Appendix 4 - Data Quality Requirements and Assessments

A. Data Quality Requirements and Assessments, Meteorological Measurements

Specifications and descriptions based on US EPA, Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final), 2008.

Parameter	Range	Resolution	Accuracy	Audit Method (Audit Frequency: Annual)
SLAMS/SPM Non-NCore Meteorology Parameters				
61103 Wind Speed	1.1-112 mph (0.5-50 m/sec), 2.2 mph (1 m/sec) threshold*	0.56 mph	0 to 11 mph: ±0.56 mph > 11 mph: ±5%	NIST-traceable synchronous motor, collocated transfer system (CTS) method; torque watch*
61104 Wind Direction	0-360° (540°)	1°	± 5° total system error	Solar noon, GPS, or magnetic compass
Temperature	-30 to +50° C	0.5° C	± 1.0° C	3-point water bath with NIST-traceable thermistor or thermometer
Relative Humidity	0-100%	1% RH	± 10% RH	NIST-traceable psychrometer, or standards solution

NCore Meteorology Parameters

61103 Wind Speed	1.1-112 mph (0.5-50 m/sec), 2.2 mph (1 m/sec) threshold*	0.22 mph	0 to 11 mph: ±0.56 mph > 11 mph: ±5%	NIST-traceable synchronous motor, collocated transfer system (CTS) method; torque watch*
61104 Wind Direction	0-360° (540°)	1°	± 5° total system error	Solar noon, GPS, or magnetic compass
Temperature	-30 to +50° C	0.1° C	± 0.5° C	3-point water bath or thermo-electric chamber with NIST-traceable thermistor or thermometer
Relative Humidity	0-100%	0.5% RH	± 7% RH	NIST-traceable psychrometer, or standards solution
63301 Solar Radiation	0-1100 W/m^2	10 W/m^2	± 5% of mean observed interval	NIST-traceable pyranometer
Barometic Pressure	600-1100 mb	0.5 mb	± 2.25 mmHg	NIST-traceable barometer
Precipitation	0-25 mm/hr	0.2 mm	± 10% of input volume	Separatory funnel and graduated cylinder

Regulatory Dispersion Modeling
Meteorology Parameters† **‡Audit Method (Audit Frequency: Semi-annual- (1/6 months)**

Insolation (Solar Radiation)				
Net radiation				
Temperature TT02	-40 to +60° C	0.1° C	± 0.5° C	3-point water bath with NIST-traceable thermistor or thermometer
Temperature TT10				
Temperature difference	-5 to +15° C	0.02° C	0.1° C	3-point water bath with NIST-traceable thermistor or thermometer
Precipitation	0-25 mm/hr	0.25 mm	± 10% of input volume	Separatory funnel and graduated cylinder
Sea level pressure				
Station pressure	600-1100 mb	0.5 mb	± 3 mb	NIST-traceable aneroid barometer
Height HT02				
Height HT10				
61103 Wind Speed (report both scalar and resultant (vector) channels	1.1-112 mph (0.5-50 m/sec), 2.2 mph (1 m/sec) threshold*	0.22 mph	±0.45 mph	NIST-traceable synchronous motor, collocated transfer system (CTS) method; torque watch*
61104 Wind Direction (report both scalar and resultant (vector) channels	0-360° (540°)	0.5°	± 5° total system error	Solar noon, GPS, or magnetic compass, CTS method
Dewpoint RH10	-40 to +60° C	0.1° C	± 0.5° C	NIST-traceable psychrometer, or standards solution
Relative humidity RH10				
Standard deviation of horizontal wind SA10				

*Starting threshold should be between 0.45 and 2.2 mph (0.2 and 1 m/sec); it should be verified at acceptance and audit with a torque watch and the torque converted to starting threshold and checked against vendor specifications.

†Meteorological monitoring parameters can vary depending on the specific PSD or modeling project. (e.g. scalar and resultant units are needed for wind speed and wind direction data to ensure data can be used for all potential applications.) Precision, accuracy, and units of measure depend on the specific model data input needs. Consult with APCP modeling staff for specific requirement needs to establish these criteria and record these in the project QAPP.

‡Quarterly Quality Control checks are required unless otherwise specified to ensure meeting data completeness and accuracy requirements for the project.

B. Ambient Air Monitoring - Measurement Quality Objectives

Method	CFR Reference (40 CFR Part58, Appendix A)	Coverage (annual)	Minimum frequency	MQOs
Automated Methods				
One-Point QC: for SO_2, NO_2, O_3, CO NOy, CO Trace, SO Trace	Section 3.2.1	Each analyzer	Once per 2 weeks	**O_3** Precision Goal – 90% CL CV≤ 7%, Bias Goal – 95% CL Absolute Bias ≤ 7%. **SO_2, NO_2, CO** Precision Goal - CV 10% , Bias Goal – Absolute Bias ± 10% Critical Criteria – Span Span ≤10% Difference, ≤7% Difference Ozone **NOy SO_2 Trace** Same as SO_2, NO **CO Trace** Precision Goal - CV 15% , Bias Goal – Absolute Bias ± 10% Critical Criteria – Span Span ≤10% Difference **All Species*** Zero drift per project SOPs and control as needed to meet precision MQOs
Annual performance evaluation for SO_2, NO_2, O_3, CO NOy, CO Trace, SO_2 Trace	Section 3.2.2	Each analyzer	Once per quarter for PSD; otherwise per project requirements See: Table A-1 of Appendix A to Part 58 for differences between SLAMS and PSD projects.	± 15 % for each audit concentration. 95% of audit percent differences fall within the one point QC check 95% probability intervals at PQAO level of aggregation **NOy, CO Trace, SO_2 Trace** Currently under Development by EPA. Use ± 15 % for each audit concentration as a goal. EPA may develop guidance on low concentration ppb criteria rather than % difference criteria at the lowest concentrations.

Flow rate verification PM_{10},$PM_{2.5}$, $PM_{10-2.5}$	Section 3.2.3	Each sampler	Once every month	± 4% of standard and 5% of design value total flow only?
Semi-annual flow rate audit PM_{10}, $PM_{2.5}$, $PM_{10-2.5}$	Section 3.2.4	Each sampler	Once every 6 months	±4% of standard and 5% of design value
Collocated sampling $PM_{2.5}$, $PM_{10-2.5}$,(PM10 not required)	Section 3.2.5	15%	Every six days	$PM_{2.5}$ 10% precision $PM_{10-2.5}$ 15% precision
PM Performance evaluation program $PM_{2.5}$,$PM_{10-2.5}$,(PM10 not required)	Section 3.2.7	1. One valid audit 2. All samplers in 3 years.	Over all 4 quarters See: Table A-1 of Appendix A to Part 58 for differences between SLAMS and PSD projects.	$PM_{2.5}$ ± 10% bias $PM_{10-2.5}$ ± 15% bias
		Manual Methods		
Collocated sampling Pb, PM_{10}, , $PM_{10-2.5}$, $PM_{2.5}$	3.3.1 and 3.3.5	15%	Every 12 days PSD -every 6 days	PM_{10}, TSP, $PM_{2.5}$, ± 10% precision $PM_{10-2.5}$ ± 15% precision Pb Precision Goal ± 20% CV PQAO - 90% CL of CV < 10%
Flow rate verification PM_{10} (low Vol),$PM_{10-2.5}$, $PM_{2.5}$	3.3.2	Each sampler	Once every month	± 4% of standard and 5% of design value
Flow rate verification PM_{10} Pb (High-Vol),	3.3.2	Each sampler	Once every quarter	± 4% of standard and 5% of design value or ± 10% of standard and design value
Flow rate audit PM_{10} , $PM_{10-2.5}$, $PM_{2.5}$(low Vol),	3.3.3	Each sampler, all locations	Each sampling quarter	± 4% of standard and 5% of design value
Flow rate audit PM_{10} Pb (High-Vol),	3.3.3	Each sampler, all locations	Each sampling quarter	± 7% of transfer standard and 10% from design value
Analysis audit Pb	3.3.4	1.. Analytical (lead strips)2 levels 3 audit strips per level	Each sampling quarter	Bias + 15% Absolute bias
Performance evaluation program $PM_{2.5}$, ,(PM10 not required)	3.3.7 and 3.3.8	1. 5 valid audits for primary QA orgs, with < 5 sites 2. 8 valid audits for primary QA orgs, with > 5 sites 3. All samplers in 6 years	Over all 4 quarters	$PM_{2.5}$ ± 10% Bias
Performance evaluation program $PM_{10-2.5}$,	3.3.8	One valid audit per PQAO	Once each year	$PM_{10-2.5}$ ± 15% Bias
Performance evaluation program Pb	3.3.4.4	1. One valid collocated sampler audit and four valid collocated filter audits for PQAOs with ≤ 5 sites 2. Two valid collocated sampler audits and six valid collocated filter audits for PQAOs with > 5 sites	Over all 4 quarters	Pb - 95% CL Absolute bias ±15%

*Zero Drift Acceptance Criteria: see http://www.epa.gov/ttn/amtic/cpreldoc.html

C. Annual Performance Evaluation for SO_2, NO_2, O_3, or CO.

Each calendar quarter (during which analyzers are operated), each analyzer that checks for SO2, NO2, O3, or CO will be evaluated. The evaluation will be conducted by a trained experienced technician other than the routine site operator who conducts span checks and calibrations.

(a) The evaluation is made by challenging the analyzer with audit gas standard of known concentration (effective concentration for open path analyzers) from at least three consecutive audit levels. The audit levels selected should represent or bracket 80 percent of ambient concentrations measured by the analyzer being evaluated:
(b) Select 3 consecutive levels from Table C-1 that would replace the current table in 40 CFR 58 Appendix A for each pollutant concentration range anticipated to be monitored at the monitoring site for the duration of the project.
(c) An additional 4th level is encouraged for those monitors that have the potential for exceeding the concentration ranges described by the initial three selected.

Audit Level	Concentration Range, ppm			
	O3	SO2	NO2	CO
1	0.004-0.0059	0.0003-0.0029	0.0003-0.0029	0.020-0.059
2	0.006-0.015	0.0030-0.0049	0.0030-0.0049	0.060-0.099
3	0.016-0.025	0.0050-0.0079	0.0050-0.0079	0.100-0.399
4	0.026-0.045	0.0080-0.0199	0.0080-0.0139	0.400-0.999
5	0.046-0.065	**0.0200-0.0499**	0.0140-0.0399	1.000-1.999
6	**0.066-0.085**	**0.0500-0.0999**	**0.0400-0.0699**	2.000-4.999
7	0.086-0.105	**0.1000-0.1499**	**0.0700-0.1499**	**5.000-15.999**
8	0.106-0.125	0.1500-0.2599	0.1500-0.2999	16.000-25.999
9	0.126-0.145	0.2600-0.7999	0.3000-0.5999	**26.000-36.999**
10	0.146-0.180	0.8000-1.000	0.6000-1.000	37.000-50.000

Red font related to a NAAQS concentrations still on the books

The QA EYE, Issue 9, July 2010, EPA OAQPS Publication
http://www.epa.gov/ttn/amtic/files/ambient/qa/qanews9.pdf

D. Data Representativeness:

See the Missouri Ambient Air Monitoring Network regarding scale of representation.

E. Data Comparability:

Parameter	Parameter Name			Units	Decimals
88101	PM2.5 FRM Filter Based PM2.5			$\mu g/m^3$	1
88101	PM2.5FEM Continuous (All)			$\mu g/m^3$	1
86101	PM10-2.5 FRM Filter Based (Difference method)			$\mu g/m^3$	1
88500	PM2.5 TEOM			$\mu g/m^3$	1
85101	PM10_LC			$\mu g/m^3$	1
88502	PM2.5 Continuous-Proposed ARM Method (Troost only)			$\mu g/m^3$	1
88503	PM2.5 Continuous Volatile Channel (all)			$\mu g/m^3$	1
81102	PM10			$\mu g/m^3$	0
81102	PM10 Continuous (Stp. conditions)			$\mu g/m^3$	0
85101	PM10 (Local conditions)			$\mu g/m^3$	1
86502	PMcoarse Continuous Pmcoarse local conditions			$\mu g/m^3$	1
14129	Lead			$\mu g/m^3$	4
85129	Lead PM_{10}			$\mu g/m^3$	4
42101	CO			ppm	1
42101	CO (Trace level)			ppm	3
42401	SO2			ppb	1
42406	SO2 5-min max in hr			ppb	1
42401	SO2S			ppb	1
42406	SO2S 5-min max in hr			ppb	1
42401	SO2 (Trace level)			ppb	1
42406	SO2 (Trace level) 5-min max in hr			ppb	1
44201	O3			ppm	3
42602	NO2			ppb	1
42601	NO			ppb	1
42603	NOx			ppb	1
42600	NOy (Trace level)			ppb	1
42601	NO (Trace Level)			ppb	1
42612	NOy-NO			ppb	1
84313	Aethalometer/Black Carbon			ug/m3	3
61103	Ws			Mph	1
61104	Wd			Degrees	0
63301	Sol. Rad.			W/m2	2
62107	Inside Temperature			o C	1
62101	Outside Temperature			o C	1
64101	Pressure			mm Hg	0
62201	Humidity			% Rel.	0
68105	Avg Ambient Temp-for Pb			o C	1
68108	Avg Baro Press-for Pb			mm Hg	0
88378	URG			LPM	2
88301	Met 1	red	Nylon	LPM	2
88502	Met 1	green	Teflon	LPM	2

F. Data Completeness:

The department recommends >80% pollutant measurement data completeness for PSD projects as suggested in EPA-450/4-87-007, page 8, http://www.epa.gov/region7/air/nsr/nsrmemos/monguide.pdf
The goal of the >80% pollutant measurement data completeness for PSD projects is to minimize data loss for projects that generally are conducted for only one year.

Most modern data acquisitions systems apply a 75% data completeness criteria for auxiliary averages making up a valid hourly average concentration which is acceptable for PSD projects.

The data completeness requirement for meteorological data is 90%.

The data collected for longer term NAAQS compliance projects must be complete enough for NAAQS analysis based on the applicable NAAQS averaging periods. The form and completeness requirements for NAAQS and associated 'interpretation of the NAAQS' appendices can be found in 40 CFR 50.

For purposes of evaluation, minimum criteria are generally 75% of possible readings per quarter except for St. Louis and Kansas City ozone monitors which require 75% daily completeness during the ozone season, April 1st - October 31st and an average of 90% completeness over any three year period. For the eight-hour ozone standard, eighteen valid eight-hour average samples must be collected.

The data completeness requirement for lead is that the average completeness for each 3-month period (i.e., the average of the 3 monthly completeness percentages) must be greater than or equal to 75%. Up to 2 makeup samples may be taken per month and used in calculating the monthly average and in calculating completeness. Makeups must be taken either before the next scheduled sampling day or exactly 1 week after the missed day, either with the usual sampler or with a collocated sampler of the same type. Because a 3-month period with less than 75% completeness can affect an area's attainment status, completeness must be closely monitored and makeup samples taken at the required time as needed to maintain 75% completeness. As a general guideline, if more than one sample day is missed in a month, every effort should be made to make up the second (and third, if applicable) missed sample(s). The table below provides general indicators of the required numbers of samples; the number can vary slightly depending on the number of days in a month and the sampling schedule. See 40CFR, Part 50, Appendix R for details of completeness calculation and makeup requirements.

The data completeness requirements for 24-hour samples are summarized in the following table.

24-Hour Samples (PM_{10}, $PM_{2.5}$)

Time Period	**Minimum Requirement for 75% Completeness**
24-hr sample every 6th day* Quarterly Yearly	 12 samples 4 complete quarters
24-hr sample every third day Quarterly Yearly	 23 samples 4 complete quarters
24-hr sample every day Quarterly Yearly	 69 samples 4 complete quarters

24-Hour Samples (Lead); see text for details

Time Period	Minimum Requirement for 75% Completeness
24-hr sample every 6th day* Monthly 3-month period (assuming 90 days)	 4 samples in a 5-sample month, 5 samples in a 6-sample month (up to 2 samples per month can be makeups) 12 samples
24-hr sample every third day Monthly 3-month period (assuming 90 days)	 8 samples in a 10-sample month, etc. (up to 2 samples per month can be makeups) 23 samples
24-hr sample every day	23 samples in a 30-day month, etc. (up to 2 samples per month can be makeups)

The data completeness requirements for continuously monitored parameters are summarized in the following table.

Continuously Monitored Data (CO, NO_2, NOx, NO, O_3, SO_2, Ws, Wd, $PM_{2.5}$, PM_{10} Solar Radiation Temp. Outdoors.)

Time Period	**Minimum Requirement for 75% Completeness**
3-hr average	3 of 3 1-hr samples
8-hr averages	6 of 8 1-hr samples
24-hr average	18 of 24 1-hr samples
Daily 8-hr ozone	18 valid eight-hour averages
Quarterly	75% of hourly values quarterly for gaseous, 75% complete daily samples quarterly for PM10 and PM2.5 90 % Meteorological data completeness for Regulatory Dispersion Modeling applications (all parameters).
Yearly	4 complete quarters

All quarters and years are calendar quarters and years, except for lead, which uses a rolling 3-month average, i.e., the average of 3 consecutive monthly averages.