Air Quality System

Precision and Accuracy Summarization Formulas

Draft

United States Environmental Protection Agency
Information Management Group

April 13, 2004
Version 1.1

1 Terms

Term	Definition
Precision	A measurement of mutual agreement among individual measurements of the same property usually under prescribed similar conditions, expressed generally in terms of the standard deviation.
Accuracy	The degree of agreement between an observed value and an accepted reference value. It includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations.
Bias	The systematic or persistent distortion of a measurement process which causes errors in one direction.
FRM	Federal Reference Method
PEP	Performance Evaluation Program

2 Precision

2.1 Precision Percent Difference

2.1.1 Analytical & Flow

$$d = \frac{(Y - X)}{X} * 100$$

where:

d = percent difference,
Y = indicated concentration or flow rate,
X = actual, or known, concentration or flow rate,

2.1.2 Collocated

$$d = \frac{(Y - X)}{\left(\frac{(Y + X)}{2}\right)} * 100$$

where:

d = percent difference,
X = measurement produced by primary sampler (routine monitor), which corresponds with the “Actual Value” field on a Precision Data (RP) input transaction,
Y = measurement produced by duplicate sampler (monitor used for quality control), which corresponds with the “Indicated Value” field on a Precision Data (RP) input transaction.

2.1.3 FRM Audit

$$d = \frac{(Y - X)}{X} * 100$$

where:

d = percent difference,
Y = measurement produced from the state-operated sampler, which corresponds with the "Indicated Value" field on a Precision Data (RP) input transaction,
X = measurement produced from the PEP sampler, which corresponds with the "Actual Value" field on a Precision Data (RP) input transaction.

2.2 Monitor Precision Summaries

2.2.1 Monitor-Reporting Organization (AR1_AR1_ID)

The monitor-reporting organization combination applicable to the summarized time period.

2.2.2 Precision Class (AUC_AUDIT_CLASS)

The type of precision checks that were summarized. The three applicable types are: analytical (gaseous checks), flow, and collocated. Load designates the class of a precision check according to the following rules:

1. If the method is automated (continuous), and the unit is not a flow unit, and the reported duration is not 24-hour block average, then the class is "Analytical". This class will generally include gaseous criteria pollutants, such as ozone (O3), carbon monoxide (CO), sulfur dioxide (SO2), and nitrogen dioxide (NO2), that were recorded using automated methods.
2. If the method is either automated or manual (intermittent), and the unit is a flow unit, then the class is "Flow". This category will generally include particulate criteria pollutants, such as lead (Pb), PM2.5 and PM10, that were recorded using automated methods.
3. If the method is manual and the unit is not a flow unit, or the method is automated, the unit is not a flow unit, and the duration is a 24-hour block average, then the class is "Collocated". This category will include

particulate criteria pollutants such as PM2.5 (both manual and automated) and PM10 (manual only).

2.2.3 Year (PREC_YEAR)

The 4-digit year of the summarized time period.

2.2.4 Time Period (TIME_PERIOD)

Indication of the scope of the summarized time period, as follows:

Indicator	Description
Q1	1st quarter, i.e., 1/1 – 3/31 of the summarized year
Q2	2nd quarter, i.e., 4/1 – 6/30 of the summarized year
Q3	3rd quarter, i.e., 7/1 – 9/30 of the summarized year
Q4	4th quarter, i.e., 10/1 – 12/31 of the summarized year
YR	The entire summarized year, i.e., 1/1 – 12/31

2.2.5 Recording Mode (RM_RECORDING_MODE)

A term that describes how the methods recorded the source samples. The possible values are: CONTINUOUS (i.e., Automated), and INTERMITTENT (i.e., Manual). The value is derived from the applicable methodology records.

2.2.6 Mean (PREC_MEAN)

A measure of the central tendency of the applicable population of precision checks.

2.2.6.1 Analytical & Flow

$$D = \frac{\sum_{i=1}^{n} d_i}{n}$$

where:

D = estimate of precision (mean),

d_i = percent difference of a analytical or flow precision check (2.1.1 Percent Difference),
n = number of gaseous or flow checks (2.2.8 Check Count).

2.2.6.2 Collocated (PM2.5)

$$CV = \sqrt{\frac{\sum_{i=1}^{n} \left(\frac{|d_i|}{\sqrt{2}} \right)^2}{n}}$$

where:

CV = coefficient of variation, i.e., estimate of precision,
d_i = percent difference of a valid collocated pair (2.1.2 Percent Difference),
n = number of valid collocated pairs (2.2.9 Valid Pair Count).

2.2.6.3 Collocated (Other)

$$D = \frac{\sum_{i=1}^{n} d_i}{n}$$

where:

D = estimate of precision (mean),
d_i = percent difference of a valid collocated pair (2.1.2 Percent Difference),
n = number of valid collocated pairs (2.2.9 Valid Pair Count).

2.2.7 Standard Deviation (PREC_STDDV)

A measure of the dispersion among the precision checks.

2.2.7.1 Analytical & Flow

$$S = \sqrt{\frac{\left(\left(n * \sum_{i=1}^{n} d_i^2\right) - \left(\sum_{i=1}^{n} d_i\right)^2\right)}{\left(n * (n-1)\right)}}$$

where:

S = standard deviation,
d_i = percent difference of a analytical or flow precision check (2.1.1 Percent Difference),
n = number of gaseous or flow checks (2.2.8 Check Count),

and $n > 1$.

If $n = 1$, then the standard deviation is assigned to be 0.

2.2.7.2 Collocated (PM2.5)

Standard deviation is not computed for collocated PM2.5.

2.2.7.3 Collocated (Other)

$$S = \sqrt{\frac{\left(\left(n * \sum_{i=1}^{n} d_i^2\right) - \left(\sum_{i=1}^{n} d_i\right)^2\right)}{\left(n * (n-1)\right)}}$$

where:

S = standard deviation,
d_i = percent difference of a valid collocated pair (2.1.2 Percent Difference),
n = number of valid collocated pairs (2.2.9 Valid Pair Count).

and $n > 1$.

If $n = 1$, then the standard deviation is assigned to be 0.

2.2.8 Check Count (PREC_CHECK_CNT)

The number of gaseous checks, flow checks, or collocated value pairs recorded during the time period.

2.2.9 Valid Pair Count (VALID_CLOC_DATA_PAIR_CNT)

The number of valid collocated value pairs recorded during the time period. A valid collocated value pair is one where both the primary and duplicate value exceed the minimum collocated value defined for the parameter on the *PARAMETERS* table. The minimum values for criteria pollutants are:

Parameter		Minimum
Code	**Name**	**Value**
11101	TSP	20 µg/m3 SC
12128	Lead	.015 µg/m3 SC
42401	SO2	.01717 ppm
42602	NO2	.01593 ppm
81102	PM10	20 µg/m3 SC
88101	PM2.5	6 µg/m3 LC

If a minimum collocated value is not defined for the parameter, then the value pair is assumed valid.

The field is not applicable to gaseous or flow checks, in which cases it is assigned a default value of 0.

2.2.10 Protocols (MP_MP_ID)

The protocols used to collect, analyze, and report the precision checks for the time period.

2.3 Reporting Organization Precision Summaries

2.3.1 Reporting Organization (AG_AGENCY_CODE)

The code assigned to the organization that generated and reported the data being summarized.

2.3.2 Parameter (PA_PARAMETER_CODE)

The code assigned to the parameter being summarized. It may be a pollutant, (e.g., ozone, carbon monoxide), or a non-pollutant, (e.g., wind direction, temperature).

2.3.3 Precision Class (AUC_AUDIT_CLASS)

The type of precision checks that were summarized. The three applicable types are: analytical (gaseous checks), flow, and collocated. Load designates the class of a precision check according to the following rules:

1. If the method is continuous, and the unit is not a flow unit, and the reported duration is not 24-hour block average, then the class is "Analytical". This class will generally include gaseous criteria pollutants, such as ozone (O3), carbon monoxide (CO), sulfur dioxide (SO2), and nitrogen dioxide (NO2), that were recorded using automated methods.
2. If the method is either continuous or intermittent, and the unit is a flow unit, then the class is "Flow". This category will generally include particulate criteria pollutants, such as lead (Pb), PM2.5 and PM10, that were recorded using automated methods.
3. If the method is intermittent (manual) and the unit is not a flow unit, or the method is continuous, the unit is not a flow unit, and the duration is a 24-hour block average, then the class is "Collocated". This category will include particulate criteria pollutants such as PM2.5 (both manual and automated) and PM10 (manual only).

2.3.4 Year (PREC_YEAR)

The 4-digit year of the summarized time period.

2.3.5 Time Period (TIME_PERIOD)

Indication of the scope of the summarized time period, as follows:

Indicator	Description
Q1	1st quarter, i.e., 1/1 – 3/31 of the summarized year
Q2	2nd quarter, i.e., 4/1 – 6/30 of the summarized year
Q3	3rd quarter, i.e., 7/1 – 9/30 of the summarized year
Q4	4th quarter, i.e., 10/1 – 12/31 of the summarized year
YR	The entire summarized year, i.e., 1/1 – 12/31

2.3.6 Recording Mode (RM_RECORDING_MODE)

A term that describes how the methods recorded the source samples. The possible values are: CONTINUOUS (i.e., Automated), and INTERMITTENT (i.e., Manual). The value is derived from the applicable methodology records.

2.3.7 Mean (PREC_MEAN)

A measure of the central tendency of the applicable population of precision checks.

2.3.7.1 Analytical & Flow

$$D = \frac{\sum_{i=1}^{n} d_i}{n}$$

where:

D = estimate of precision (mean),
d_i = percent difference of a analytical or flow precision check (2.1.1 Percent Difference),
n = number of gaseous or flow checks (2.3.9 Check Count).

2.3.7.2 Collocated (PM 2.5)

$$CV = \sqrt{\frac{\sum_{i=1}^{n} \left(\frac{|d_i|}{\sqrt{2}} \right)^2}{n}}$$

where:

CV = coefficient of variation, i.e., estimate of precision,
d_i = percent difference of a valid collocated pair (2.1.2 Percent Difference),
n = number of valid collocated pairs (2.3.11 Valid Pair Count).

2.3.8 Collocated (Other)

$$D = \frac{\sum_{i=1}^{n} d_i}{n}$$

where:

D = estimate of precision (mean),
d_i = percent difference of a valid collocated pair (2.1.2 Percent Difference),
n = number of valid collocated pairs (2.3.11 Valid Pair Count).

2.3.8.1 FRM Audit

$$D = \frac{\sum_{i=1}^{n} d_i}{n}$$

where:

D = estimate of precision (mean),
d_i = percent difference of an FRM audit pair (2.1.3 Percent Difference),
n = number of FRM audits (2.3.9 Check Count).

2.3.9 Standard Deviation (PREC_STDDV)

A measure of the dispersion among the applicable population of precision checks.

2.3.9.1 Analytical & Flow

$$S = \sqrt{\frac{\left(\left(n * \sum_{i=1}^{n} d_i^2\right) - \left(\sum_{i=1}^{n} d_i\right)^2\right)}{\left(n * (n-1)\right)}}$$

where:

S = standard deviation,
d_i = percent difference of a analytical or flow precision check (2.1.1 Percent Difference),
n = number of gaseous or flow checks (2.3.9 Check Count),

and $n > 1$.

If $n = 1$, then the standard deviation is assigned to be 0.

2.3.9.2 Collocated (PM2.5)

Standard deviation is not computed for collocated PM2.5.

2.3.9.3 Collocated (Other)

$$S = \sqrt{\frac{\left(\left(n * \sum_{i=1}^{n} d_i^2\right) - \left(\sum_{i=1}^{n} d_i\right)^2\right)}{\left(n * (n-1)\right)}}$$

where:

S = standard deviation,
d_i = percent difference of a valid collocated pair (2.1.2 Percent Difference),
n = number of valid collocated pairs (2.3.11 Valid Pair Count).

and $n > 1$.

If $n = 1$, then the standard deviation is assigned to be 0.

2.3.9.4 FRM Audit

$$S = \sqrt{\frac{\left(\left(n * \sum_{i=1}^{n} d_i^2\right) - \left(\sum_{i=1}^{n} d_i\right)^2\right)}{\left(n * (n-1)\right)}}$$

where:

S = standard deviation,
d_i = percent difference of an FRM audit pair (2.1.3 Percent Difference),
n = number of FRM audits (2.3.9 Check Count),

and $n > 1$.

If $n = 1$, then the standard deviation is assigned to be 0.

2.3.10 Check Count (PREC_CHECK_CNT)

The number of precision checks, (gaseous, flow, collocated, FRM) recorded during the time period.

2.3.11 Analyzer Count (ANALYZER_CNT)

For gaseous or flow, it is the number of monitors for checks were recorded during the time period. For collocated, it is the number of collocated sampler pairs that recorded collocated value pairs during the time period, (i.e., the 2.3.12 Collocated Site Count). It is not applicable to FRM audits, in which cases is assigned a default value of 0.

2.3.12 Valid Pair Count (VALID_CLOC_DATA_PAIR_CNT)

The number of valid collocated value pairs recorded during the time period. A valid collocated value pair is one where both the primary and duplicate value exceed the minimum collocated value defined for the parameter on the *PARAMETERS* table. The minimum values for criteria pollutants are:

Parameter		Minimum Value
Code	**Name**	
11101	TSP	20 µg/m3 SC
12128	Lead	.015 µg/m3 SC
42401	SO2	.01717 ppm
42602	NO2	.01593 ppm
81102	PM10	20 µg/m3 SC
88101	PM2.5	6 µg/m3 LC

If a minimum collocated value is not defined for the parameter, then the value pair is assumed valid.

The field is not applicable to gaseous or flow checks, in which cases it is assigned a default value of 0.

2.3.13 Collocated Site Count (CLOC_SITE_CNT)

The number of collocated sampler pairs that recorded collocated value pairs during the time period. It is not applicable to gaseous checks, flow checks, or FRM audits, and, therefore, in those cases it is assigned a default value of 0.

2.3.14 Lower Probability/Confidence Limit (PREC_LOWER_PROB_LIMIT)

The lower bound of either a probability distribution, or confidence interval, for the applicable population of precision checks .

2.3.14.1 Analytical & Flow (Other)

$$l = D - (S * 1.96)$$

where:

l = lower 95% probability limit,
D = mean (2.3.7.1 Mean),
S = standard deviation (2.3.8.1 Standard Deviation).

2.3.14.2 Flow (PM 2.5)

$$l = D - \left(\frac{S * t_{0.975,\, n-1}}{\sqrt{n}} \right)$$

where:

l = lower 95% confidence limit,
D = mean (2.3.7.1 Mean),
S = standard deviation (2.3.8.1 Standard Deviation),
$t_{0.975,\, n-1}$ = the 0.975 quantile of the Student's T distribution with degrees of freedom equal to $n-1$,
n = number of flow checks (2.3.9 Check Count).

2.3.14.3 Collocated (PM 2.5)

$$l = CV \sqrt{\frac{n}{\chi^2_{0.95,\, n}}}$$

where:

l = lower 90% confidence limit,
CV = coefficient of variation, (2.3.7.2 Mean),
n = number of valid collocated pairs (2.3.11 Valid Pair Count),
$X^2_{0.95,n}$ = the 0.95 quantile of the chi-square distribution with degrees of freedom equal to n.

2.3.14.4 Collocated (Other)

$$l = D - \left(\frac{S * 1.96}{\sqrt{2}} \right)$$

where:

l = lower 95% probability limit,

D = mean (2.3.7.3 Mean),
S = standard deviation (2.3.8.3 Standard Deviation).

2.3.14.5 FRM Audit

$$l = D - \left(\frac{S * t_{0.975,\, n-1}}{\sqrt{n}} \right)$$

where:

l = lower 95% confidence limit,
D = mean (2.3.7.4 Mean),
S = standard deviation (2.3.8.4 Standard Deviation),
$t_{0.975,\, n-1}$ = the 0.975 quantile of the Student's T distribution with degrees of freedom equal to $n-1$,
n = number of FRM pairs ((2.3.9 Check Count).

2.3.15 Upper Probability/Confidence Limit (PREC_UPPER_PROB_LIMIT)

The upper bound of either a probability distribution, or confidence interval, for the applicable population of precision checks .

2.3.15.1 Analytical & Flow (Other)

$$u = D + (S * 1.96)$$

where:

u = upper 95% probability limit,
D = mean (2.3.7.1 Mean),
S = standard deviation (2.3.8.1 Standard Deviation).

2.3.15.2 Flow (PM 2.5)

$$u = D + \left(\frac{S * t_{0.975,\, n-1}}{\sqrt{n}} \right)$$

where:

u = upper 95% confidence limit,
D = mean (2.3.7.1 Mean),
S = standard deviation (2.3.8.1 Standard Deviation),
$t_{0.975,\, n-1}$ = the 0.975 quantile of the Student's T distribution with degrees of freedom equal to $n-1$,
n = number of flow checks (2.3.9 Check Count).

2.3.15.3 Collocated (PM 2.5)

$$u = CV \sqrt{\frac{n}{\chi^2_{0.05,\, n}}}$$

where:

u = upper 90% confidence limit,
CV = coefficient of variation, (2.3.7.2 Mean),
n = number of valid collocated pairs (2.3.11 Valid Pair Count),
$X^2_{0.95,n}$ = the 0.95 quantile of the chi-square distribution with degrees of freedom equal to n.

2.3.15.4 Collocated (Other)

$$u = D + \left(\frac{S * 1.96}{\sqrt{2}} \right)$$

where:

u = upper 95% probability limit,
D = mean (2.3.7.3 Mean),
S = standard deviation (2.3.8.3 Standard Deviation)

2.3.15.5 FRM Audit

$$u = D + \left(\frac{S * t_{0.975,\, n-1}}{\sqrt{n}} \right)$$

where:

u = upper 95% confidence limit,
D = mean (2.3.7.4 Mean),
S = standard deviation (2.3.8.4 Standard Deviation),
$t_{0.975,\, n-1}$ = the 0.975 quantile of the Student's T distribution with degrees of freedom equal to $n-1$,
n = number of FRM pairs ((2.3.9 Check Count).

3 Accuracy

3.1 Accuracy Percent Difference

$$d = \frac{(Y - X)}{X} * 100$$

where:

d = percent difference,
Y = indicated concentration or flow rate,
X = actual, or known, concentration or flow rate.

3.2 Monitor Accuracy Summaries

Monitor accuracy summaries are identified by the ACS_TYPE column on ACCURACY_SUMMARIES begin equal to "MAS".

3.2.1 Monitor – Reporting Organization (AR1_AR1_ID)

The monitor-reporting organization combination applicable to the summarized time period.

3.2.2 Audit Class (AUC_AUDIT_CLASS)

A term describing the process by which the audits were performed, (analytical or flow.) Analytical audits are generally performed for gaseous parameters, (e.g., O3, CO, SO2), and flow audits are generally performed for particulate parameters, (e.g., Pb, PM2.5, PM10). The audit class is designated by the reporting organization at the time of data submission.

3.2.3 Recording Mode (RM_RECORDING_MODE)

A term that describes how the methods recorded the source samples. The possible values are: CONTINUOUS (i.e., Automated), and INTERMITTENT (i.e., Manual). The value is derived from the applicable methodology records.

3.2.4 Accuracy Type (ACT_ACC_TYPE)

A description of the program for which the audits were conducted. The accuracy type is designated by the reporting organization at the time of data submission.

3.2.5 Year (ACC_SUMMARY_YEAR)

The 4-digit year of the summarized time period.

3.2.6 Time Period (TIME_PERIOD)

Indication of the scope of the summarized time period, as follows:

Indicator	Description
Q1	1st quarter, i.e., 1/1 – 3/31 of the summarized year
Q2	2nd quarter, i.e., 4/1 – 6/30 of the summarized year
Q3	3rd quarter, i.e., 7/1 – 9/30 of the summarized year
Q4	4th quarter, i.e., 10/1 – 12/31 of the summarized year
YR	The entire summarized year, i.e., 1/1 – 12/31

3.2.7 Audit Type (AUTY_AUDIT_TYPE)

A term describing the method for performing the audits and certifying the audit standards. The assigned value represents the most frequently assigned value for the population of source data.

3.2.8 Local Primary Standard (LPS_LOCAL_PRI_STD)

A description of the source of the local primary standards. The assigned value represents the most frequently assigned value for the population of source data.

3.2.9 Audit Level (AL_AL_ID)

The level number associated with a concentration range specified for the parameter by regulation (see below), or specified by the reporting organization with the specific transaction.

Parameter		Recording Mode	Level	Concentration Range (in standard units)	
Code	Name				
12128	PB	Intermittent	1	0.4	3.5
			2	2	6.5
42101	CO	Continuous	1	2.7	10.5
			2	13.5	25
			3	21.1	50.5
			4	35	99
42401	SO2	Continuous	1	0.027	0.095
			2	0.124	0.31
			3	0.221	0.495
			4	0.72	0.99
42602	NO2	Continuous	1	0.024	0.15
			2	0.135	0.29
			3	0.221	0.53
			4	0.72	0.99
44201	O3	Continuous	1	0.027	0.09
			2	0.125	0.26
			3	0.22	0.495
			4	0.72	0.99

3.2.10 Mean (ACC_MEAN)

A measure of the central tendency of the applicable population of accuracy audits.

$$D = \frac{\sum_{i=1}^{n} d_i}{n}$$

where:

D = estimate of accuracy (mean),
d_i = percent difference of a analytical or flow audit (3.1 Percent Difference),
n = number of audits (3.2.11 Audit Count).

3.2.11 Audit Count (AUDIT_CNT)

The number of accuracy audits recorded during the time period.

3.2.12 Protocols (MP_MO_MO_ID, MP_MP_ID)

The protocols used to collect, analyze, and report the audits for the time period.

3.3 Reporting Organization Accuracy Summaries

Monitor accuracy summaries are identified by the ACS_TYPE column on ACCURACY_SUMMARIES begin equal to “MAS”.

3.3.1 Reporting Organization (AG_AGENCY_CODE)

The code assigned to the organization that generated and reported the data being summarized.

3.3.2 Parameter (PA_PARAMETER_CODE)

The code assigned to the parameter being summarized.

3.3.3 Audit Class (AUC_AUDIT_CLASS)

A term describing the process by which the audits were performed, (analytical or flow.) Analytical audits are performed for gaseous parameters, (e.g., O3, CO, SO2), and flow audits are performed for particulate parameters, (e.g., Pb, PM2.5, PM10).

The audit class is designated by the reporting organization at the time of data submission.

3.3.4 Recording Mode (RM_RECORDING_MODE)

A term that describes how the methods recorded the source samples. The possible values are: CONTINUOUS (i.e., Automated), and INTERMITTENT (i.e., Manual). The value is derived from the applicable methodology records.

3.3.5 Accuracy Type (ACT_ACC_TYPE)

A description of the program for which the audits were conducted. The accuracy type is designated by the reporting organization at the time of data submission.

3.3.6 Year (ACC_SUMMARY_YEAR)

The 4-digit year of the summarized time period.

3.3.7 Time Period (TIME_PERIOD)

Indication of the scope of the summarized time period, as follows:

Indicator	Description
Q1	1st quarter, i.e., 1/1 – 3/31 of the summarized year
Q2	2nd quarter, i.e., 4/1 – 6/30 of the summarized year
Q3	3rd quarter, i.e., 7/1 – 9/30 of the summarized year
Q4	4th quarter, i.e., 10/1 – 12/31 of the summarized year
YR	The entire summarized year, i.e., 1/1 – 12/31

3.3.8 Audit Type (AUTY_AUDIT_TYPE)

A term describing the method for performing the audits and certifying the audit standards. The assigned value represents the most frequently assigned value for the population of source data.

3.3.9 Local Primary Standard (LPS_LOCAL_PRI_STD)

A description of the source of the local primary standards. The assigned value represents the most frequently assigned value for the population of source data

3.3.10 Audit Level (AL_AL_ID)

The level number associated with a concentration range specified for the parameter by regulation (see below), or specified by the reporting organization with the specific transaction.

Parameter		Recording Mode	Level	Concentration Range (in standard units)	
Code	Name				
12128	PB	Intermittent	1	0.4	3.5
			2	2	6.5
42101	CO	Continuous	1	2.7	10.5
			2	13.5	25
			3	21.1	50.5
			4	35	99
42401	SO2	Continuous	1	0.027	0.095
			2	0.124	0.31
			3	0.221	0.495
			4	0.72	0.99
42602	NO2	Continuous	1	0.024	0.15
			2	0.135	0.29
			3	0.221	0.53
			4	0.72	0.99
44201	O3	Continuous	1	0.027	0.09
			2	0.125	0.26
			3	0.22	0.495
			4	0.72	0.99

3.3.11 Mean (ACC_MEAN)

A measure of the central tendency of the applicable population of accuracy audits.

$$D = \frac{\sum_{i=1}^{n} d_i}{n}$$

where:

D = estimate of accuracy (mean),
d_i = percent difference of a analytical or flow audit (3.1 Percent Difference),
n = number of audits (3.3.12 Audit Count).

If either quarter in either half of the year has an Audit Count (3.3.12 Audit Count) of 1, then the source data for both quarters in that half will be merged for purposes of calculating the mean, and reported with the second quarter of the half (i.e., Q2 or Q4). In this case, there will be no value for the corresponding first quarter in the half (i.e., Q1 or Q3).

3.3.12 Audit Count (AUDIT_CNT)

The number of accuracy audits recorded during the time period. If either quarter in either half of the year has an Audit Count of 1, then the audits for both quarters will be counted and reported with the second quarter for the half (Q2 or Q4). However, for the first quarter in the half (Q1 or Q3), the audits will still be counted and reported with that quarter.

3.3.13 Standard Deviation (ACC_STDDV)

A measure of the dispersion among the applicable population of accuracy audits.

$$S = \sqrt{\frac{\left(\left(n * \sum_{i=1}^{n} d_i^{2}\right) - \left(\sum_{i=1}^{n} d_i\right)^{2}\right)}{\left(n * (n-1)\right)}}$$

S = standard deviation,
d_i = percent difference of a analytical or flow audit (3.1 Percent Difference),
n = number of audits (3.3.12 Audit Count).

If either quarter in either half of the year has an Audit Count (3.3.12 Audit Count) of 1, then the source data for both quarters in that half will be merged for purposes of calculating the standard deviation, and reported with the second quarter of the half

(i.e., Q2 or Q4). In this case, there will be no value for the corresponding first quarter in the half (i.e., Q1 or Q3).

3.3.14 Lower Probability/Confidence Limit (ACC_LOWER_PROB_LIMIT)

The lower bound of either a probability distribution, or confidence interval, for the applicable population of accuracy audits .

If either quarter in either half of the year has an Audit Count (3.3.12 Audit Count) of 1, then the source data for both quarters in that half will be merged for purposes of calculating the lower probability/confidence limit, and reported with the second quarter of the half (i.e., Q2 or Q4). In this case, there will be no value for the corresponding first quarter in the half (i.e., Q1 or Q3).

3.3.14.1 Analytical & Flow (Non-PM 2.5)

$$l = D - (S * 1.96)$$

where:

l = lower 95% probability limit,
D = mean (3.3.11 Mean),
S = standard deviation (3.3.13 Standard Deviation).

3.3.14.2 Flow (PM 2.5)

$$l = D - \left(\frac{S * t_{0.975,\, n-1}}{\sqrt{n}} \right)$$

where:

l = lower 95% confidence limit,
D = mean (3.3.11 Mean),
S = standard deviation (3.3.13 Standard Deviation),
$t_{0.975,\, n-1}$ = the 0.975 quantile of the Student's T distribution with degrees of freedom equal to $n-1$,
n = number of audits (3.3.12 Audit Count).

3.3.15 Upper Probability/Confidence Limit (ACC_UPPER_PROB_LIMIT)

The upper bound of either a probability distribution, or confidence interval, for the applicable population of accuracy audits .

If either quarter in either half of the year has an Audit Count (3.3.12 Audit Count) of 1, then the source data for both quarters in that half will be merged for purposes of calculating the upper probability/confidence limit, and reported with the second quarter of the half (i.e., Q2 or Q4). In this case, there will be no value for the corresponding first quarter in the half (i.e., Q1 or Q3).

3.3.15.1 Analytical & Flow (Non-PM 2.5)

$$u = D + (S * 1.96)$$

where:

u = upper 95% probability limit,
D = mean (3.3.11 Mean),
S = standard deviation (3.3.13 Standard Deviation).

3.3.15.2 Flow (PM 2.5)

$$u = D + \left(\frac{S * t_{0.975,\, n-1}}{\sqrt{n}} \right)$$

where:

u = upper 95% confidence limit,
D = mean (3.3.11 Mean),
S = standard deviation (3.3.13 Standard Deviation),
$t_{0.975,\, n-1}$ = the 0.975 quantile of the Student's T distribution with degrees of freedom equal to $n-1$,
n = number of audits (3.3.12 Audit Count).