

(2) Start and operate the nonmethane cutter according to the manufacturer's instructions, including any temperature optimization.

(3) Confirm that the FID analyzer meets all the specifications of § 1065.360.

(4) Start and operate the FID analyzer according to the manufacturer's instructions.

(5) Zero and span the FID as you would during emission testing. Span the FID with CH₄ span gas by bypassing the cutter. Note that you must span the FID on a C₁ basis. For example, if your span gas has a methane reference value of 100 µmol/mol, the correct FID response to that span gas is 100 µmol/mol because there is one carbon atom per CH₄ molecule.

(6) Introduce the C₂H₆ analytical gas mixture upstream of the nonmethane cutter at the same point the zero gas was introduced.

(7) Allow time for the analyzer response to stabilize. Stabilization time may include time to purge the nonmethane cutter and to account for the analyzer's response.

(8) While the analyzer measures a stable concentration, record 30 seconds of sampled data. Calculate the arithmetic mean of these data points.

(9) Reroute the flow path to bypass the nonmethane cutter, introduce the C₂H₆ analytical gas mixture to the bypass, and repeat the steps in paragraphs (e)(7) and (8) of this section.

(10) Divide the mean C₂H₆ concentration measured through the nonmethane cutter by the mean concentration measured after bypassing the nonmethane cutter. The result is the C₂H₆ combined response factor and penetration fraction, $RFPF_{C_2H_6[NMC-FID]}$. Use this combined response factor and penetration fraction according to § 1065.660(b)(2)(iii) or § 1065.665, as applicable.

(11) Repeat the steps in paragraphs (e)(6) through (10) of this section, but with the CH₄ analytical gas mixture instead of C₂H₆. The result will be the CH₄ penetration fraction, $PF_{CH_4[NMC-FID]}$. Use this penetration fraction according to § 1065.660(b)(2)(iii) or § 1065.665, as applicable.

NO_x MEASUREMENTS

§ 1065.370 CLD CO₂ and H₂O quench verification.

(a) *Scope and frequency.* If you use a CLD analyzer to measure NO_x, verify the amount of H₂O and CO₂ quench after installing the CLD analyzer and after major maintenance.

(b) *Measurement principles.* H₂O and CO₂ can negatively interfere with a CLD's NO_x response by collisional quenching, which inhibits the chemiluminescent reaction that a CLD utilizes to detect NO_x. The calculations

in § 1065.672 for H₂O quench account for the water vapor in humidified NO span gas. The procedure and the calculations scale the quench results to the water vapor and CO₂ concentrations expected during testing. If the CLD analyzer uses quench compensation algorithms that utilize H₂O and/or CO₂ measurement instruments, use these instruments to measure H₂O and/or CO₂ and evaluate quench with the compensation algorithms applied.

(c) *System requirements.* A CLD analyzer must have a combined H₂O and CO₂ quench of ±2% or less, though we strongly recommend a quench of ±1% or less. Combined quench is the sum of the CO₂ quench determined as described in paragraph (d) of this section, plus the H₂O quench determined in paragraph (e) of this section.

(d) *CO₂ quench verification procedure.* Use the following method to determine CO₂ quench, or use good engineering judgment to develop a different protocol:

(1) Use PTFE tubing to make necessary connections.

(2) Connect a pressure-regulated CO₂ span gas to one of the inlets of a three-way valve made of 300 series stainless steel. Use a CO₂ span gas that meets the specifications of § 1065.750 and attempt to use a concentration that is approximately twice the maximum CO₂ concentration expected to enter the CLD sample port during testing, if available.

(3) Connect a pressure-regulated purified N₂ gas to the valve's other inlet. Use a purified N₂ gas that meets the specifications of § 1065.750.

(4) Connect the valve's single outlet to the balance-gas port of a gas divider that meets the specifications in § 1065.248.

(5) Connect a pressure-regulated NO span gas to the span-port of the gas divider. Use an NO span gas that meets the specifications of § 1065.750. Attempt to use an NO concentration that is approximately twice the maximum NO concentration expected during testing, if available.

(6) Configure the gas divider such that nearly equal amounts of the span gas and balance gas are blended with each other. Apply viscosity corrections

as necessary to appropriately ensure correct gas division.

(7) While flowing balance and span gases through the gas divider, stabilize the CO₂ concentration downstream of the gas divider and measure the CO₂ concentration with an NDIR analyzer that has been prepared for emission testing. Record this concentration, $x_{\text{CO}_2\text{meas}}$, and use it in the quench verification calculations in §1065.675.

(8) Measure the NO concentration downstream of the gas divider. If the CLD has an operating mode in which it detects NO-only, as opposed to total NO_x, operate the CLD in the NO-only operating mode. Record this concentration, $x_{\text{NO,CO}_2}$, and use it in the quench verification calculations in §1065.675.

(9) Switch the three-way valve so 100% purified N₂ flows to the gas divider's balance-port inlet. Monitor the CO₂ at the gas divider's outlet until its concentration stabilizes at zero.

(10) Measure NO concentration at the gas divider's outlet. Record this value, $x_{\text{NO,N}_2}$, and use it in the quench verification calculations in §1065.675.

(11) Use the values recorded according to this paragraph (d) of this section and paragraph (e) of this section to calculate quench as described in §1065.675.

(e) *H₂O quench verification procedure.* Use the following method to determine H₂O quench, or use good engineering judgment to develop a different protocol:

(1) Use PTFE tubing to make necessary connections.

(2) If the CLD has an operating mode in which it detects NO-only, as opposed to total NO_x, operate the CLD in the NO-only operating mode.

(3) Measure an NO calibration span gas that meets the specifications of §1065.750 and is near the maximum concentration expected during testing. Record this concentration, x_{NOdry} .

(4) Humidify the gas by bubbling it through distilled water in a sealed vessel. We recommend that you humidify the gas to the highest sample dewpoint that you estimate during emission sampling. Regardless of the humidity during this test, the quench verification calculations in §1065.675 scale the recorded quench to the highest dewpoint that you expect entering

the CLD sample port during emission sampling.

(5) If you do not use any sample dryer for NO_x during emissions testing, record the vessel water temperature as T_{dew} , and its pressure as p_{total} and use these values according to §1065.645 to calculate the amount of water entering the CLD sample port, $x_{\text{H}_2\text{Omeas}}$. If you do use a sample dryer for NO_x during emissions testing, measure the humidity of the sample just upstream of the CLD sample port and use the measured humidity according to §1065.645 to calculate the amount of water entering the CLD sample port, $x_{\text{H}_2\text{Omeas}}$.

(6) To prevent subsequent condensation, make sure that any humidified sample will not be exposed to temperatures lower than T_{dew} during transport from the sealed vessel's outlet to the CLD. We recommend using heated transfer lines.

(7) Introduce the humidified sample upstream of any sample dryer, if one is used.

(8) Use the CLD to measure the NO concentration of the humidified span gas and record this value, x_{NOwet} .

(9) Use the recorded values from this paragraph (e) to calculate the quench as described in §1065.675.

(10) Use the values recorded according to this paragraph (e) of this section and paragraph (d) of this section to calculate quench as described in §1065.675.

(f) *Corrective action.* If the sum of the H₂O quench plus the CO₂ quench is not within ±2%, take corrective action by repairing or replacing the analyzer. Before using a CLD for emission testing, demonstrate that the corrective action resulted in a value within ±2% combined quench.

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

(1) You may omit this verification if you can show by engineering analysis that for your NO_x sampling system and your emission calculations procedures, the combined CO₂ and H₂O interference for your NO_x CLD analyzer always affects your brake-specific NO_x emission results within no more than ±1.0% of the applicable NO_x standard.

(2) You may use a NO_x CLD analyzer that you determine does not meet this verification, as long as you try to correct the problem and the measurement

Environmental Protection Agency

§ 1065.370

deficiency does not adversely affect your ability to show that engines comply with all applicable emission standards.

EFFECTIVE DATE NOTE: At 73 FR 37311, June 30, 2008, §1065.370 was amended by revising paragraphs (d), (e), and (g)(1), effective July 7, 2008. For the convenience of the user, the revised text is set forth as follows:

§ 1065.370 CLD CO₂ and H₂O quench verification.

* * * * *

(d) *CO₂ quench verification procedure.* Use the following method to determine CO₂ quench, or use good engineering judgment to develop a different protocol:

(1) Use PTFE or stainless steel tubing to make necessary connections.

(2) Connect a pressure-regulated CO₂ span gas to the port of a gas divider that meets the specifications in §1065.248 at the appropriate time. Use a CO₂ span gas that meets the specifications of §1065.750 and attempt to use a concentration that is approximately twice the maximum CO₂ concentration expected to enter the CLD sample port during testing, if available.

(3) Connect a pressure-regulated purified N₂ gas to the port of a gas divider that meets the specifications in §1065.248 at the appropriate time. Use a purified N₂ gas that meets the specifications of §1065.750.

(4) Connect a pressure-regulated NO span gas to the port of the gas divider that meets the specifications in §1065.248. Use an NO span gas that meets the specifications of §1065.750. Attempt to use an NO concentration that is approximately twice the maximum NO concentration expected during testing, if available.

(5) Configure the gas divider such that nearly equal amounts of the span gas and balance gas are blended with each other. Apply viscosity corrections as necessary to appropriately ensure correct gas division.

(6) While flowing NO and CO₂ through the gas divider, stabilize the CO₂ concentration downstream of the gas divider and measure the CO₂ concentration with an NDIR analyzer that has been prepared for emission testing. You may alternatively determine the CO₂ concentration from the gas divider cut-point, applying viscosity correction as necessary to ensure accurate gas division. Record this concentration, $x_{CO_2, meas}$, and use it in the quench verification calculations in §1065.675.

(7) Measure the NO concentration downstream of the gas divider. If the CLD has an operating mode in which it detects NO-only, as opposed to total NO_x, operate the CLD in the NO-only operating mode. Record this

concentration, x_{NO, CO_2} , and use it in the quench verification calculations in §1065.675.

(8) Switch the flow of CO₂ off and start the flow of 100% purified N₂ to the inlet port of the gas divider. Monitor the CO₂ at the gas divider's outlet until its concentration stabilizes at zero.

(9) Measure NO concentration at the gas divider's outlet. Record this value, x_{NO, N_2} , and use it in the quench verification calculations in §1065.675.

(10) Use the values recorded according to this paragraph (d) of this section and paragraph (e) of this section to calculate quench as described in §1065.675.

(e) *H₂O quench verification procedure.* Use the following method to determine H₂O quench, or use good engineering judgment to develop a different protocol:

(1) Use PTFE or stainless steel tubing to make necessary connections.

(2) If the CLD has an operating mode in which it detects NO-only, as opposed to total NO_x, operate the CLD in the NO-only operating mode.

(3) Measure an NO calibration span gas that meets the specifications of §1065.750 and is near the maximum concentration expected during testing. Record this concentration, $x_{NO, dry}$.

(4) Humidify the NO span gas by bubbling it 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). We recommend that you humidify the gas to the highest sample dewpoint that you estimate at the CLD inlet during emission sampling. Regardless of the humidity during this test, the quench verification calculations in §1065.675 scale the recorded quench to the highest dewpoint expected for flow entering the CLD sample port during emission sampling.

(5) Introduce the humidified NO test gas into the sample system. You may introduce it downstream of any sample dryer, if one is used during testing.

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

(7) Downstream of the vessel, maintain the humidified NO test gas temperature at least 5 °C above its dewpoint.

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

(9) While the analyzer measures the sample's concentration, record the analyzer's output for 30 seconds. Calculate the arithmetic mean of these data. This mean is $x_{NO, meas}$.

§ 1065.372

(10) Set $x_{NO_{wet}}$ equal to $x_{NO_{meas}}$ from paragraph (e)(9) of this section.

(11) Use $x_{NO_{wet}}$ to calculate the quench according to § 1065.675.

* * * * *

(g) * * *

(1) You may omit this verification if you can show by engineering analysis that for your NO_x sampling system and your emission calculations procedures, the combined CO₂ and H₂O interference for your NO_x CLD analyzer always affects your brake-specific NO_x emission results within no more than ±1.0% of the applicable NO_x standard.

* * * * *

§ 1065.372 NDUV analyzer HC and H₂O interference verification.

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

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

(c) *System requirements.* A NO_x NDUV analyzer must have combined H₂O and HC interference within ±2% of the flow-weighted mean concentration of NO_x expected at the standard, though we strongly recommend keeping interference within ±1%.

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

(1) Start, operate, zero, and span the NO_x NDUV analyzer according to the instrument manufacturer's instructions.

(2) We recommend that you extract engine exhaust to perform this verification. Use a CLD that meets the specifications of subpart C of this part to quantify NO_x in the exhaust. Use the CLD response as the reference value. Also measure HC in the exhaust with a FID analyzer that meets the specifications of subpart C of this part. Use the

FID response as the reference hydrocarbon value.

(3) Upstream of any sample dryer, if one is used during testing, introduce the engine exhaust to the NDUV analyzer.

(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 all analyzers measure the sample's concentration, record 30 seconds of sampled data, and calculate the arithmetic means for the three analyzers.

(6) Subtract the CLD mean from the NDUV mean.

(7) Multiply this difference by the ratio of the flow-weighted mean HC concentration expected at the standard to the HC concentration measured during the verification. The analyzer meets the interference verification of this section if this result is within ±2% of the HC concentration 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 NO_x sampling system and your emission calculations procedures, the combined HC and H₂O interference for your NO_x NDUV analyzer always affects your brake-specific NO_x emission results by less than 0.5% of the applicable NO_x standard.

(2) You may use a NO_x NDUV 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 37312, June 30, 2008, § 1065.372 was amended by revising paragraphs (d)(7) and (e)(1), effective July 7, 2008. For the convenience of the user, the revised text is set forth as follows:

§ 1065.372 NDUV analyzer HC and H₂O interference verification.

* * * * *

(d) * * *

(7) Multiply this difference by the ratio of the flow-weighted mean HC concentration