$PM_{2.5}$ Validation Template

This $PM_{2.5}$ Validation Template is one of a number of validation templates found for criteria pollutants in the EPA document *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program*"[1] (QA Handbook). It is temporarily separated from the QA Handbook due to the January 2016 revision of the EPA *Quality Assurance Guidance Document 2.12 Monitoring $PM_{2.5}$ Ambient Air Using Designated Reference or Class I Equivalent Methods*[2] (Method 2.12). Since Method 2.12 included new guidance, as well as reformatting and changes to sections, the Method 2.12 references were no longer valid in the current validation template. In addition, recent events related to data invalidation of $PM_{2.5}$ have caused some operational criteria to be moved to critical criteria in the $PM_{2.5}$ validation template. Therefore, in order to help monitoring organizations follow and find the appropriate Method 2.12 references, the $PM_{2.5}$ validation template has been posted separately on AMTIC.

The QA Handbook Volume II is under revision and is expected to be published in the summer of 2016. At that time, EPA will include this revised $PM_{2.5}$ validation template into the QA Handbook.

Validation Template Background and Use

In June 1998, a workgroup was formed to develop a procedure that could be used by monitoring organizations that would provide for a consistent validation of $PM_{2.5}$ mass concentrations across the US. The workgroup included personnel from the monitoring organizations, EPA Regional Offices, and OAQPS who were involved with assuring the quality of $PM_{2.5}$ mass; additionally, the workgroup was headed by a State and local representative. The workgroup developed a table consisting of three criteria: critical, operational, and systematic criteria, where each criterion had a different degree of implication about the quality of the data. The criteria included on the tables were from 40 Code of Federal Regulations (CFR) Part 50 Appendices L and N, 40 CFR Part 58 Appendix A, and Method 2.12; a few criteria were also added that were neither in CFR nor Method 2.12, but were technical elements of which the workgroup felt should be included. Upon completion and use of the $PM_{2.5}$ table, it was decided that a "validation template" should be developed for all the criteria pollutants.

To determine the appropriate table for each criterion, the members of the workgroup considered how significantly the criterion impacted the resulting concentration. This was based on experience from workgroup members, experience from non-workgroup members, and feasibility of implementing the criterion.

Criteria that were deemed critical to maintaining the integrity of a sample or group of samples were placed on the first table. Observations that do not meet each and every criterion on the **Critical Criteria** should be invalidated unless there are compelling reason and justification for not doing so. In most cases, this criterion can identify a distinct group of measurements and time period. For example, a flow rate exceedance represents a single sampler for a particular period of time (and, therefore, a distinct number of samples); whereas, with a field blank or QA collocation exceedance, it is harder to identify the sample(s) the exceedance may represent. In most cases the critical criteria, the implementation frequency of the criteria, and the acceptance criteria are found in CFR and are, therefore, regulatory in nature. The sample or group of samples for which one or more of these criteria are not met is invalid until proven otherwise[3]. The cause of not operating in the acceptable range for each of the violated criteria must be investigated and minimized to reduce the

[1] EPA-454/B-13-003, May 2013 http://www3.epa.gov/ttn/amtic/qalist.html
[2] http://www3.epa.gov/ttn/amtic/qapollutant.html
[3] In a number of cases precedence has been set with invalidating data based on failure of critical criteria.

likelihood that additional samples will be invalidated. Typically, EPA Regional Offices will be in the best position to assess whether there are compelling reasons and justification for not deleting the data. The evaluation will be informed by a weight of evidence approach, considering input from States/locals and EPA's national office, and be documented.

Criteria that are important for maintaining and evaluating the quality of the data collection system are included under **Operational Criteria**. Violation of a criterion or a number of criteria may be cause for invalidation. The decision maker should consider other quality control information that may or may not indicate the data are acceptable for the parameter being controlled. Therefore, the sample or group of samples for which one or more of these criteria are not met are suspect unless other quality control information demonstrates otherwise. The reason for not meeting the criteria MUST be investigated, mitigated or justified.

Finally, those criteria which are important for the correct interpretation of the data, but do not usually impact the validity of a sample or group of samples, are included on the third table: the **Systematic Criteria**. For example, the data quality objectives are included in this table. If the data quality objectives are not met, this does not invalidate any of the samples but it may impact the uncertainty associated with the attainment/non-attainment decision.

> **NOTE: The designation of quality control checks as Operational or Systematic does not imply that these quality control checks need not be performed.** Not performing an operational or systematic quality control check that is required by regulation (i.e., in CFR) can be a basis for invalidation of all associated data. Any time a CFR requirement is identified in the Requirement, Frequency or Acceptance Criteria column it will be identified by ***bold*** and ***italics*** font.

For each criterion, the tables include: (1) the requirement; (2) the frequency with which compliance is to be evaluated; (3) acceptance criteria; and, (4) information where the requirement can be found or additional guidance on the requirement.

The validation templates have been developed based on the current state of knowledge. The templates should evolve as new information is discovered about the impact of the various criteria on the error in the resulting mass estimate or concentration. Due to the potential misuse of invalid data, data that are invalidated will not be uploaded to AQS but should be retained on the monitoring organization's local database. This data will be invaluable to the evolution of the validation template.

Use of Bold Italics Font to Identify CFR Requirements.

The criteria listed in the validation templates are either requirements that can be found in the CFR, guidance found in a variety of EPA documents, or recommendations by the QA Workgroup or EPA. As mentioned above, any time a CFR requirement is identified in the Requirement, Frequency, or Acceptance Criteria column, it will be identified by ***bold and italics*** font and can be used for data invalidation depending on the infraction. The Information/Action column will provide the appropriate references for CFR or guidance documents.

Hyperlink References

Where requirements or guidance documents are found on the web, a hyperlink is created which will lead the user to the closest URL address. Any links to CFR are directed to the electronic CFR document (e-CFR), which is the most up-to-date. E-CFR will not get you to an individual section; therefore, the e-CFR is only hyperlinked once on each page.

Change in Acceptance Criteria

In order to provide more consistent guidance in the use of acceptance criteria, we have developed more definitive information on rounding. The acceptance criteria will show more digits than might otherwise be found in regulations or guidance. For example, where in the past the one-point flow rate verification was stated as "$\pm$ *4% of transfer standard*," some monitoring organizations equated a flow rate of $< \pm$ 4.5% as acceptable, while others considered anything $< \pm$ 4.1% as acceptable. Therefore, in order to ensure consistency, EPA has provided clearer interpretation of the acceptance limits. In this specific example, the acceptance criterion for the flow rate verification is $< \pm$ 4.1%. In the cases where the CFR lists a requirement (as is the case with the flow rate verification), EPA will interpret the acceptance criterion to a level that will provide a more consistent application of the template across the ambient air monitoring network. The rounding policy will be placed in an Appendix of the QA Handbook in the next revision.

Truncation

Under no circumstances should quality measurements for comparison to acceptance criteria be truncated, rather than rounded.

$PM_{2.5}$ Filter Based Local Conditions Validation Template

1) Criteria (PM2.5 LC)	2) Frequency	3) Acceptable Range	Information /Action
CRITICAL CRITERIA- $PM_{2.5}$ Filter Based Local Conditions			
Field Activities			
Sampler/Monitor	NA	***Meets requirements listed in FRM/FEM/ARM designation***	1) 40 CFR Part 58 App C Section 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Pre-sampling	***all filters***	***≤ 30 days before sampling***	1,2 and 3) 40 CFR Part 50, App.L Sec 8.3.5
Sample Recovery	***all filters***	***≤ 7 days 9 hours from sample end date***	1,2 and 3) 40 CFR Part 50, App. L 10.10
Sampling Period (including multiple power failures)	***all filters***	***1380-1500 minutes, or if value < 1380 and exceedance of NAAQS 1/ midnight to midnight local standard time***	1, 2 and 3) 40 CFR Part 50 App L Sec 3.3 and 40 CFR Part 50 App N section 1 for the midnight to midnight local standard time requirement See details if less than 1380 min sampled
Sampling Instrument			
Average Flow Rate	***every 24 hours of op***	***average within 5% of 16.67 liters/minute***	1, 2 and 3) Part 50 App L Sec 7.4.3.1
Variability in Flow Rate	***every 24 hours of op***	***CV ≤ 2%***	1, 2 and 3) 40 CFR Part 50, App .L Sec 7.4.3.2
One-point Flow Rate Verification	***every 30 days***	***< ± 4.1% of transfer standard*** < ± 5.1% of flow rate design value	1, 2 and 3) 40 CFR Part 50, App .L, Sec 9.2.5 and 7.4.3.1 and 40 CFR Part 58, Appendix A Sec 3.2.1
Design Flow Rate Adjustment	***After multi-point calibration or verification***	***< ± 2.1% of design flow rate***	1,2 and 3) 40 CFR Part 50, App. L, Sec 9.2.6
Individual Flow Rates	***every 24 hours of op***	***no flow rate excursions > ±5% for > 5 min. 1/***	1, 2 and 3) 40 CFR Part 50, App. L Sec 7.4.3.1
Filter Temp Sensor	***every 24 hours of op***	***no excursions of > 5º C lasting longer than 30 min 1/***	1, 2 and 3) 40 CFR Part 50, App. L Sec 7.4.11.4
External Leak Check	***Before each flow rate verification/calibration*** and before and after $PM_{2.5}$ separator maintenance	***< 80.1 mL/min*** (see comment #1)	1) 40 CFR Part 50 App L, Sec 7.4.6.1 2) 40 CFR Part 50 App L Sect 9.2.3 and Method 2-12 Section 7.4.3 3) 40 CFR Part 50, App. L, Sec 7.4.6.1
Internal Leak Check	If failure of external leak check	***< 80.1 mL/min***	1) 40 CFR Part 50, App. L, Sec 7.4.6.2 2) Method 2-12 7.4.4 3) 40 CFR Part 50, App. L, Sec 7.4.6.2
Laboratory Activities			
Post-sampling Weighing	***all filters***	***≤10 days from sample end date if shipped at ambient temp, or ≤30 days if shipped below avg ambient (or 4º C or below for avg sampling temps < 4º C) from sample end date***	1, 2 and 3) 40 CFR Part 50 App L Sec 8.3.6 Sampled filters must be protected from exposure to temperatures above 25C from sample retrieval to conditioning 40 CFR part 50 Appendix L Sec 10.13. See technical note on holding time requirements at : https://www3.epa.gov/ttn/amtic/pmpolgud.html

1) Criteria (PM2.5 LC)	2) Frequency	3) Acceptable Range	Information /Action
Filter Visual Defect Check (unexposed)	***all filters***	***Correct type & size and for pinholes, particles or imperfections***	1, 2 and 3) 40 CFR Part 50, App. L Sec 10.2
Filter Conditioning Environment			
Equilibration	***all filters***	***24 hours minimum***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.2.5
Temp. Range	***all filters***	***24-hr mean 20.0-23.0º C***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.2.1
Temp.Control	***all filters***	***< 2.1º C SD* over 24 hr***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.2.2
Humidity Range	***all filters***	***24-hr mean 30.0% - 40.0% RH or Within ±5.0 % sampling RH but ≥ 20.0%RH***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.2.3
Humidity Control	***all filters***	***< 5.1 % SD* over 24 hr.***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.2.4
Pre/post Sampling RH	***all filters***	***difference in 24-hr means < ± 5.1% RH***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.3.3
Balance	***all filters***	***located in filter conditioning environment***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.3.2
Microbalance Auto-Calibration	***Prior to each weighing session***	Manufacturer's specification	1) 40 CFR Part 50, App. L, Sec 8.1 2) 40 CFR Part 50, App. L, Sec 8.1 and Method 2.12 Sec. 10.6 3) NA
OPERATIONAL EVALUATIONS TABLE $PM_{2.5}$ Filter Based Local Conditions			
Field Activities			
One-point Temp Verification	every 30 days	<± 2.1ºC	1) 40 CFR Part 50, App. L, Sec 9.3 2) Method 2.12 Sec 7.4.5 and table 6-1 3) Recommendation
Pressure Verification	every 30 days	< ± 10.1 mm Hg	1) 40 CFR Part 50, App. L, Sec 9.3 2) Method 2.12 Sec 7.4.6 and Table 6-1 3) Recommendation
Annual Multi-point Verifications/Calibrations			
Temperature multi-point Verification/Calibration	on installation, then every 365 days and once a calendar year	<± 2.1ºC	1) 40 CFR Part 50, App. L, Sec 9.3 2 and 3) Method 2.12 sec 6.4.4 Table 6-1
Pressure Verification/Calibration	on installation, and on one-point verification failure	<± 10.1 mm Hg	1) 40 CFR Part 50, App. L, Sec 9.3 2 and 3) Method 2.12 sec 6.5 Sampler BP verified against independent standard verified against a lab primary standard that is certified as NIST traceable 1/year
Flow Rate Multi-point Verification/ Calibration	***Electromechanical maintenance or transport or every 365 days and once a calendar year***	***<± 4.1% of transfer standard***	1) 40 CFR Part 50, App. L, Sec 9.2. 2) 40 CFR Part 50, App. L, Sec 9.1.3, Method 2.12 Sec 6.3 & Table 6-1 3) 40 CFR Part 50, App. L, Sec 9.2.5
Other Monitor Calibrations	per manufacturers' op manual	per manufacturers' operating manual	1,2 and 3) Recommendation
Precision			
Collocated Samples	***every 12 days for 15% of sites by method designation***	CV < 10.1% of samples ≥ 3.0 µg/m^3	1) and 2) Part 58 App A Sec 3.2.3 3 Recommendation based on DQO in 40 CFR Part 58 App A Sec 2.3.1.1

1) Criteria (PM2.5 LC)	2) Frequency	3) Acceptable Range	Information /Action
Accuracy			
Temperature Audit	every 180 days and at time of flow rate audit	<+ 2.1ºC	1, 2 and 3) Method 2.12 Sec. 11.2.2
Pressure Audit	every 180 days and at time of flow rate audit	<+10.1 mm Hg	1, 2 and 3) Method 2.12 Sec. 11.2.3
Semi Annual Flow Rate Audit	***every 180 days and twice a calendar year***	<+ 4.1% of audit standard <+ 5.1% of design flow rate	1 and 2) Part 58, App A, Sec 3.2.2 3) Method 2.12 Sec. 11.2.1
Monitor Maintenance			
$PM_{2.5}$ Separator (WINs)	every 5 sampling events	cleaned/changed	1, 2,and 3) Method 2.12 Sec 8.2.2
$PM_{2.5}$ Separator (VSCC)	every 30 days	cleaned/changed	1,2 and 3) Method 2.12 Sec 8.3.3
Inlet Cleaning	every 30 days	cleaned	1,2 and 3) Method 2.12 Sec 8.3
Downtube Cleaning	every 90 days	cleaned	1,2 and 3) Method 2.12 Sec 8.4
Filter Housing Assembly Cleaning	every 30 days	cleaned	1, 2 and 3) Method 2.12 Sec 8.3
Circulating Fan Filter Cleaning	every 30 days	cleaned/changed	1, 2 and 3) Method 2.12 Sec 8.3
Manufacturer-Recommended Maintenance	per manufacturers' SOP	per manufacturers' SOP	
Laboratory Activities			
Filter Checks			
Lot Blanks	9 filters per lot	< +15.1 µg change between weighings	1, 2, 3) Recommendation and used to determine filter stability of the lot of filters received from EPA or vendor. Method 2.12 Sec. 10.5
Exposure Lot Blanks	3 filters per lot	< +15.1 µg change between weighings	1,2 and 3) Method 2.12 Sec. 10.5 Used for preparing a subset of filters for equilibration
Filter Integrity (exposed)	each filter	no visual defects	1,2 and 3) Method 2.12 Sec. 10.7 and 10.3
Lab QC Checks			
Field Filter Blank	10% or 1 per weighing session	<+ 30.1 µg change between weighings	1) 40 CFR Part 50, App. L Sec 8.3.7.1 2 and 3) Method 2.12 Table 7-1 & Sec.10.5
Lab Filter Blank	10% or 1 per weighing session	<+ 15.1 µg change between weighings	1) 40 CFR Part 50, App. L Sec 8.3.7.2 2 and 3) Method 2.12 Sec. 10.5
Balance Check (working standards)	beginning, 10th sample, end	< +3.1 µg from certified value	1,2 and 3) Method 2.12 Sec. 10.6 Standards used should meet specifications in Method 2.12, Section 4.3.7
Routine Filter re-weighing	1 per weighing session	<+ 15.1 µg change between weighings	1,2 and 3) Method 2.12 Sec 10.8
Microbalance Audit	every 365 days and once a calendar year	<+ 0.003 mg or manufacturers specs, whichever is tighter	1,2 and 3) Method 2.12 Sec. 11.2.7
Lab Temp Check	Every 90 days	< + 2.1ºC	1,2 and 3) Method 2.12 Sec. 10.10
Lab Humidity Check	Every 90 days	< + 2.1%	1,2 and 3) Method 2.12 Sec. 10.10
Verification/Calibration			

1) Criteria (PM2.5 LC)	2) Frequency	3) Acceptable Range	Information /Action
Microbalance Calibration	***At installation*** every 365 days and once a calendar year	Manufacturer's specification	1) 40 CFR Part 50, App. L, Sec 8.1 2) 40 CFR Part 50, App. L, Sec 8.1 and Method 2.12 Sec. 10.11 3) NA
Lab Temperature Certification	every 365 days and once a year	< ± 2.1°C	1-3) Method 2.12 Sections 4.3.8 and 9.4
Lab Humidity Certification	every 365 days and once a year	< ± 2.1%	1-3) Method 2.12 4.3.8 and 9.4
Calibration & Check Standards -			
Working Mass Stds. Certification Compared to primary standards	Every 365 days and once a calendar year Every 90 days	0.025 mg tolerance (Class 2) 0.025 mg tolerance (Class 2)	1, 2 and 3) Method 2.12 Sec 4.3.7 & 9.7
Primary standards certification	every 365 days and once a calendar year	0.025 mg tolerance (Class 2)	1, 2 and 3) Method 2.12 Sec 4.3.7 & 9.7
SYSTEMATIC CRITERIA -$PM_{2.5}$ Filter Based Local Conditions			
Siting	every 365 days and once a calendar year	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58 App E, sections 2-5 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-5
Data Completeness	***Annual Standard***	***≥ 75% scheduled sampling days in each quarter***	1, 2 and 3) 40 CFR Part 50, App. N, Sec. 4.1 (b) 4.2 (a)
	24- Hour Standard	***≥ 75% scheduled sampling days in each quarter***	1, 2 and 3) 40 CFR Part 50, App. N, Sec. 4.1 (b) 4.2 (a)
Reporting Units	***all filters***	***µg/m³ at ambient temp/pressure ($PM_{2.5}$)***	1. 2 and 3) 40 CFR Part 50 App N Sec 3.0 (b)
Rounding convention for data reported to AQS	***all filters***	***to one decimal place, with additional digits to the right being truncated***	1. 2 and 3) 40 CFR Part 50 App N Sec 3.0 (b)
Annual 3-yr average	***all concentrations***	***nearest 0.1 µg/m³*** (≥ 0.05 round up)	1,2 and 3) 40 CFR Part 50, App. N Sec 3 and 4 Rounding convention for data reported to AQS is a recommendation
24-hour, 3-year average	***all concentrations***	***nearest 1 µg/m³*** (≥ 0.5 round up)	1,2 and 3) 40 CFR Part 50, App. N Sec 3 and 4 Rounding convention for data reported to AQS is a recommendation
Detection Limit			
Lower DL	***all filters***	***≤ 2 µg/m³***	1,2 and 3) 40 CFR Part 50, App. L Sec 3.1
Upper Conc. Limit	***all filters***	***≥ 200 µg/m³***	1,2 and 3) 40 CFR Part 50, App. L Sec 3.2
Precision			
Single analyzer (collocated monitors)	every 90 days	Coefficient of variation (CV) < 10.1% for values ≥ 3.0 µg/m³	1,2 and 3) Recommendation in order to provide early (quarterly) evaluation of achievement of DQOs.
Primary Quality Assurance Org.	***Annual and 3 year estimates***	***90% CL of CV < 10.1 % for values ≥ 3.0 µg/m³***	1,2 and 3) 40 CFR Part 58, App A, Sec 4.2.1 and 2.3.1.1
Bias			

1) Criteria (PM2.5 LC)	2) Frequency	3) Acceptable Range	Information /Action
Performance Evaluation Program (PEP)	***5 audits for PQAOs with ≤ 5 sites 8 audits for PQAOs with > 5 sites***	***< ± 10.1% for values ≥ 3.0 µg/m^3***	1,2 and 3) 40 CFR Part 58, App A, Sec 3.2.4, 4.2.5 and 2.3.1.1
Field Activities			
Verification/Calibration Standards Recertifications – All standards should have multi-point certifications against NIST Traceable standards			
Flow Rate Transfer Std.	every 365 days and once a calendar year	***< ± 2.1% of NIST Traceable Std.***	1) 40 CFR Part 50, App.L Sec 9.1 & 9.2 2) Method 2-12 Section 4.2.2 & 6.4.3 3) 40 CFR Part 50, App.L Sec 9.1 & 9.2
Field Thermometer	every 365 days and once a calendar year	± 0.1º C resolution, ± 0.5º C accuracy	1, 2 and 3) Method 2.12 Sec 4.2.2
Field Barometer	every 365 days and once a calendar year	± 1 mm Hg resolution, ± 5 mm Hg accuracy	1, 2 and 3) Method 2.12 Sec 4.2.2
Clock/timer Verification	Every 30 days	***1 min/mo***	1 and 2) Method 2.12 Sec 4.2.1 3) 40 CFR Part 50, App.L Sec 7.4.12
Laboratory Activities			
Microbalance Readability	***at purchase***	***1 µg***	1, 2 and 3) 40 CFR Part 50, App.L Sec 8.1
Microbalance Repeatability	every 365 days and once a calendar year	1 µg	1) Method 2.12 Sec 4.3.6 2) Recommendation 3) Method 2.12 Sec 4.3.6
Primary Mass. Verification/Calibration Standards Recertifications	every 365 days and once a calendar year	0.025 mg	1, 2 and 3) Method 2.12 Sec 4.3.7
Working Mass Standards			
Comment #1 The associated leak test procedure shall require that for successful passage of this test, the difference between the two pressure measurements shall not be greater than the number of mm of Hg specified for the sampler by the manufacturer, based on the actual internal volume of the sampler, that indicates a leak of less than 80 mL/min.			

1/ value must be flagged SD * = standard deviation CV= coefficient of variation