Data Validation Clarification Document (DRAFT) – Continuous Source Monitoring Manual Revision No. 8 (Manual)

Disclaimer:

The Continuous Source Monitoring Manual Revision No. 8 (Manual) - Data Validation Clarification Document has been developed in order to clarify the Pennsylvania Department of Environmental Protection's (Department or DEP) data reduction criteria pertaining to hourly averages, contained on page 64 (4.a. and 4.b) of the Manual. The policies and procedures outlined in this document are intended to supplement existing requirements. Nothing in the policies or procedures shall affect regulatory requirements. The policies and procedures provided herein are not an adjudication or a regulation. There is no intent on the part of the Department to give these policies and procedures that weight or deference. DEP reserves the discretion to deviate from this document, if circumstances warrant.

Background:

The owners/operators of affected facilities and their vendors have requested that the Department clarify and provide examples pertaining to the validation of hourly averages for Revision No. 8 of the Manual. This document is designed to assist facility owners and operators in programming their data acquisition and handling systems (DAHS) and ensuring that hourly averages are coded/calculated properly.

The Department's position has always been that a "valid data reading" would correspond to a valid one-minute average. This was reiterated during the recent Department workshops at each of the Regional Offices.

The owners/operators of sources may petition the Department to use a more stringent applicable Federal data reduction criterion (in order to maintain consistency between data considered invalid by multiple agency programs). This enables those that operate under multiple programs to harmonize reporting to the extent practicable.

Should you have any comments or questions concerning the examples provided below, please contact Chuck Zadakis by e-mail at czadakis@state.pa.us.

1. With respect to Topic: Hourly averages (page 64, 4.a.)

CLARIFICATION: For hours during which calibration or maintenance **did not** occur, if at least one valid one-minute average during each quadrant of a clock hour during which the process was

operating was obtained, the hourly average would be considered valid.

For hours during which calibration or maintenance occurred, if 1) at least two valid one-minute averages were obtained during the hour, and 2) if the time period between any two valid one-minute averages obtained during the hour was at least 15 minutes, the hourly average would be considered valid.

REASONING: The Department's rationale is provided as follows: 1) the parameters affected by this paragraph would not be expected to fluctuate rapidly on a continuing basis, and 2) compliance with emissions standards for the parameters affected by this paragraph would be determined based on a minimum of one clock hour.

2. With respect to Topic: Hourly averages (page 64, 4.b.)

CLARIFICATION: With respect to validation by "segments" of a clock hour:

For example, for carbon monoxide (CO), if the process operated only during the first 6 5-minute segments of a clock hour, if at least one one-minute average during at least 5 of those segments was obtained, the hourly average would be considered valid (see Example 4, below).

REASONING: The Department treats these parameters differently because they might be expected to fluctuate more rapidly on a continuing basis. The intention was that validity would depend on obtaining data in "segments", corresponding to the required minimum cycle time for recording, (rather than quadrants) during which the process operated.

3. Updated hourly average data validation criteria language

CLARIFICATION: The following language will be included in future revisions of the Manual in order to clarify the hourly average data reduction criteria. A number of **NOTES** will also be included to clarify the invalidation of data due to "process down". This language represents the current requirements for validation of hourly averages.

4. Hourly averages.

   a. For all parameters except for opacity, temperature, CO, and parameters addressed by Tables XI, or XII of this manual – data from measurement devices of these types can be used to calculate a valid monitoring system hourly average if at least one valid **one-minute average** is obtained in each 15-min quadrant during which the process was operating. Notwithstanding this requirement, if the process operated during more than one quadrant of the hour and if some data is unavailable as a result of the performance of calibration, quality assurance activities, preventive maintenance activities, or backups of data from the data acquisition and handling system, valid data readings from at least two points separated by a minimum of 15 minutes may be used.

   b. For opacity, temperature, CO, and parameters addressed by Tables XI, or XII, of this manual – data from measurement devices of these types can be used to calculate a valid monitoring system hourly average if **at least one valid one-minute average is obtained in** at least 75 percent of the segments of the hour corresponding to the minimum required cycle time (for measurement) during which the process was operating.

NOTE: During all valid hours, the hourly average would be calculated as: [Sum of valid one-minute averages] / [number of valid one-minute averages]

NOTE: Under the requirements of a and b, above, hourly averages can only be identified as "invalid due to process down" if the process **did not** operate (monitoring is not required) for the **entire** hour.

Please also note: these requirements will also affect the reporting of "substitute" data, where required. For instance, if a source operates for only a small portion of a clock hour, rather than identifying the hour as invalid due to "Process Down" the emission results monitored during the portion of the clock hour during which the source operated will be used to represent the hour (for hours considered “valid”). In such cases, no "substitute" data will be required (since data substitution is only required for "invalid" hours).

REASONING: Consistent with items 1 and 2, above.

4. Generation of hourly averages utilizing data collected at varying times and frequencies and with different data validation requirements

Tables I – XII of the Manual identify the minimum data recorder resolution and number of cycles per hour on an analyzer specific basis. Therefore, calculating the hourly average emission result in the applicable units of measurement may involve the use of data collected at varying times and frequencies as well as different validation requirements (page 64, 4.a or 4.b). This was not an issue in past revisions of the Manual because analyzers were required to meet the most stringent requirement of all analyzers that were used to develop the emission result in the applicable units of measurement and there was a uniform data validation requirement.

A typical example is the calculation of a CO PPM @ 15% O_2 hourly average. CO requires a minimum data recorder resolution of 5 minutes and 12 cycles per hour, while O_2 requires a minimum data recorder resolution of 15 minutes and 4 cycles per hour.

By defining the data collection requirements by analyzer, we are forced to calculate an hourly average "analyzer" value and to use those values to calculate emissions in the applicable units of measurement in instances that the timing and frequency of data sample collection is not identical. (See Example 2, below)

5. With respect to Topic: Waste Incinerator Monitoring Requirements

CLARIFICATION: This topic applies to monitoring systems installed on municipal and hospital waste incinerators reference in 25 Pa Code § 139.111. **More stringent validation requirements** (relative to the "general" validation requirements as listed in item 3, above) **apply to carbon monoxide and temperature monitoring systems**, in that at least 90% of the data collected during process operation for each hour is required to be valid in order to constitute a valid hour. In other words, 90% of the **cycle averages** (one-minute for temperature or five-minute averages for CO) for each hour during which the process was operating is required to be valid.

6. Rounding Conventions for Reported Data

When it is necessary to round a value to report it using the number of required decimal places, use the standard arithmetic rounding convention where numbers 5-9 round to the next highest number in the previous decimal position to the left. It is not always appropriate to report values to the number of decimal places in the EDR format. The precision of each measured parameter should be the same as the precision of the hourly record for the parameter. Zeros may be used as placeholders to the right of the last digit in each measurement, but are not considered to be significant figures. (Manual, Attachment No. 3, II.C(7)(b), Page 103)

7. Data substitution

Monitoring systems used to report data for compliance with emission standards based on total mass, tons per year, etc. are required to report "substitute" data for hours when the data hour is considered invalid. The Department will notify the owners/operators of sources when data substitution is required. They must be notified and concur with the procedure that is ultimately utilized. Revision No. 8 of the Manual indicates that the following procedures are acceptable:

1. The emission value for any hours that are invalid during which the process operated for the entire hour should be calculated using data collected during valid data periods for the hour and the highest valid one-hour emission value that occurred during the reporting quarter for any invalid data periods during that hour (if no valid data were collected during the reporting quarter, use the most recent quarter for which valid data was collected; if no valid data was collected during the reporting quarter or any previous quarter, contact the Department for specific instructions).

Sources are required to use minute level emission result data (i.e. pollutant, lbs/hr) when data substitution is required. In such cases, once it is determined that an hourly average isn't valid for the pollutant, diluent, flow, etc. (based upon the data collection requirements identified for each monitor), the data substituted value should be inserted for the invalid pollutant, lbs/hr readings and the hourly average calculated.

The applicable Method of Determination Code (MODC) should be included for each hour to explain how the value for the hour was calculated. The MODC of the monitor with the most missing data should be utilized. In the case of a tie, utilize the MODC of the primary pollutant analyzer.

2. The "Missing Data Substitution Procedures" of 40 CFR, Part 75 (only for the specific parameters covered by that subpart). This method is not applicable for all sources.

3. An alternative method of data substitution as approved concurrently by the Air Quality Program Manager of the appropriate DEP Regional Office and the Chief of the Division of Source Testing and Monitoring.

All the examples provided, below, utilize data substitution procedure 1. Substitution of the highest valid one-hour emission value that occurred during the reporting quarter for any invalid hours continues to be an acceptable option.

8. Flowcharts on Data Validation and Emission Data Reporting Conventions

Three flowcharts on data validation and a table on emissions data reporting have been developed (see, below) to assist users with hourly average determination and the reporting of quarterly emissions to the Department.

9. Use of Federal requirements for substitute data

NOTE 5 of the Quality Assurance Section of the Manual states that the owners/operators of sources subject to applicable Federal requirements for substitute data for "Diluent Cap", or "Over-scaling" may petition the Department for use of such substitute data for DEP purposes if they can demonstrate that the use of such substitute data will not adversely impact the Department's ability to enforce compliance with all applicable requirements. Monitoring Code (MC) 99 should be used in RT 884 for hours in which the substituted data is utilized at any time during the hour unless otherwise stated by the Department in the petition approval letter. The substituted data will be considered **valid** for the purposes of compliance with Department emission and data availability standards.

A Diluent Cap (40 CFR, Part 75, App. F § 3.3.4.1) is used in instances that the heat input of the unit approaches zero.

For boilers, a minimum concentration of 5.0% CO_2 or a maximum concentration of 14.0% O_2 may be substituted for the measured diluent gas concentration value for any operating hour in which the hourly average CO_2 concentration is < 5.0% CO_2 or the hourly average O_2 concentration is >14.0% O_2.

For stationary gas turbines, a minimum concentration of 1.0% CO_2 or a maximum concentration of 19.0% O_2 may be substituted for measured diluent gas concentration values for any operating hour in which the hourly average CO_2 concentration is <1.0% CO_2 or the hourly average O_2 concentration is >19.0% O_2.

Under 40 CFR, Part 75, App. F § 3, the use of the diluent cap is limited to the calculation of the NO_x emission rate (lbs/MBtu), and only for hours in which a quality-assured diluent gas reading is obtained, showing that use of the cap is justified. Petitions for the use of the diluent cap for NO_x and SO_2 emission rates (lbs/MBtu) will be accepted by the Department.

Method of Determination Code (MDC) 14 should be used in RT 884 for hours in which a "Diluent Cap" is utilized unless otherwise stated by the Department in the petition approval letter.

Over-scaling is an exceedance of the high range of a continuous monitor, as described in 40 CFR, Part 75, Appendix A, Sections 2.1.1.5 (for SO_2), 2.1.2.5 (for NO_x), and 2.1.4.3 (for flow). During hours in which the NO_x concentration, SO_2 concentration, or flow rate is greater than the analyzer's capability to measure, the owner or operator is instructed to substitute 200% of the full scale range of the instrument for that hour. Use the applicable Process Code and an MDC of 20 when reporting the hour in RT 884. Additional information is available in the answer to Question 8.1 of the Department's Question and Answer Document, available on the CEM Homepage.

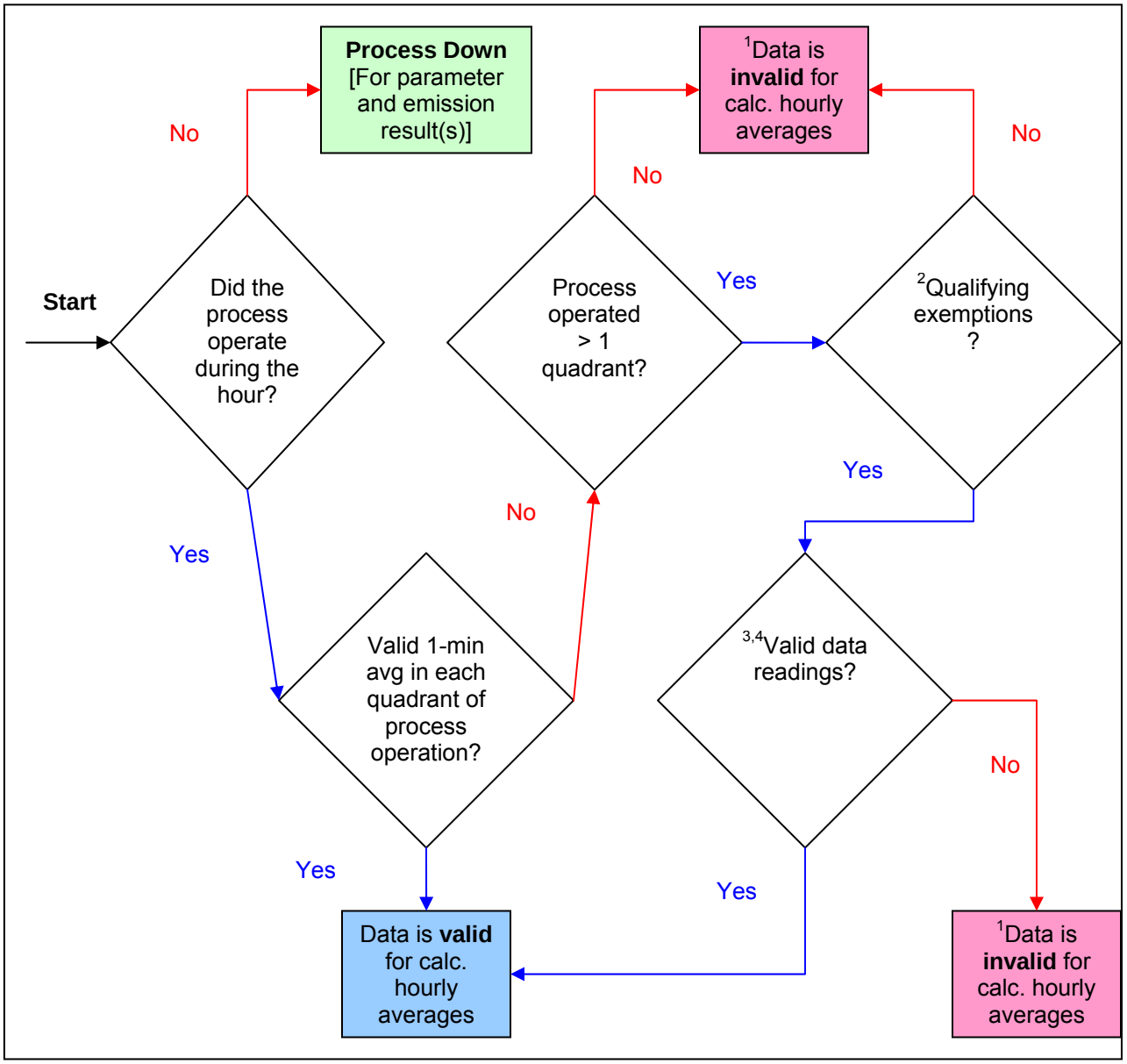
10. Reporting of Exempt hours

There may be cases when the owners/operators of sources may be either exempt from monitoring or authorized for exemptions from short-term average emission standards (3-hour average, 4-hour average, etc.) during specific process conditions (start-up, shut-down, etc.) by the applicable permit, plan approval, or order.

If the regulation explicitly states that monitoring is not required during certain process conditions, the corresponding time periods should be reported as "process down/monitoring not required".

If the regulation requires monitoring for all time periods but authorizes exemptions from short-term emission standards during specific process conditions (start-up, shut-down, etc.) then exempt periods should be considered as operating time subject to monitoring. An hourly average must be reported using the appropriate, approved exempt code, for each hour that includes any exempt time.

Data Validation Flowchart 1
Data Inputs – Quality Assurance I.B.4.a



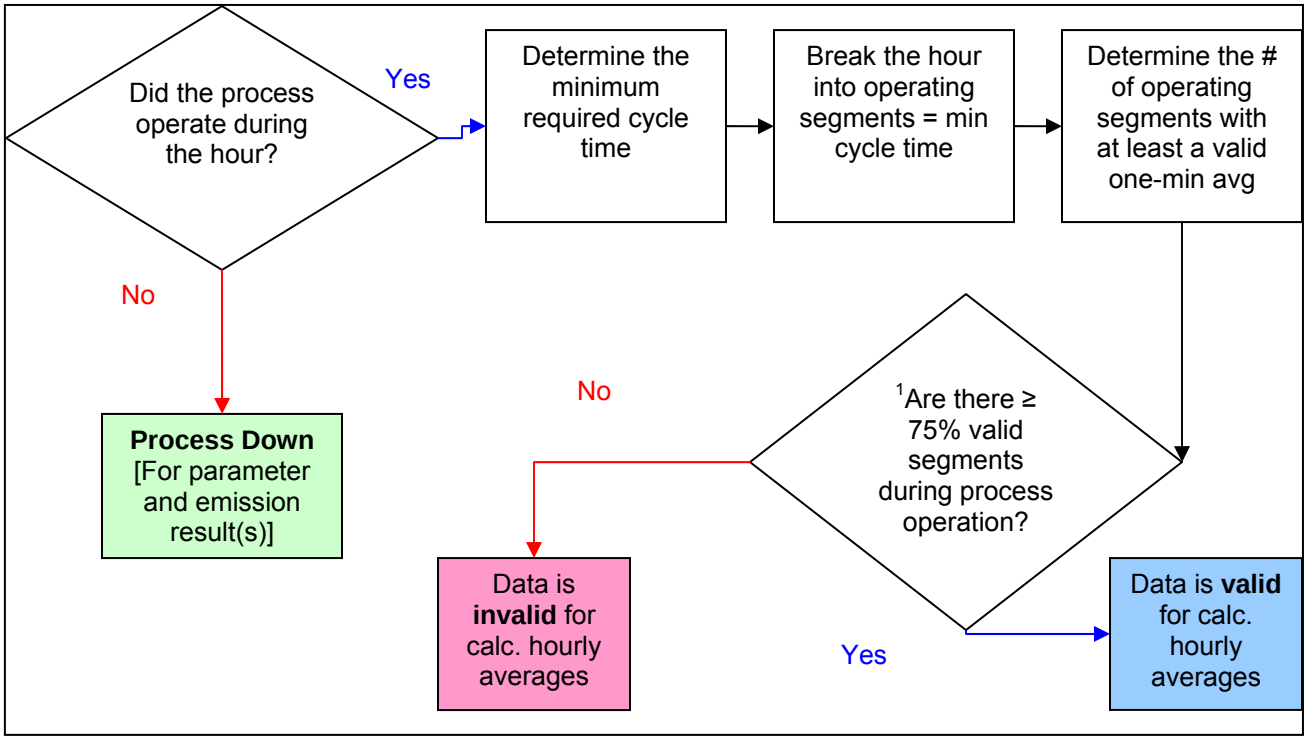
Key

[1] Insert the most prevalent monitoring code.
[2] A qualifying exemption would include the following: performance of a calibration, quality assurance activities, preventive maintenance activities, or backups of data from the data acquisition and handling system.
[3] Are there valid data readings from at least 2 points separated by a minimum of 15 minutes?
[4] For an hour containing a failed calibration error test, a passed calibration error test may be used to *prospectively* validate data for the hour in which it is performed only if, after completion of the test, the minimum data requirements of Quality Assurance I.B.4.a of the Manual are met. Therefore, data collected before the failed daily calibration test would not be utilized in the calculation of the hourly average.

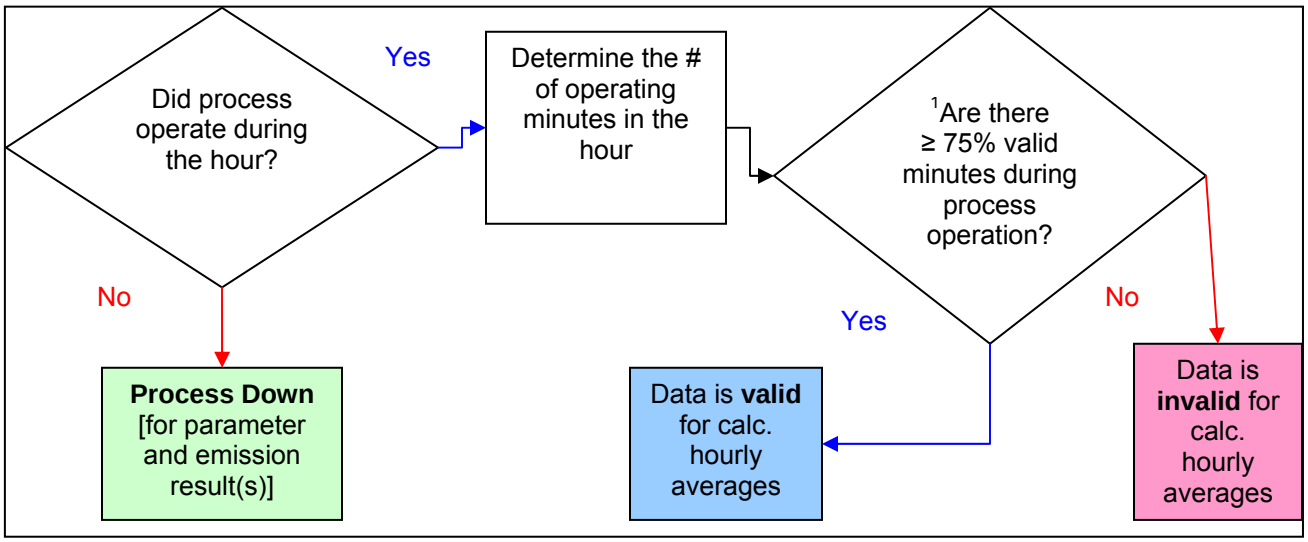
Data Validation Flowchart 2

Data Inputs – Quality Assurance I.B.4.b

Applicable for those pollutants/parameters where the minimum required cycle time **is not** one-minute (CO, etc.)



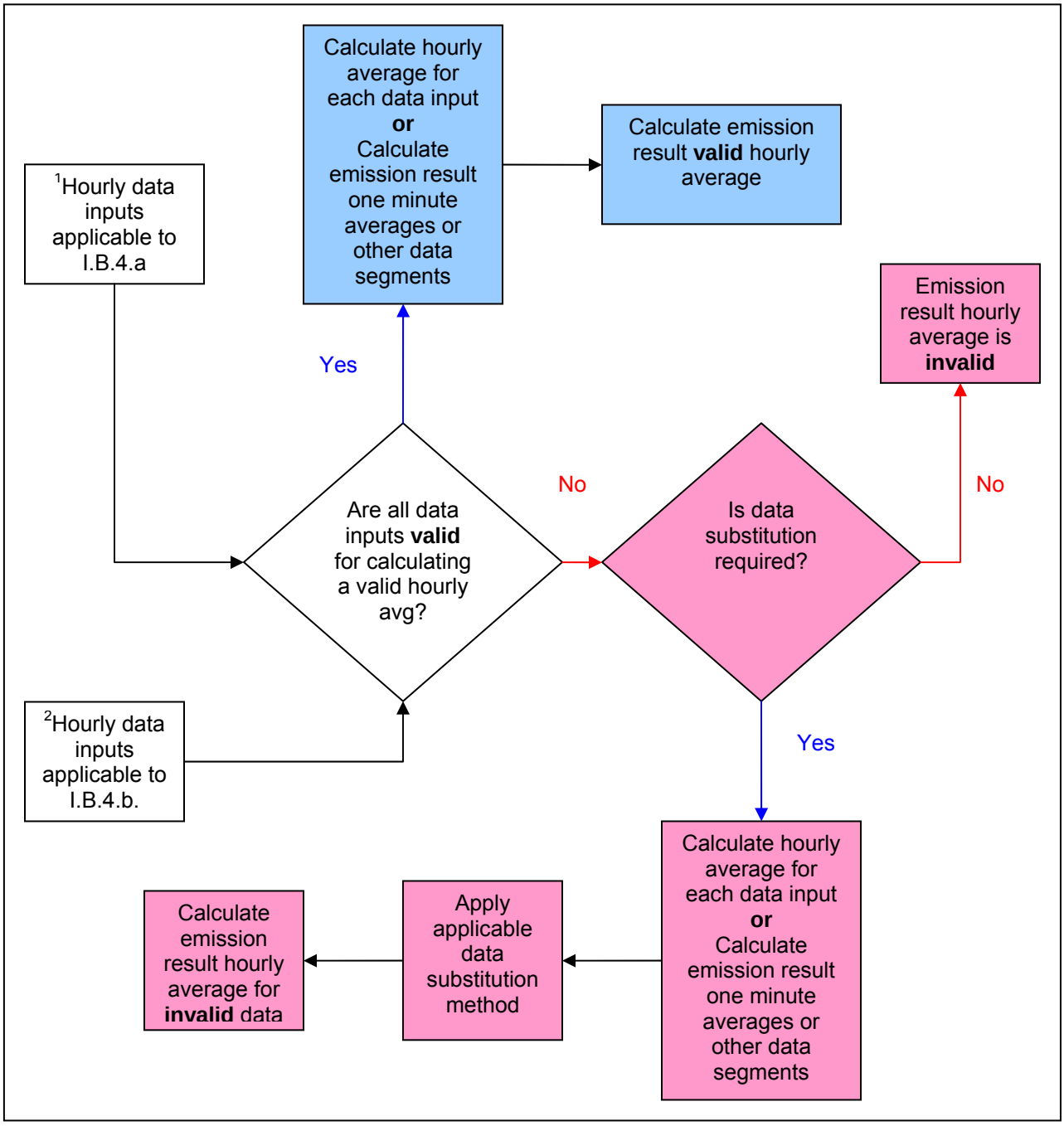
Applicable for those pollutants/parameters where the minimum required cycle time **is** one-minute (opacity, temperature, etc.)



Key

[1] This would be 90% for CO and Temperature CEMSs for waste incinerators.

Data Validation Flowchart 3
Calculating Emission Result Hourly Averages



Key

Valid data
Invalid data

[1] Utilize hourly data inputs from **Data Validation Flowchart 1**.
[2] Utilize hourly data inputs from **Data Validation Flowchart 2**.

[1]Emissions Data Reporting Conventions

[2]Process Operational Status	Valid/Invalid /Process Down	No Data Substitution				Data Substitution			
		Value	PC	MC	MDC	Value	PC	MC	MDC
On (whole hour)	Valid	V.VVV	PC	[4]00	[4]P, B, S	V.VVV	PC	[4]00	[4]P, B, S
	Invalid	(blank)	PC	MC≠00, 13	NV	S.SSS	PC	MC≠00, 13	MDC≠P, B, S
Off (whole hour)	Process Down	0.000	08	13	P	0.000	08	13	P
[3]Partial hour of operation	Valid	V.VVV	PC	[4]00	[4]P, B, S	V.VVV	PC	[4]00	[4]P, B, S
	Invalid	(blank)	PC	MC≠00, 13	NV	P.PPP	PC	MC≠00, 13	MDC≠P, B, S

Key:

MC – Monitoring Code
MDC – Method of Determination Code
PC – Process Code

P.PPP – Substituted value (prorated) as generated by the DAHS
S.SSS – Substituted value as calculated by the CEMS
V.VVV – Valid data as recorded by the CEMS

[1] View the "Field Descriptions and Instructions" contained in RT 884 of Revision No. 8 of the Manual for additional information.
[2] As defined by the Department and the Continuous Source Monitoring Manual.
[3] Process down is a non-existing condition during a partial hour of operation.
[4] For the owners/operators of sources subject to Federal requirements for "Diluent CAP" or "Over-scaling that have been approved by the Department for use of these procedures for DEP purposes; use Monitoring Code 99 for the reporting of the subject data in RT 884. The Method of Determination codes that should be applied are as follows:

Procedure Type	MDC
[5]Diluent Cap	14
Over-scaling	20

[5] May only be used for NO_x and SO_2 lbs/MBtu reporting when approved by the Department.

Example 1
With respect to Topic: Hourly average (page 64, 4.a.):

In scenarios 1-14, it was assumed that there were no failed calibration error tests during quadrants in which maintenance was conducted.

[3, 4, 6]Scenario	1	2	3	4	5	6	7
Quadrant 1	O-V	O-M	O-V	O-V	O-V	O-V	O-V
Quadrant 2	O-V	O-V	O-V	O-V	O-V	O-V	D
Quadrant 3	O-V	O-V	O-I	O-V	D	O-I	O-V
Quadrant 4	O-V	O-V	O-V	D	O-M	D	D
Hourly Average	V	[1]V	I	V	[2]I	I	V

[3, 4, 6]Scenario	8	9	10	11	12	13	14
Quadrant 1	O-V	O-V	O-V	D	D	D	O-I
Quadrant 2	O-M	O-I	D	D	O-I	D	O-M
Quadrant 3	D	O-M	D	O-M	O-I	D	O-M
Quadrant 4	D	D	D	D	D	D	O-I
Hourly Average - Status	[2]I	[2]I	V	[2]I	I	[5]D	[2]I

Key:
In a clock hour:
Quadrant 1 – Minutes 1-15 Quadrant 2 – Minutes 16-30
Quadrant 3 – Minutes 31-45 Quadrant 4 – Minutes 46-60

D – Process Down (monitoring not required). Assume the process is down the entire quadrant.
I – Invalid (not maintenance). Assume data is invalid for the entire quadrant.
M – Invalid Maintenance (calibration, quality assurance activities, preventive maintenance activities, or backups of data from the data acquisition and handling system). Assume that maintenance took place during the entire quadrant and that no calibration error tests were failed.
O – Process Operating. Assume that the process was in operation during the entire quadrant.
V – Valid. Assume at least one minute of valid data during which the process was operating during the entire quadrant.

[1] Valid data readings from at least two points separated by a minimum of 15 minutes **existed** as required in 4.a. (above).
[2] Valid data readings from at least two points separated by a minimum of 15 minutes **did not exist** as required in 4.a. (above).
[3] During all valid hours, the hourly average would be calculated as: [Sum of valid one-minute averages] / [number of valid one-minute averages]
[4] For cases, in which the hour is invalid (no data substitution required), leave the emissions value blank, enter a process and monitoring code and use "NV" as the method of determination code when reporting quarterly emissions.
[5] The process did not operate during the hour.
[6] When data substitution is required, the hourly average would be calculated as: [Sum of one-minute averages]/60. Process down minutes would count as "0" and the data substituted value should be inserted for invalid minutes.

For an hour containing a failed calibration error test, a passed calibration error test may be used to prospectively validate data for the hour in which it is performed only if, after completion of the test, the minimum data requirements of Quality Assurance I.B.4.a of the Manual are met. All valid one-minute averages collected during the hour must be used to calculate the hourly averages.

In scenarios 15-22, it was assumed that there was a failed calibration error test during the hour in which maintenance was conducted.

[3, 4, 7]Scenario	15	16	17	18	19	20	21	22
Quadrant 1	O-V	O-V	O-V	O-V	[5]O-M	[6]O-M	[6]O-M	O-I
Quadrant 2	O-V	O-V	[5]O-M	[5]O-M	O-V	[5]O-M	[5]O-M	[5]O-M
Quadrant 3	D	D	O-V	O-V	D	O-V	O-V	O-V
Quadrant 4	[5]O-M	[6]O-M	O-V	O-V	D	O-V	O-V	O-V
Hourly Average - Status	[2]I	[2]I	[1]V	[2]I	[2]I	[1]V	[2]I	[1]V

Key:

D – Process Down (monitoring not required). Assume the process is down the entire quadrant.
I – Invalid (not maintenance). Assume data is invalid for the entire quadrant.
M – Invalid Maintenance (calibration, quality assurance activities, preventive maintenance activities, or backups of data from the data acquisition and handling system). Assume that maintenance took place during the entire quadrant
O – Process Operating. Assume that the process was in operation during the entire quadrant.
V – Valid. Assume at least one minute of valid data during which the process was operating during the entire quadrant.

[1] Valid data readings from at least two points separated by a minimum of 15 minutes **existed** after a passed calibration error test as required in 4.a. (above).
[2] Valid data readings from at least two points separated by a minimum of 15 minutes **did not exist** after a passed calibration error test as required in 4.a. (above).
[3] During all valid hours, the hourly average would be calculated as: [Sum of valid one-minute averages] / [number of valid one-minute averages]. When a daily calibration test is failed, the data from that monitor is prospectively invalidated, beginning with the hour of the test failure and ending when a subsequent daily calibration test is passed. Therefore, data collected before the failed daily calibration test would not be utilized in the calculation of the hourly average.
[4] For cases, in which the hour is invalid (no data substitution required), leave the emissions value blank, enter a process and monitoring code and use "NV" as the method of determination code when reporting quarterly emissions.
[5] The monitor initially failed a calibration error test then passed it after corrective maintenance.
[6] The monitor initially failed a calibration error test and did not pass a calibration error test.
[7] When data substitution is required, the hourly average would be calculated as: [Sum of one-minute averages]/60. Process down minutes would count as "0" and the data substituted value should be inserted for invalid minutes.

Example 2
With respect to Topic: Hourly average (page 64, 4.a. and 4.b):

Given the following scenario:

CEMS, CO PPM @ 15% O_2, Primary CEMS
Operational time – normal operation
No invalid data and the process operated the entire hour
Actual cycle time for CO = 5 minutes
Actual cycle time for O_2 = 15 minutes
Data for CO and O_2 is measured and recorded at different times and frequencies
Data substitution **is not** required for "invalid" hours

Minute	Pollutant		Minute	Pollutant		Minute	Pollutant	
	CO	O_2		CO	O_2		CO	O_2
1		15	21			41		
2	Cycle 1		22	Cycle 5		42	Cycle 9	
3			23			43		
4		Cycle 1	24		Cycle 2	44		
5	10		25	20		45	30	
6			26			46		16
7	Cycle 2		27	Cycle 6		47	Cycle 10	
8			28			48		
9			29			49		
10	10		30	20		50	30	
11			31		16	51		
12	Cycle 3		32	Cycle 7		52	Cycle 11	
13			33			53		
14			34		Cycle 3	54		Cycle 4
15	10		35	20		55	30	
16		15	36			56		
17	Cycle 4		37	Cycle 8		57	Cycle 12	
18			38			58		
19			39			59		
20	10		40	20		60	30	

Please note that in order to produce valid CO PPM @ 15% O_2 values, the underlying analyzer data (CO and O_2) must be valid.

The Manual stipulates that data for the CO analyzer can be utilized to calculate a valid monitoring system hourly average if it contains at least 75 percent of the segments of the hour corresponding to the "minimum required cycle time" (for measurement) during which the process was operating. According to Table IV of the Manual (Specifications for Carbon Monoxide Monitors), 12 cycles per hour (for measurement) are required if the process operates the entire hour. This equates to a "minimum cycle time" of 5 minutes (data segment) as identified by

yellow shaded vs. unshaded "Minutes". In the above example, the process operated during 12 cycles, corresponding to 12 data segments.

Data for CO would be considered valid, because it contains at least one valid one-minute average during at least 75% of the segments of the hour corresponding to the minimum required cycle time (for measurement) during which the process was operating.

$$\frac{\text{12 valid data segments in hour}}{\text{12 operating segments in the hour}} = 1 > 0.75; \text{therefore data for the hour is valid}$$

with,

$$\text{CO Hourly average} = \frac{[(4 * 10) + (4 * 20) + (4 * 30)]}{12} = 20\,\text{PPM}$$

The Manual stipulates that data from an O_2 analyzer can be used to calculate a valid monitoring system hourly average if at least one valid data reading (one-minute average) is obtained in each 15-min quadrant during which the process was operating as identified by grey shaded vs. unshaded "Minutes". **Data for O_2 would be considered valid** because it meets this stipulation.

with,

$$O_2 \text{ Hourly average} = \frac{(15 + 15 + 16 + 16)}{4} = 15.5\,\%$$

The hourly average for CO PPM @ 15% O_2 would be considered valid because the underlying analyzer data (for CO and O_2) is considered valid. The hourly average for the CEMS would be calculated as follows:

$$\text{CO PPM @ 15\% } O_2 \text{ Hourly average} = (\text{CO Hourly average}) * \left[\frac{5.9}{(20.9 - O_2 \text{ Hourly average})}\right]$$

$$= 20 * \left[\frac{5.9}{(20.9 - 15.5)}\right] = 21.9\,\text{PPM}$$

This would be considered a full hour of operation (process on) and should be reported with the above hourly average, PC=08, MC=00, and MDC=P.

If the above example was for a waste incinerator, **the hour would be considered valid, because the underlying analyzer data (for CO and O_2) is considered valid.** Keep in mind that for CO, it must contain at least one valid one-minute average during at least 90% of the segments of the hour corresponding to the minimum required cycle time (for measurement) during which the process was operating. The reporting would be the same as above.

$$\frac{\text{12 valid data segments in hour}}{\text{12 operating segments in the hour}} = 1 > 0.90; \text{therefore data for the hour is valid}$$

Example 3
With respect to Topic: Hourly average (page 64, 4.a. and 4.b.):

Given the following scenario:

CEMS, CO, lbs/hr, Primary CEMS
Contains a CO and O_2 analyzer and flow monitor
Operational time – normal operation
Actual cycle time = 1 minute
Minimum cycle time = 5 minutes
Invalid data time (primary analyzer malfunction) = 8 minutes
Process down = 30 minutes
Valid data = 22 minutes
Data substitution **is not** required for "invalid" hours

Minute	Value	Minute	Value	Minute	Value
1	20	21	10	41	0
2	20	22	10	42	0
3	20	23	10	43	0
4	20	24	10	44	0
5	20	25	10	45	0
6	Invalid	26	10	46	0
7	Invalid	27	10	47	0
8	Invalid	28	10	48	0
9	20	29	10	49	0
10	20	30	10	50	0
11	20	31	0	51	0
12	20	32	0	52	0
13	20	33	0	53	0
14	20	34	0	54	0
15	20	35	0	55	0
16	Invalid	36	0	56	0
17	Invalid	37	0	57	0
18	Invalid	38	0	58	0
19	Invalid	39	0	59	0
20	Invalid	40	0	60	0

Cycle 1 Valid
Cycle 2 Valid
Cycle 3 Valid
Cycle 4 Invalid
Cycle 5 Valid
Cycle 6 Valid
Cycle 7 Down
Cycle 8 Down
Cycle 9 Down
Cycle 10 Down
Cycle 11 Down
Cycle 12 Down

Please note that in order to produce minute CO lbs/hr values, the underlying analyzer data (CO, O_2 and flow) must be valid.

The Manual stipulates that data for the CO analyzer can be utilized to calculate a valid monitoring system hourly average if it contains at least 75 percent of the segments of the hour corresponding to the "minimum required cycle time" (for measurement) during which the process was operating. According to Table IV of the Manual (Specifications for Carbon Monoxide Monitors), 12 cycles per hour (for measurement) are required if the process operates the entire hour. This

equates to a “minimum cycle time” of 5 minutes (data segment) as identified by grey shaded vs. unshaded "Minutes". In the above example, the process operated during 6 cycles, corresponding to 6 data segments.

Data for CO would be considered valid, because it contains at least one valid one-minute average during at least 75% of the segments of the hour corresponding to the minimum required cycle time (for measurement) during which the process was operating.

$$\frac{\text{5 valid data segments in hour}}{\text{6 operating segments in the hour}} = 0.83 > 0.75; \text{therefore data for the hour is valid}$$

The Manual stipulates that data from an O_2 analyzer and flow monitor can be used to calculate a valid monitoring system hourly average if at least one valid data reading (one-minute average) is obtained in each 15-min quadrant during which the process was operating. **Data for O_2 and flow would be considered valid** because it meets this stipulation.

The hourly average for CO lbs/hr would be considered valid because the underlying data is considered valid. The hourly average for the CEMS would be calculated as follows:

$$\text{Hourly average} = \frac{\left[(12 * 20) + (10 * 10)\right]}{22} = 15.45 \frac{\text{lbs}}{\text{hr}}$$

This would be considered a partial hour of operation (no data substitution required) and should be reported with the above hourly average, PC=08, MC=00, and MDC=P.

If the above example was for a waste incinerator, **the hour would be considered invalid,** because it does not contain at least one valid one-minute average during at least 90% of the segments of the hour corresponding to the minimum required cycle time (for measurement) during which the process was operating for CO. An hourly average cannot be considered valid if the underlying data is not considered valid.

$$\frac{\text{5 valid data segments in hour}}{\text{6 operating segments in the hour}} = 0.83 < 0.90; \text{therefore data for the hour is invalid}$$

This would be considered a partial hour of operation (no data substitution required) and should be reported with the emissions value blank, PC=08, MC=16, and MDC=NV.

Example 4
With respect to Topic: Hourly average (page 64, 4.a. and 4.b.):

Given the following scenario:

CEMS, CO, lbs/hr, Primary CEMS
Contains a CO and O_2 analyzer and flow monitor
Operational time – normal operation
Actual cycle time = 1 minute
Minimum cycle time = 5 minutes
Invalid data time (primary analyzer malfunction) = 21 minutes
Process down = 17 minutes
Valid data = 22 minutes
Data substitution **is** required for "invalid" hours
Data substituted value = 50 lbs/hr

Minute	Value	Minute	Value	Minute	Value
1	20	21	10	41	50
2	20	22	10	42	50
3	20	23	10	43	50
4	20	24	10	44	0
5	20	25	10	45	0
6	50	26	10	46	0
7	50	27	10	47	0
8	50	28	10	48	0
9	20	29	10	49	0
10	20	30	10	50	0
11	20	31	50	51	0
12	20	32	50	52	0
13	20	33	50	53	0
14	20	34	50	54	0
15	20	35	50	55	0
16	50	36	50	56	0
17	50	37	50	57	0
18	50	38	50	58	0
19	50	39	50	59	0
20	50	40	50	60	0

Cycle 1 Valid
Cycle 2 Valid
Cycle 3 Valid
Cycle 4 Invalid
Cycle 5 Valid
Cycle 6 Valid
Cycle 7 Invalid
Cycle 8 Invalid
Cycle 9 Invalid
Cycle 10 Down
Cycle 11 Down
Cycle 12 Down

Please note that in order to produce minute CO lbs/hr values, the underlying analyzer data (CO, O_2 and flow) must be valid.

The Manual stipulates that data for the CO analyzer can be utilized to calculate a valid monitoring system hourly average if it contains at least 75 percent of the segments of the hour corresponding to the "minimum required cycle time" (for measurement) during which the process was operating. According to Table IV of the Manual (Specifications for Carbon Monoxide Monitors), 12 cycles per hour

(for measurement) are required if the process operates the entire hour. This equates to a “minimum cycle time” of 5 minutes (data segment) as identified by grey shaded vs. unshaded "Minutes". In the above example, the process operated during 9 cycles, corresponding to 9 data segments.

Data for CO would be considered invalid, because it does not contain at least one valid one-minute average during at least 75% of the segments of the hour corresponding to the minimum required cycle time (for measurement) during which the process was operating. **The hourly average would be considered invalid because data from the CO analyzer is invalid.**

$$\frac{5 \text{ valid data segments in hour}}{9 \text{ operating segments in the hour}} = 0.55 < 0.75; \text{ therefore data for the hour is invalid}$$

an hourly average would need to be reported because data substitution is required.

$$\text{Hourly average} = \frac{[(17 * 0) + (12 * 20) + (10 * 10) + (21 * 50)]}{60} = 23.17 \frac{\text{lbs}}{\text{hr}}$$

This would be considered a partial hour of operation (data substitution required) and should be reported with the above hourly average, PC=08, MC=16, and MDC=DA (assuming this is a Department agreed data substitution method).

If the above example was for a waste incinerator, **the hour would be considered invalid,** because it does not contain at least one valid one-minute average during at least 90% of the segments of the hour corresponding to the minimum required cycle time (for measurement) during which the process was operating for CO. An hourly average cannot be considered valid if the underlying data is not considered valid.

$$\frac{5 \text{ valid data segments in hour}}{9 \text{ operating segments in the hour}} = 0.55 < 0.90; \text{ therefore data for the hour is invalid}$$

Data substitution is **not currently** required for pollutants of incinerators. Therefore, this would be considered a partial hour of operation (no data substitution required) and should be reported with the emissions value blank, PC=08, MC=16, and MDC=NV.

Example 5
With respect to Topic: Hourly average (page 64, 4.a. and 4.b.):

Given the following scenario:

CEMS, CO, lbs/hr, Stand-by CEMS
Contains a CO and O_2 analyzer and flow monitor
Dominating process condition – In the process of changing fuels
Actual cycle time = 1 minute
Minimum cycle time = 5 minutes
Invalid data time (data handling system malfunction) = 18 minutes
Process down = 18 minutes
Valid data = 24 minutes
Data substitution **is not** required for "invalid" hours

Minute	Value	Minute	Value	Minute	Value
1	20	21	10	41	25
2	20	22	10	42	25
3	20	23	10	43	0
4	20	24	10	44	0
5	20	25	10	45	0
6	Invalid	26	10	46	0
7	Invalid	27	10	47	0
8	Invalid	28	10	48	0
9	20	29	10	49	0
10	20	30	10	50	0
11	20	31	Invalid	51	0
12	20	32	Invalid	52	0
13	20	33	Invalid	53	0
14	20	34	Invalid	54	0
15	20	35	Invalid	55	0
16	Invalid	36	Invalid	56	0
17	Invalid	37	Invalid	57	0
18	Invalid	38	Invalid	58	0
19	Invalid	39	Invalid	59	0
20	Invalid	40	Invalid	60	0

Cycle 1 Valid
Cycle 2 Valid
Cycle 3 Valid
Cycle 4 Invalid
Cycle 5 Valid
Cycle 6 Valid
Cycle 7 Invalid
Cycle 8 Invalid
Cycle 9 Valid
Cycle 10 Down
Cycle 11 Down
Cycle 12 Down

Please note that in order to produce minute CO lbs/hr values, the underlying analyzer data (CO, O_2 and flow) must be valid.

The Manual stipulates that data for the CO analyzer can be utilized to calculate a valid monitoring system hourly average if it contains at least 75 percent of the segments of the hour corresponding to the "minimum required cycle time" (for measurement) during which the process was operating. According to Table IV of the Manual (Specifications for Carbon Monoxide Monitors), 12 cycles per hour (for measurement) are required if the process operates the entire hour. This

equates to a “minimum cycle time” of 5 minutes (data segments) as identified by grey shaded vs. unshaded "Minutes". In the above example, the process operated during 9 cycles, corresponding to 9 data segments.

Data for CO would be considered invalid, because it does not contain at least one valid one-minute average during at least 75% of the segments of the hour corresponding to the minimum required cycle time (for measurement) during which the process was operating. **The hourly average would be considered invalid because data from the CO analyzer is invalid.**

$$\frac{6 \text{ valid data segments in hour}}{9 \text{ operating segments in the hour}} = 0.67 < 0.75; \text{ therefore data for the hour is invalid}$$

This would be considered a partial hour of operation (no data substitution required) and should be reported with the emissions value blank, PC=01, MC=14, and MDC=NV.

If the above example was for a waste incinerator, **the hour would be considered invalid,** because it does not contain at least one valid one-minute average during at least 90% of the segments of the hour corresponding to the minimum required cycle time (for measurement) during which the process was operating for CO. An hourly average cannot be considered valid if the underlying data is not considered valid. The reporting would be unchanged from the above solution.

$$\frac{6 \text{ valid data segments in hour}}{9 \text{ operating segments in the hour}} = 0.67 < 0.90; \text{ therefore data for the hour is invalid}$$

Example 6
With respect to Topic: Hourly average (page 64, 4.a. and 4.b.):

Given the following scenario:

CEMS, CO, lbs/hr, Primary CEMS
Contains a CO and O_2 analyzer and flow monitor
Operating condition – normal operation
Actual cycle time = 1 minute
Minimum cycle time = 5 minutes
Invalid data time (primary analyzer malfunction) = 11 minutes
Process down = 18 minutes
Valid data = 31 minutes
Data substitution **is** required for "invalid" hours
Data substituted value = 50 lbs/hr

Minute	Value	Minute	Value	Minute	Value
1	20	21	10	41	50
2	20	22	10	42	25
3	20	23	10	43	0
4	20	24	10	44	0
5	20	25	10	45	0
6	20	26	10	46	0
7	20	27	10	47	0
8	20	28	10	48	0
9	20	29	10	49	0
10	20	30	10	50	0
11	20	31	50	51	0
12	20	32	50	52	0
13	20	33	50	53	0
14	20	34	50	54	0
15	20	35	50	55	0
16	20	36	50	56	0
17	20	37	50	57	0
18	20	38	50	58	0
19	20	39	50	59	0
20	20	40	50	60	0

Cycle 1 Valid
Cycle 2 Valid
Cycle 3 Valid
Cycle 4 Valid
Cycle 5 Valid
Cycle 6 Valid
Cycle 7 Invalid
Cycle 8 Invalid
Cycle 9 Valid
Cycle 10 Down
Cycle 11 Down
Cycle 12 Down

Please note that in order to produce minute CO lbs/hr values, the underlying analyzer data (CO, O2 and flow) must be valid.

The Manual stipulates that data for the CO analyzer can be utilized to calculate a valid monitoring system hourly average if it contains at least 75 percent of the segments of the hour corresponding to the "minimum required cycle time" (for measurement) during which the process was operating. According to Table IV of the Manual (Specifications for Carbon Monoxide Monitors), 12 cycles per hour

(for measurement) are required if the process operates the entire hour. This equates to a “minimum cycle time” of 5 minutes (data segments) as identified by grey shaded vs. unshaded "Minutes". In the above example, the process operated during 9 cycles, corresponding to 9 data segments.

Data for CO would be considered valid, because it contains at least one valid one-minute average during at least 75% of the segments of the hour corresponding to the minimum required cycle time (for measurement) during which the process was operating.

$$\frac{7 \text{ valid data segments in hour}}{9 \text{ operating segments in the hour}} = 0.78 > 0.75; \text{ therefore data for the hour is valid}$$

The Manual stipulates that data from an O_2 analyzer and flow monitor can be used to calculate a valid monitoring system hourly average if at least one valid data reading (one-minute average) is obtained in each 15-min quadrant during which the process was operating. **Data for O_2 and flow would be considered valid** because it meets this stipulation.

The hourly average for CO lbs/hr would be considered valid because the underlying data is considered valid. The hourly average for the CEMS would be calculated as follows:

$$\text{Hourly average} = \frac{[(20 * 20) + (10 * 10) + (1 * 25)]}{31} = 16.94 \frac{\text{lbs}}{\text{hr}}$$

This would be considered a partial hour of operation and should be reported with the above hourly average, PC=08, MC=00, and MDC=P.

If the above example was for a waste incinerator, **the hour would be considered invalid,** because it does not contain at least one valid one-minute average during at least 90% of the segments of the hour corresponding to the minimum required cycle time (for measurement) during which the process was operating for CO. An hourly average cannot be considered valid if the underlying data is not considered valid.

$$\frac{7 \text{ valid data segments in hour}}{9 \text{ operating segments in the hour}} = 0.78 < 0.90;$$

therefore data for the hour is invalid

Data substitution is **not currently** required for pollutants of incinerators. Therefore, this would be considered a partial hour of operation (no data substitution required) and should be reported with the emissions value blank, PC=08, MC=16, and MDC=NV.

Example 7
Applicable for those pollutants/parameters where the minimum required cycle time is one-minute (opacity, temperature, etc.)

[1, 2]Scenario	1	2	3	4	5	6	7
Process Down minutes	0	0	0	2	2	16	25
Invalid minutes	0	15	16	16	14	0	18
Operating minutes	60	60	60	58	58	44	35
Valid minutes	60	45	44	42	44	44	17
% Operating time valid	100	75	73	72	76	100	49
Hourly Average - Status	[3]Valid	[3]Valid	[4]Invalid	[4]Invalid	[3]Valid	[3]Valid	[4]Invalid

[1, 2]Scenario	8	9	10	11	12	13	14
Process Down minutes	16	30	16	16	55	55	60
Invalid minutes	16	15	6	17	0	5	0
Operating minutes	44	30	44	44	5	5	0
Valid minutes	28	15	38	27	5	0	0
% Operating time valid	64	50	86	61	100	0	0
Hourly Average - Status	[4]Invalid	[4]Invalid	[3]Valid	[4]Invalid	[3]Valid	[4]Invalid	[5]Process Down

Key:

[1] During all valid hours, the hourly average would be calculated as: [Sum of valid one-minute averages] / [number of valid one-minute averages]
[2] For cases, in which the hour is invalid (no data substitution required), leave the emissions value blank, enter a process and monitoring code and use "NV" as the method of determination code.
[3] At least 75% of the one-minute averages for the hour during which the process was operating are contained in the hour.
[4] Less than 75% of the one-minute averages for the hour during which the process was operating are contained in the hour.
[5] The process did not operate during the hour.