

(1) Seal the probe end of the system as close to the probe opening as possible by taking one of the following steps:

- (i) Cap or plug the end of the sample probe.
- (ii) Disconnect the transfer line at the probe and cap or plug the transfer line.
- (iii) Close a leak-tight valve in-line between a probe and transfer line.

(2) Operate all vacuum pumps. Draw a vacuum that is representative of normal operating conditions. In the case of sample bags, we recommend that you repeat your normal sample bag pump-down procedure twice to minimize any trapped volumes.

(3) Turn off the sample pumps and seal the system. Measure and record the absolute pressure of the trapped gas and optionally the system absolute temperature. Wait long enough for any transients to settle and long enough for a leak at 0.5% to have caused a pressure change of at least 10 times the resolution of the pressure transducer, then again record the pressure and optionally temperature.

(4) Calculate the leak flow rate based on an assumed value of zero for pumped-down bag volumes and based on known values for the sample system volume, the initial and final pressures, optional temperatures, and elapsed time. Using the calculations specified in 1065.644, verify that the vacuum-decay leak flow rate is less than 0.5% of the system's normal in-use flow rate.

CO AND CO₂ MEASUREMENTS

§ 1065.350 H₂O interference verification for CO₂ NDIR analyzers.

(a) *Scope and frequency.* If you measure CO₂ using an NDIR analyzer, verify the amount of H₂O interference after initial analyzer installation and after major maintenance.

(b) *Measurement principles.* H₂O can interfere with an NDIR analyzer's response to CO₂.

If the NDIR analyzer uses compensation algorithms that utilize measurements of other gases to meet this interference verification, simultaneously conduct these other measurements to test the compensation algorithms during the analyzer interference verification.

(c) *System requirements.* A CO₂ NDIR analyzer must have an H₂O interference that is within ±2% of the flow-weighted mean CO₂ concentration expected at the standard, though we strongly recommend a lower interference that is within ±1%.

(d) *Procedure.* Perform the interference verification as follows:

(1) Start, operate, zero, and span the CO₂ NDIR analyzer as you would before an emission test.

(2) Create a water-saturated test gas by bubbling zero air that meets the specifications in §1065.750 through distilled water in a sealed vessel at (25 ±10) °C.

(3) Introduce the water-saturated test gas upstream of any sample dryer, if one is used during testing.

(4) Allow time for the analyzer response to stabilize. Stabilization time may include time to purge the transfer line and to account for analyzer response.

(5) While the analyzer measures the sample's concentration, record 30 seconds of sampled data. Calculate the arithmetic mean of this data. The analyzer meets the interference verification if this value is within ±2% of the flow-weighted mean concentration of CO₂ expected at the standard.

(e) *Exceptions.* The following exceptions apply:

(1) You may omit this verification if you can show by engineering analysis that for your CO₂ sampling system and your emission-calculation procedures, the H₂O interference for your CO₂ NDIR analyzer always affects your brake-specific emission results within ±0.5% of each of the applicable standards.

(2) You may use a CO₂ NDIR analyzer that you determine does not meet this verification, as long as you try to correct the problem and the measurement deficiency does not adversely affect your ability to show that engines comply with all applicable emission standards.

EFFECTIVE DATE NOTE: At 73 FR 37308, June 30, 2008, §1065.355 was amended by revising paragraphs (c) and (d), effective July 7, 2008. For the convenience of the user, the revised text is set forth as follows:

§ 1065.350 H₂O interference verification for CO₂ NDIR analyzers.

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(c) *System requirements.* A CO₂ NDIR analyzer must have an H₂O interference that is within (0.0 ±0.4) mmol/mol, though we strongly recommend a lower interference that is within (0.0 ±0.2) mmol/mol.

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(d) *Procedure.* Perform the interference verification as follows:

(1) Start, operate, zero, and span the CO₂ NDIR analyzer as you would before an emission test.

(2) Create a humidified test gas by bubbling zero air that meets the specifications in §1065.750 through distilled water in a sealed vessel. If the sample is not passed through a dryer, control the vessel temperature to generate an H₂O level at least as high as the maximum expected during testing. If the sample is passed through a dryer during testing, control the vessel temperature to generate an H₂O level at least as high as the level determined in §1065.145(d)(2).

(3) Introduce the humidified test gas into the sample system. You may introduce it downstream of any sample dryer, if one is used during testing.

(4) Measure the humidified test gas dewpoint, T_{dew} , and pressure, p_{total} , as close as possible to the inlet of the analyzer.

(5) Downstream of the vessel, maintain the humidified test gas temperature at least 5 °C above its dewpoint.

(6) Allow time for the analyzer response to stabilize. Stabilization time may include time to purge the transfer line and to account for analyzer response.

(7) While the analyzer measures the sample's concentration, record 30 seconds of sampled data. Calculate the arithmetic mean of this data. The analyzer meets the interference verification if this value is within (0 ±0.4) mmol/mol.

§ 1065.355 H₂O and CO₂ interference verification for CO NDIR analyzers.

(a) *Scope and frequency.* If you measure CO using an NDIR analyzer, verify the amount of H₂O and CO₂ interference after initial analyzer installation and after major maintenance.

(b) *Measurement principles.* H₂O and CO₂ can positively interfere with an NDIR analyzer by causing a response similar to CO. If the NDIR analyzer uses compensation algorithms that utilize measurements of other gases to meet this interference verification, simultaneously conduct these other measurements to test the compensation algorithms during the analyzer interference verification.

(c) *System requirements.* A CO NDIR analyzer must have combined H₂O and CO₂ interference that is within ±2 % of the flow-weighted mean concentration of CO expected at the standard, though we strongly recommend a lower interference that is within ±1%.

(d) *Procedure.* Perform the interference verification as follows:

(1) Start, operate, zero, and span the CO NDIR analyzer as you would before an emission test.

(2) Create a water-saturated CO₂ test gas by bubbling a CO₂ span gas through distilled water in a sealed vessel at (25 ±10) °C.

(3) Introduce the water-saturated CO₂ test gas upstream of any sample dryer, if one is used during testing.

(4) Allow time for the analyzer response to stabilize. Stabilization time may include time to purge the transfer line and to account for analyzer response.

(5) While the analyzer measures the sample's concentration, record its output for 30 seconds. Calculate the arithmetic mean of this data.

(6) Multiply this mean value by the ratio of expected CO₂ to span gas CO₂ concentration. In other words, estimate the flow-weighted mean dry concentration of CO₂ expected during testing, and then divide this value by the concentration of CO₂ in the span gas used for this verification. Then multiply this ratio by the mean value recorded during this verification.

(7) The analyzer meets the interference verification if the result of paragraph (d)(6) of this section is within ±2 % of the flow-weighted mean concentration of CO expected at the standard.

(e) *Exceptions.* The following exceptions apply:

(1) You may omit this verification if you can show by engineering analysis that for your CO sampling system and your emission calculations procedures, the combined CO₂ and H₂O interference for your CO NDIR analyzer always affects your brake-specific CO emission results within ±0.5 % of the applicable CO standard.

(2) You may use a CO NDIR analyzer that you determine does not meet this verification, as long as you try to correct the problem and the measurement deficiency does not adversely affect your ability to show that engines comply with all applicable emission standards.

EFFECTIVE DATE NOTE: At 73 FR 37308, June 30, 2008, §1065.355 was amended by revising paragraph (d), effective July 7, 2008. For the