in a sample can have either a null code or qualifier code(s), but not both.

j) Therefore, if the selected species already has a qualifier code(s) and you would like to apply a null code, you must first remove the existing qualifier code(s) by clicking the "x" next to the code in the qualifier drop-down menu.

k) Similarly, if the selected species already has a null code and you would like to apply a qualifier code or codes, you must first remove the existing null code by selecting "No null code" from the null code drop-down. If a species concentration is missing, which displays as the value -999 in DART, a null code is required.

l) Add a comment to describe the changes you are making to the null code and/or qualifier code(s). Comments provide helpful information that is shared with other data validators in your agency. All comments and associated null or qualifier code changes are also provided to the laboratory at the end of the data review period.

m) Click "Save" to apply your changes or click "Cancel" to exit the window. By default, only specific null and qualifier code(s) will be appended or removed based on the user's selections in the Edit Batch window. All other existing null and qualifier code(s) that are currently applied to the species or a group of species (e.g., metals, ions, entire sample) will be retained. DART also has an option to overwrite all existing null and qualifier code(s) prior to applying the new null or qualifier code(s) specified by the user in the Edit Batch window. This option can be invoked by checking the "Overwrite Codes" box next to the "Apply to" drop-down menu.

n) After the 30-day review period, CSN data are automatically sent back to the laboratory; data that were not marked as reviewed are assumed to be approved by the agency.

o) The laboratory reviews any null or qualifier code changes and the comments provided by the data validators; the laboratory then prepares the final data for submission to AQS.

p) Watch a webinar from March 2016 for more information about using approval mode for the CSN review process.

4) Further Analysis

The DART interface provides many useful tools for visualizing the data sets. In addition to the online DART interface, DART allows users to export data for further analysis using a spreadsheet or other software. There are innumerable methods for data analysis, which are outside the scope of this document. Offered here are some examples of analyses that may be useful for SLT validators both using the DART interface and offline. Other useful analyses not covered in this document may incorporate wind rose plots, trajectory analysis, and AirNow-Tech data.

a) *Regression analysis* is a common tool used for evaluating the relationship between two or more interrelated variables. For data validation, linear regression can be used to determine the comparability of two types of results, such as reconstructed mass versus gravimetric mass or titanium versus silicon (typical soil elements). For measurements we expect to be very similar, a regression slope near one would indicate subjectively good agreement. A slope that deviates from one may indicate a methodological bias by one instrument or analysis. Likewise, a non-zero intercept indicates a bias between the two variables. The analyst should take uncertainties, methodological differences, and local factors into account when interpreting results.

b) In DART, *time-series plots* can be viewed for one or more parameters simultaneously. Additionally, several calculated parameters are provided to aid in interpreting the data. These include reconstructed mass, summed elements, summed ions, ammonium sulfate, ammonium nitrate, soil, and organic carbon by mass. Viewing multiple parameters across different filter types can be a useful tool for determining whether a data point is atmospherically real or a sampling anomaly. For species with common sources, comparing their concentrations can provide supporting evidence if they exhibit similar trends. For example, if sodium ion and chloride both have high concentrations it can be indicative of sea salt influence. However, if the concentrations of all ions species are high, this could indicate an issue with the sample itself, as not all of the measured species from the nylon filter have a common source. Comparing the sulfate from the nylon filter with the sulfur from the corresponding PTFE filter could be used to corroborate the results.
c) Comparing species concentrations between sites can provide insight into local and regional events as well as highlight potential issues with the data. When performing a *geospatial analysis,* it is important to consider the site location relative to other CSN sites and potential local influences. It is also important to understand the sources and atmospheric lifetimes of the species being compared; for example, sulfur is generally regional whereas organic carbon can have local and regional sources and evolves in the atmosphere with time.

2.63.4.9Acronyms

AM – AQS null code signifying a miscellaneous void

AQI – Air Quality Index

AQS – Air Quality System

ARM – Air Resource Manager

BAM – beta attenuation monitor

CFR – Code of Federal Regulations

CSN – Chemical Speciation Network

DART – Data Analysis and Reporting Tool

EC – Elemental Carbon

EPA – United States Environmental Protection Agency

FEM – Federal Equivalent Method

FRM – Federal Reference Method

FTP – File transfer protocol

IBEAM - Internet-Based Enterprise Application Management

MDL – Method Detection Limit

MS - Microsoft

NAAQS – National Ambient Air Quality Standard

NC DAQ – North Carolina Division of Air Quality

NO_x – Nitrogen oxides or oxides of nitrogen

O_3 - Ozone

PAMS – Photochemical Assessment Monitoring Station

PM – Particle matter

$PM_{2.5}$ – Fine particles, i.e., particles with aerodynamic diameters of 2.5 microns or less

PM_{10} – particles with aerodynamic diameters of 10 microns or less

PTFE – Polytetrafluoroethylene

QA – quality assurance

QAPP – quality assurance project plan

RCO – Raleigh Central Office

SASS – Speciated Air Sampling System

SCC – sharp cut cyclone

SLT – State, Local, Tribal programs or agencies

SOP – standard operating procedures

STI – Sonoma Technology, Incorporated

STP – standard temperature and pressure

UCD – University of California - Davis

URG – University Research Glass

µg – microgram

µg/m^3 – micrograms per cubic meter

VOC – Volatile Organic Compounds

VOCDat (Volatile Organic Compound data validation and analysis software tool)

VSCC – very sharp cut cyclone

WNC – Western North Carolina Regional Air Quality Agency

2.63.4.10 Revision History

New SOP

2.63.4.11 References

- EPA Quality Assurance Handbook for Air Pollution Measurement Systems Volume II Ambient Air Quality Monitoring Program January 2017
- EPA Guidance on Environmental Data Verification and Data Validation EPA QA/G-8 November 2002
- Guidance for Preparing Standard Operating Procedures (SOPs) EPA QA/G-6 April 2007
- Quality Assurance Project Plan for the North Carolina Division of Air Quality Particulate Matter Monitoring Program August 2018
- DART Training for PAMS and CSN (Data Analysis and Reporting Tool for Photochemical Assessment Monitoring Station and Chemical Speciation Network Data) August 2016
- CSN DART Webinar on July 25, 2018

HQ_PMSOP_07820revision1

Final Audit Report 2020-08-12

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