$PM_{2.5}$ Mass Validation Criteria

In June 1998, a workgroup was formed to develop a procedure that could be used by State and locals that would provide for a consistent validation of $PM_{2.5}$ mass concentrations across the US. The workgroup included State and locals, EPA Regional Offices, and OAQPS personnel who are involved with assuring the quality of $PM_{2.5}$ mass and was headed by a State and local representative. The workgroup developed three tables of criteria where each table has a different degree of implication about the quality of the data. The criteria included on the tables are from 40 CFR Part 50, 40 CFR Part 50 Appendices L and N, 40 CFR Part 58 Appendix A, Method 2.12, and a few criteria that are neither in CFR nor Method 2.12.

One of the tables has the criteria that *must* be met to ensure the quality of the data. An example criterion is that the average flow rate for the sampling period must be maintained to within 5% of 16.67 liters per minute. The second table has the criteria that indicate that there *might* be a problem with the quality of the data and further investigation is warranted before making a determination about the validity of the sample or samples. An example criterion is that the field filter blanks should not change weight by more than 30 µg between weighings. The third table has criteria that indicate a potentially systematic problem with the environmental data collection activity. Such systematic problems may impact the ability to make decisions with the data. An example criterion is that at least 75% of the scheduled samples for each quarter should be successfully collected and validated.

To determine the appropriate table for each criterion, the members of the workgroup considered how significantly the criterion impact the resulting $PM_{2.5}$ mass. 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 Table** should be invalidated unless there are compelling reason and justification for not doing so. Basically, the sample or group of samples for which one or more of these criteria are not met is invalid until proven otherwise. The cause of not operating in the acceptable range for each of the violated criteria must be investigated and minimized to reduce the likelihood that additional samples will be invalidated.

Criteria that are important for maintaining and evaluating the quality of the data collection system are included on the second table, the **Operational Evaluations Table**. Violation of a criterion or a number of criteria may be cause for invalidation. The decision 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 is 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 Issues Table**. 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 error rate associated with the attainment/non-attainment decision.

Following are the tables. For each criterion, the tables include (1) the operational range that is acceptable, (2) the frequency with which compliance is to be evaluated, (3) the number of samples that are impacted if violation of a criterion occurs (possible values include single filters, a batch of filters, or a group of filters from a specific instrument);.(4) sections of 40 CFR and (5) Method 2.12 that describe the criterion. The table also indicates whether samples violating the criterion must be flagged before entering them into AIRS.

This validation template has been developed based on the current state of knowledge. The template should evolve as new information is discovered about the impact of the various criterion on the error in the resulting mass estimate. Interactions of the criteria, whether synergistic or antagonistic, should also be incorporated when the impact of these interactions becomes quantified. Due to the potential misuse of invalid data, data that are invalidated will not be uploaded to AIRS but should be retained on the States' databases. This data will be invaluable to the evolution of the validation template.

CRITICAL CRITERIA TABLE

[a] S- Single Filter, G- Group of filters (i.e. batch), G1-Group of filters from 1 instrument

Criteria	Acceptable Range	Frequency	Samples Impacted[a]	40 CFR Reference	QA Guidance Document 2.12 Reference
Filter Holding Times					
Sample Recovery	≤ 4 days from sample end date	all filters	S	Part 50, App. L Sec 10.10	Sec. 7.11
Post-sampling Weighing	≤ 10 days at 25° C from sample end date, or ≤ 30 days at 4° C from sample end date	all filters	S	Part 50, App. L Sec 8.3	Sec. 7.11
Sampling Period (including multiple power failures)	1380-1500 minutes, or value if < 1380 and exceedance of NAAQS 1/ midnight to midnight	all filters	S	Part 50, App.L Sec 3.3 Part 50, App.L Sec 7.4.15	
Sampling Instrument					
Average Flow Rate	average within 5% of 16.67 liters/minute	every 24 hours of op	S	Part 50, App.L Sec 7.4	
Variability in Flow Rate	CV ≤ 2%	every 24 hours of op	S	Part 50, App.L Sec 7.4.3.2	
Filter					
Visual Defect Check (unexposed)	see reference	all filters	S	Part 50, App.L Sec 10.2	Sec 7.5
Filter Conditioning Environment					
Equilibration	24 hours minimum	all filters	G	Part 50, App.L Sec 8.2	Sec. 7.6
Temp. Range	24-hr mean 20-23° C	all filters	G	Part 50, App.L Sec 8.2	Sec. 7.6
Temp.Control	± 2° C SD* over 24 hr	all filters	G	Part 50, App.L Sec 8.2	Sec. 7.6
Humidity Range	24-hr mean 30% - 40% RH or ≤ 5% sampling RH but > 20%RH	all filters	G	Part 50, App.L Sec 8.2	Sec. 7.6
Humidity Control	± 5% SD* over 24 hr.	all filters	G	Part 50, App.L Sec 8.2	Sec. 7.6
Pre/post Sampling RH	difference in 24-hr means ≤ ± 5% RH	all filters	S/G	Part 50, App.L Sec 8.3.3	
Balance	located in filter conditioning environment	all filters	G	Part 50, App.L Sec 8.3.2	
Calibration/Verification					
One-point FR Check	± 4% of transfer standard	1/4 weeks	G1	Part 50, App.L, Sec 9.2.5	Sec 8.4

1/ value must be flagged
***= variability estimate not defined in CFR**
SD= standard deviation
CV= coefficient of variation

OPERATIONAL EVALUATIONS TABLE

[a] S- Single Filter, G- Group of filters (i.e. batch), G1-Group of filters from 1 instrument

Criteria	Acceptance Range	Frequency	Samples Impacted [a]	40 CFR Reference	QA Guidance Document 2.12 Reference
Filter Checks					
Lot Blanks	less than 15 μg change between weighings	9 filters per lot	G	not described	Sec. 7.7
Exposure Lot Blanks	less than 15 μg change between weighings	3 filters per lot	G	not described	Sec. 7.7
Filter Integrity (exposed)	no visual defects	each filter	S	not described	Sec. 8.2
Filter Holding Times					
Pre-sampling	< 30 days before sampling	all filters	S	Part 50, App.L Sec 8.3	Sec. 7.9
Lab QC Checks					
Field Filter Blank	± 30 μg change between weighings	10% or 1 per weighing session	G/G1	Part 50, App.L Sec 8.3	Sec. 7.7
Lab Filter Blank	± 15 μg change between weighings	10% or 1 per weighing session	G	Part 50, App.L Sec 8.3	Sec. 7.7
Balance Check	≤3 μg	beginning, 10th sample, end	G	not described	Sec. 7.9
Duplicate Filter Weighing	± 15 μg change between weighings	1 per weighing session	G	not described	Sec 7.11
Sampling Instrument					
Individual Flow Rates	no flow rate excursions > ±5% for > 5 min. [1/]	every 24 hours of op	S	Part 50, App.L Sec 7.4.3.1	
Filter Temp Sensor	no excursions of > 5° C lasting longer than 30 min [1/]	every 24 hours of op	S	Part 50, App.L Sec 7.4	
Calibration/Verification					
External Leak Check	< 80 mL/min	every 5 sampling events*	G1	Part 50, App.L, Sec 7.4	Sec. 6.6 & 8.4
Internal Leak Check	< 80 mL/min	every 5 sampling events	G1	Part 50, App.L, Sec 7.4	Sec. 6.6 & 8.4
Temperature Calibration	± 2°C of standard	if multi-point failure	G1	Part 50, App.L, Sec 9.3	Sec. 6.4
Temp M-point Verification	± 2°C of standard	on installation, then 1/yr	G1	Part 50, App.L, Sec 9.3	Sec. 6.7 & 8.4
One-point Temp Check	± 4°C of standard	1/4 weeks	G1	Part 50, App.L, Sec 9.3	Sec. 6.7 & 8.4
Pressure Calibration	± 10 mm Hg	on installation, then 1/yr	G1	Part 50, App.L, Sec 9.3	Sec. 6.5
Pressure Verification	± 10 mm Hg	1/4 weeks	G1	Part 50, App.L, Sec 9.3	Sec. 6.7 & 8.2
Other Monitor Calibrations	per manufacturers' operating manual	per manufacturers' op manual	G		
Lab Temperature	± 2°C	1/6 months	G	not described	Sec 3.3
Lab Humidity	± 2%	1/6 months	G	not described	Sec 3.3
Flow Rate (FR) Calibration	± 2% of transfer standard	if multi-point failure	G1	Part 50, App.L, Sec 9.2	Sec 6.3
FR Multi-point Verification	± 2% of transfer standard	1/yr	G1	Part 50, App.L, Sec 9.2	Sec 6.3 & 6.7
Design Flow Rate Adjustment	± 2% of design flow rate	at one-point or multi-point	G1	Part 50, App.L, Sec 9.2.6	6.7
Mirobalance Calibration	Manufacturer's specification	1/yr	G	Part 50, App.L, Sec 8.1	Sec 7.2

OPERATIONAL EVALUATIONS TABLE

[a] S- Single Filter, G- Group of filters (i.e. batch), G1-Group of filters from 1 instrument

Criteria	Acceptance Range	Frequency	Samples Impacted [a]	40 CFR Reference	QA Guidance Document 2.12 Reference
Precision					
Collocated Samples	CV $\leq$ 10% of samples > 6 $\mu g/m^3$	every 6 days for 25% of sites	G	Part 58, App.A, Sec 3.5 and 5.5	Sec. 10.2
Accuracy					
Temperature Audit	± 2°C	4/yr	G1	not described	Sec. 10.2
Pressure Audit	±10 mm Hg	4/yr	G1	not described	Sec. 10.2
Balance Audit	± 0.050 mg or manufacturers specs, whichever is tighter	1/yr	G	not described	Sec. 10.2
Flow Rate Audit	± 4% of audit standard ± 5% of design flow rate	1/2wk (automated) 4/yr (manual)	G1	Part 58, App A, Sec 3.5	Sec. 10.1 & 10.2
Calibration & Check Standards (working standards)					
Field Thermometer	± 0.1° C resolution, ± 0.5° C accuracy	1/yr	G/G1	not described	Sec 4.2 & 6.4
Field Barometer	± 1 mm Hg resolution, ± 5 mm Hg accuracy	1/yr	G/G1	not described	Sec 4.2 & 6.5
Working Mass Stds. (compare to primary standards)	0.025 mg	1/3 mo.	G	not described	Sec 4.3 and 7.3
Monitor Maintenance					
Impactor	cleaned/changed	every 5 sampling events	G1	not described	Sec 9.2
Inlet/downtube Cleaning	cleaned	every 15 sampling event	G1	not described	Sec 9.3
Filter Chamber Cleaning	cleaned	monthly	G1	not described	Sec 9.3
Leak Check [@]	see ***Calibration/Verification***				
Circulating Fan Filter Cleaning	cleaned/changed	monthly	G1	not described	Sec 9.3
Manufacturer-Recommended Maintenance	per manufacturers' SOP	per manufacturers' SOP	G1	not described	not described

1/ value must be flagged
***= variability estimate not defined in CFR**
[@] = Scheduled to occur immediately after impactor cleaned/changed.

SYSTEMATIC ISSUES [a] S- Single Filter, G- Group of filters (i.e. batch), G1-Group of filters from 1 instrument					
Criteria	**Acceptable Range**	**Frequency**	**Samples Impacted [a]**	**40 CFR Reference**	**QA Guidance Document 2.12 Reference**
Data Completeness	$\geq$ 75%	quarterly	G1	Part 50, App. N, Sec. 2.1	
Reporting Units	$\mu g/m^3$ at ambient temp/pressure	all filters		Part 50.3	Sec. 11.1
Rounding Convention					
Annual 3-yr average	nearest 0.1 $\mu g/m^3$ ($\geq$ 0.05 round up)	quarterly	G	Part 50, App. N Sec 2.3	
24-hour, 3-year average	nearest 1 $\mu g/m^3$ ($\geq$ 0.5 round up)	quarterly	G	Part 50, App. N Sec 2.3	
Detection Limit					
Lower DL	$\leq$ 2 $\mu g/m^3$	all filters	G/G1	Part 50, App.L Sec 3.1	
Upper Conc. Limit	$\geq$ 200 $\mu g/m^3$	all filters	G/G1	Part 50, App.L Sec 3.2	
Standards Recertifications					
Flow Rate Transfer Std.	± 2% of NIST-traceable Std.	1/yr	G/G1	Part 50, App.L Sec 9.1 & 9.2	Sec. 6.3
Field Thermometer	± 0.1° C resolution, ± 0.5° C accuracy	1/yr	G/G1		Sec 4.2.2
Field Barometer	± 1 mm Hg resolution, ± 5 mm Hg accuracy	1/yr	G/G1		Sec 4.2.2
Primary Mass Stds. (compare to NIST-traceable standards)	0.025 mg	1/yr	G		Sec 4.3.7
Microbalance					
Readability	1 μg	at purchase	G	Part 50, App.L Sec 8.1	Sec 4.3.6
Repeatability	1μg	1/yr	G	not described	Sec 4.3.6
Calibration & Check Standards					
Flow Rate Transfer Std.	± 2% of NIST-traceable Std.	1/yr	G1	Part 50, APP L, Sec 9.1 & 9.2	
Calibration/Verification					
Clock/timer Verification	1 min/mo	1/4 weeks	G1	Part 50, App.L, Sec 7.4	Table 3-1
Precision					
Single analyzer	CV$\leq$ 10%	1/3 mo.	G1	Part 58, App A, Sec 5.5	not described
Single Analyzer	CV $\leq$ 10%	1/ yr	G1	Part 58, App A, Sec 5.5	not described
Reporting Org.	CV $\leq$ 10%	1/3 mo.	G	Part 58, App A, Sec 5.5	not described
Bias					
FRM Performance Evaluation	±10%	25% of sites 4/yr	G/G1	Part 58, App A, Sec 3.5	Sec 10.2

CV= coefficient of variation