device is recommended when blending span gases diluted in N\textsubscript{2} with span gases diluted in air. You may use a multi-gas span gas, such as NO-CO-CO\textsubscript{2}-C\textsubscript{3}H\textsubscript{8}-CH\textsubscript{4}, to verify multiple analyzers at the same time. If you use standard binary span gases, you must run separate response tests for each analyzer. In designing your experimental setup, avoid pressure pulsations due to stopping the flow through the gas-blending device.

(3) **Data collection.** (i) Start the flow of zero gas.

(ii) Allow for stabilization, accounting for transport delays and the slowest analyzer’s full response.

(iii) Start recording data. For this verification you must record data at a frequency greater than or equal to that of the updating-recording frequency used during emission testing. You may not use interpolation or filtering to alter the recorded values.

(iv) Switch the flow to allow the blended span gases to flow to the analyzer. If you intend to use the data from this test to determine \( t_{50} \) for time alignment, record this time as \( t_{50} \).

(v) Allow for transport delays and the slowest analyzer’s full response.

(vi) Switch the flow to allow zero gas to flow to the analyzer. If you intend to use the data from this test to determine \( t_{50} \) for time alignment, record this time as \( t_{100} \).

(vii) Allow for transport delays and the slowest analyzer’s full response.

(viii) Repeat the steps in paragraphs (d)(3)(iv) through (vii) of this section to record seven full cycles, ending with zero gas flowing to the analyzers.

(ix) Stop recording.

(e) **Performance evaluation.** (1) If you choose to demonstrate compliance with paragraph (c)(1) of this section, use the data from paragraph (d)(3) of this section to calculate the mean rise time, \( t_{10-90} \), and mean fall time, \( t_{90-10} \), for each of the analyzers being verified. You may use interpolation between recorded values to determine rise and fall times. If the recording frequency used during emission testing is different from the analyzer’s output update frequency, you must use the lower of these two frequencies for this verification. Multiply these times (in seconds) by their respective updating-recording frequencies in Hertz (1/second). The resulting product must be at least 5 for both rise time and fall time. If either value is less than 5, increase the updating-recording frequency, or adjust the flows or design of the sampling system to increase the rise time and fall time as needed. You may also configure analog or digital filters before recording to increase rise and fall times. In no case may the mean rise time or mean fall time be greater than 10 seconds.

(2) If a measurement system fails the criterion in paragraph (e)(1) of this section, ensure that signals from the system are updated and recorded at a frequency of at least 5 Hz. In no case may the mean rise time or mean fall time be greater than 10 seconds.

(3) If a measurement system fails the criteria in paragraphs (e)(1) and (2) of this section, you may use the measurement system only if the deficiency does not adversely affect your ability to show compliance with the applicable standards.

(f) **Transformation time, \( t_{50} \), determination.** If you choose to determine \( t_{50} \) for purposes of time alignment using data generated in paragraph (d)(3) of this section, calculate the mean \( t_{10-50} \) and the mean \( t_{90-50} \) from the recorded data. Average these two values to determine the final \( t_{50} \) for the purposes of time alignment in accordance with §1065.650(c)(2)(1).

[73 FR 59325, Oct. 8, 2008]

§ 1065.309 Continuous gas analyzer system-response and updating-recording verification—for gas analyzers continuously compensated for other gas species.

(a) **Scope and frequency.** This section describes a verification procedure for system response and updating-recording frequency for continuous gas analyzers that output a single gas species mole fraction (i.e., concentration) based on a continuous combination of multiple gas species measured with multiple detectors (i.e., gas analyzers continuously compensated for other gas species). See §1065.308 for verification procedures that apply to continuous gas analyzers that are not continuously compensated for other
gas species or that use only one detector for gaseous species. Perform this verification to determine the system response of the continuous gas analyzer and its sampling system. This verification is required for continuous gas analyzers used for transient or ramped-modal testing. You need not perform this verification for batch gas analyzers or for continuous gas analyzers that are used only for discrete-mode testing. For this check we consider water vapor a gaseous constituent. This verification does not apply to any processing of individual analyzer signals that are time aligned to their $t_{50}$ times and were verified according to §1065.308. For example, this verification does not apply to correction for water removed from the sample done in post-processing according to §1065.659 and it does not apply to NMHC determination from THC and CH$_4$ according to §1065.660. Perform this verification after initial installation (i.e., test cell commissioning) and after any modifications to the system that would change the system response.

(b) Measurement principles. This procedure verifies that the updating and recording frequencies match the overall system response to a rapid change in the value of concentrations at the sample probe. It indirectly verifies the time-alignment and uniform response of all the continuous gas detectors used to generate a continuously combined/compen-sated concentration measurement signal. Gas analyzer systems must be optimized such that their overall response to rapid change in concentration is updated and recorded at an appropriate frequency to prevent loss of information. This test also verifies that the measurement system meets a minimum response time. For this procedure, ensure that all compensation algorithms and humidity corrections are turned on. You may use the results of this test to determine $t_{50}$ for the purposes of time alignment of continuous data in accordance with §1065.650(c)(2)(i). You may also use an alternate procedure to determine $t_{50}$ consistent with good engineering judgment. Note that any such procedure for determining $t_{50}$ must account for both transport delay and analyzer response time.

(c) System requirements. Demonstrate that each continuously combined/compen-sated concentration measurement has adequate updating and recording frequencies and has a minimum rise time and a minimum fall time during a system response to a rapid change in multiple gas concentrations, including H$_2$O concentration if H$_2$O compensation is applied. You must meet one of the following criteria:

(1) The product of the mean rise time, $t_{10-90}$, and the frequency at which the system records an updated concentration must be at least 5, and the product of the mean fall time, $t_{90-10}$, and the frequency at which the system records an updated concentration must be at least 5. If the recording frequency is different than the update frequency of the continuously combined/compen-sated signal, you must use the lower of these two frequencies for this verification. This criterion makes no assumption regarding the frequency content of changes in emission concentrations during emission testing; therefore, it is valid for any testing. Also, the mean rise time must be at or below 10 seconds and the mean fall time must be at or below 10 seconds.

(2) The frequency at which the system records an updated concentration must be at least 5 Hz. This criterion assumes that the frequency content of significant changes in emission concentrations during emission testing does not exceed 1 Hz. Also, the mean rise time must be at or below 10 seconds and the mean fall time must be at or below 10 seconds.

(3) You may use other criteria if we approve them in advance.

(4) You may meet the overall PEMS verification in §1065.920 instead of the verification in this section for field testing with PEMS.

(d) Procedure. Use the following procedure to verify the response of each continuously compensated analyzer (verify the combined signal, not each individual continuously combined concentration signal):
(1) Instrument setup. Follow the analyzer manufacturer’s start-up and operating instructions. Adjust the measurement system as needed to optimize performance. Run this verification with the analyzer operating in the same manner you will use for emission testing. If the analyzer shares its sampling system with other analyzers, and if gas flow to the other analyzers will affect the system response time, then start up and operate the other analyzers while running this verification test. You may run this verification test on multiple analyzers sharing the same sampling system at the same time. If you use any analog or real-time digital filters during emission testing, you must operate those filters in the same manner during this verification.

(2) Equipment setup. We recommend using minimal lengths of gas transfer lines between all connections and fast-acting three-way valves (2 inlets, 1 outlet) to control the flow of zero and blended span gases to the sample system’s probe inlet or a tee near the outlet of the probe. Normally the gas flow rate is higher than the probe sample flow rate and the excess is overflowed out the inlet of the probe. If the gas flow rate is lower than the probe flow rate, the gas concentrations must be adjusted to account for the dilution from ambient air drawn into the probe. Select span gases for the species being continuously combined, other than the species containing the compound of interest. Select concentrations of compensating species that will yield concentrations of these species at the analyzer inlet that covers the range of concentrations expected during testing. You may use binary or multi-gas span gases. You may use a gas blending or mixing device to blend span gases. A gas blending or mixing device is recommended when blending span gases diluted in N₂ with span gases diluted in air. You may use a multi-gas span gas, such as NO-CO-CO₂-C₃H₈-CH₄, to balance N₂ blended gas by flowing the gas mixture through a sealed vessel that humidifies the gas by bubbling it through distilled water and then mixing the gas with dry NO₂ gas, balance purified synthetic air. If your system does not use a sample dryer to remove water from the sample gas, you must humidify your span gas to the highest sample H₂O content that you estimate during emission sampling. If your system uses a sample dryer during testing, it must pass the sample dryer verification check in §1065.342, and you must humidify your span gas to an H₂O content greater than or equal to the level determined in §1065.145(e)(2). If you are humidifying span gases without NO₂, use good engineering judgment to ensure that the wall temperatures in the transfer lines, fittings, and valves from the humidifying system to the probe are above the dewpoint required for the target H₂O content. If you are humidifying span gases with NO₂, use good engineering judgment to ensure that there is no condensation in the transfer lines, fittings, or valves from the point where humidified gas is mixed with NO₂ span gas to the probe. We recommend that you design your setup so that the wall temperatures in the transfer lines, fittings, and valves from the humidifying system to the probe are at least 5 °C above the local sample gas dewpoint. Operate the measurement and sample handling system as you do for emission testing. Make no modifications to the sample handling system to reduce the risk of condensation. Flow humidified gas through the sampling system before this check to allow stabilization of the measurement system’s sampling handling system to occur, as it would for an emission test.

(3) Data collection. (i) Start the flow of zero gas. (ii) Allow for stabilization, accounting for transport delays and the slowest analyzer’s full response. (iii) Start recording data. For this verification you must record data at a frequency greater than or equal to that of the updating-recording frequency.
used during emission testing. You may not use interpolation or filtering to alter the recorded values.

(iv) Switch the flow to allow the blended span gases to flow to the analyzer. If you intend to use the data from this test to determine \( t_{50} \) for time alignment, record this time as \( t_{0} \).

(v) Allow for transport delays and the slowest analyzer’s full response.

(vi) Switch the flow to allow zero gas to flow to the analyzer. If you intend to use the data from this test to determine \( t_{50} \) for time alignment, record this time as \( t_{100} \).

(vii) Allow for transport delays and the slowest analyzer’s full response.

(viii) Repeat the steps in paragraphs (d)(3)(iv) through (vii) of this section to record seven full cycles, ending with zero gas flowing to the analyzers.

(ix) Stop recording.

(e) Performance evaluations. (1) If you choose to demonstrate compliance with paragraph (c)(1) of this section, use the data from paragraph (d)(3) of this section to calculate the mean rise time, \( t_{10–90} \), and mean fall time, \( t_{90–10} \), for the continuously combined signal from each analyzer being verified. You may use interpolation between recorded values to determine rise and fall times. If the recording frequency used during emission testing is different from the analyzer’s output update frequency, you must use the lower of these two frequencies for this verification. Multiply these times (in seconds) by their respective updating-recording frequencies in Hz (1/second). The resulting product must be at least 5 for both rise time and fall time. If either value is less than 5, increase the recording frequency used during emission testing by at least 10 times.

(2) If a measurement system fails the criteria in paragraphs (e)(1) and (2) of this section, you may use the measurement system only if the deficiency does not adversely affect your ability to show compliance with the applicable standards.

(f) Transformation time, \( t_{50} \), determination. If you choose to determine \( t_{50} \) for purposes of time alignment using data generated in paragraph (d)(3) of this section, calculate the mean \( t_{0–50} \) and the mean \( t_{90–50} \) from the recorded data. Average these two values to determine the final \( t_{50} \) for the purposes of time alignment in accordance with §1065.650(c)(2)(i).

§ 1065.310 Torque calibration.

(a) Scope and frequency. Calibrate all torque-measurement systems including dynamometer torque measurement transducers and systems upon initial installation and after major maintenance. Use good engineering judgment to repeat the calibration. Follow the torque transducer manufacturer’s instructions for linearizing your torque sensor’s output. We recommend that you calibrate the torque-measurement system with a reference force and a lever arm.

(b) Recommended procedure. (1) Reference force quantification. Use either a set of dead-weights or a reference meter such as strain gage or a proving ring to quantify the reference force, NIST-traceable within \( \pm 0.5\% \) uncertainty.

(2) Lever-arm length quantification. Quantify the lever arm length, NIST-traceable within \( \pm 0.5\% \) uncertainty. The lever arm’s length must be measured from the centerline of the dynamometer to the point at which the reference force is measured. The lever arm must be perpendicular to gravity (i.e., horizontal), and it must be perpendicular to the dynamometer’s rotational axis. Balance the lever arm’s torque or quantify its net hanging torque, NIST-traceable within \( \pm 1\% \) uncertainty, and account for it as part of the reference torque.