Environmental Protection Agency

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PF\(_{\text{CH}_4\text{NMC–FID}}\). Use this penetration fraction according to §1065.660(b)(2)(ii), §1065.660(c)(1)(ii), or §1065.665, as applicable.

(f) Procedure for a FID calibrated with methane, bypassing the NMC. If you use a FID with an NMC that is calibrated with methane, CH\(_4\), by bypassing the NMC, determine its combined ethane (C\(_2\)H\(_6\)) response factor and penetration fraction, RPF\(_{\text{C}_2\text{H}_6\text{NMC–FID}}\), as well as its CH\(_4\) penetration fraction, PF\(_{\text{CH}_4\text{NMC–FID}}\), as follows:

1. Select CH\(_4\) and C\(_2\)H\(_6\) analytical gas mixtures and ensure that both mixtures meet the specifications of §1065.750. Select a CH\(_4\) concentration that you would use for spanning the FID during emission testing and select a C\(_2\)H\(_6\) concentration that is typical of the peak NMHC concentration expected at the hydrocarbon standard or equal to the THC analyzer’s span value.

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 by bypassing the cutter and by using CH\(_4\) span gas. Note that you must span the FID on a CH\(_4\) 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 CH\(_4\) molecule.

6. Introduce the C\(_2\)H\(_6\) analytical gas mixture upstream of the nonmethane cutter. Use good engineering judgment to address the effect of hydrocarbon contamination if your point of introduction is vastly different from the point of zero/span gas introduction.

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. Divide the mean CH\(_4\) concentration by the reference concentration of CH\(_4\), converted to a CH\(_4\) basis. The result is the CH\(_4\) combined response factor and penetration fraction, RPF\(_{\text{CH}_4\text{NMC–FID}}\). Use this combined response factor and penetration fraction according to §1065.660(b)(2)(ii), §1065.660(c)(1)(iii), or §1065.665, as applicable.

10. Introduce the CH\(_4\) analytical gas mixture upstream of the nonmethane cutter. Use good engineering judgment to address the effect of hydrocarbon contamination if your point of introduction is vastly different from the point of zero/span gas introduction.

11. 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.

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

13. Reroute the flow path to bypass the nonmethane cutter, introduce the CH\(_4\) analytical gas mixture, and repeat the steps in paragraphs (e)(11) and (12) of this section.

14. Divide the mean CH\(_4\) concentration measured through the nonmethane cutter by the mean CH\(_4\) concentration measured after bypassing the nonmethane cutter. The result is the CH\(_4\) penetration fraction, PF\(_{\text{CH}_4\text{NMC–FID}}\). Use this penetration fraction according to §1065.660(b)(2)(ii), §1065.660(c)(1)(iii), or §1065.665, as applicable.


NO\(_X\) AND N\(_2\)O MEASUREMENTS

§ 1065.370 CLD CO\(_2\) and H\(_2\)O quench verification.

(a) Scope and frequency. If you use a CLD analyzer to measure NO\(_X\), verify the amount of H\(_2\)O and CO\(_2\) quench after installing the CLD analyzer and after major maintenance.

(b) Measurement principles. H\(_2\)O and CO\(_2\) 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\(_X\). This procedure
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and the calculations in §1065.675 determine quench and scale the quench results to the maximum mole fraction of H₂O and the maximum CO₂ concentration expected during emission testing. If the CLD analyzer uses quench compensation algorithms that utilize H₂O and/or CO₂ measurement instruments, evaluate quench with these instruments active 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 by using a gas divider that blends binary span gases with zero gas as the diluent and meets the specifications in §1065.248, or use good engineering judgment to develop a different protocol:

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

(2) Configure the gas divider such that nearly equal amounts of the span and diluent gases are blended with each other.

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

(4) Use a CO₂ span gas that meets the specifications of §1065.750 and a concentration that is approximately twice the maximum CO₂ concentration expected during emission testing.

(5) Use an NO span gas that meets the specifications of §1065.750 and a concentration that is approximately twice the maximum NO concentration expected during emission testing.

(6) Zero and span the CLD analyzer. Span the CLD analyzer with the NO span gas from paragraph (d)(5) of this section through the gas divider. Connect the NO span gas to the span port of the gas divider; connect a zero gas to the diluent port of the gas divider; use the same nominal blend ratio selected in paragraph (d)(2) of this section; and use the gas divider’s output concentration of NO to span the CLD analyzer. Apply gas property corrections as necessary to ensure accurate gas division.

(7) Connect the CO₂ span gas to the span port of the gas divider.

(8) Connect the NO span gas to the diluent port of the gas divider.

(9) While flowing NO and CO₂ through the gas divider, stabilize the output of the gas divider. Determine the CO₂ concentration from the gas divider output, applying gas property correction as necessary to ensure accurate gas division. Record this concentration, xCO₂act, and use it in the quench verification calculations in §1065.675. Alternatively, you may use a simple gas blending device and use an NDIR to determine this CO₂ concentration. If you use an NDIR, it must meet the requirements of this part for laboratory testing and you must span it with the CO₂ span gas from paragraph (d)(4) of this section.

(10) Measure the NO concentration downstream of the gas divider with the CLD analyzer. Allow time for the analyzer response to stabilize. Stabilization time may include time to purge the transfer line and to account for analyzer response. While the analyzer measures the sample’s concentration, record the analyzer’s output for 30 seconds. Calculate the arithmetic mean concentration from these data, xNOmeas. Record xNOmeas, and use it in the quench verification calculations in §1065.675.

(11) Calculate the actual NO concentration at the gas divider’s outlet, xNOact, based on the span gas concentrations and xCO₂act according to Equation 1065.675–2. Use the calculated value in the quench verification calculations in Equation 1065.675–1.

(12) Use the values recorded according to this paragraph (d) 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 analyzer has an operating mode in which it detects NO-only, as opposed to total NOₓ, operate the CLD analyzer in the NO-only operating mode.
(3) Use an NO span gas that meets the specifications of §1065.750 and a concentration that is near the maximum concentration expected during emission testing.

(4) Zero and span the CLD analyzer. Span the CLD analyzer with the NO span gas from paragraph (e)(3) of this section, record the span gas concentration as $X_{\text{NO}_\text{dry}}$, and use it in the quench verification calculations in §1065.675.

(5) Humidify the NO span gas by bubbling it through distilled water in a sealed vessel. If the humidified NO span gas sample does not pass through a sample dryer for this verification test, control the vessel temperature to generate an H$_2$O level approximately equal to the maximum mole fraction of H$_2$O expected during emission testing. If the humidified NO span gas sample does not pass through a sample dryer, the quench verification calculations in §1065.675 scale the measured H$_2$O quench to the highest mole fraction of H$_2$O expected during emission testing.

If the humidified NO span gas sample passes through a dryer for this verification test, control the vessel temperature to generate an H$_2$O level at least as high as the level determined in §1065.145(e)(2). For this case, the quench verification calculations in §1065.675 do not scale the measured H$_2$O quench.

(6) Introduce the humidified NO test gas into the sample system. You may introduce it upstream or downstream of any sample dryer that is used during emission testing. Note that the sample dryer must meet the sample dryer verification check in §1065.342.

(7) Measure the mole fraction of H$_2$O in the humidified NO span gas downstream of the sample dryer, $x_{\text{H}_2\text{O}_\text{meas}}$. We recommend that you measure $x_{\text{H}_2\text{O}_\text{meas}}$ as close as possible to the CLD analyzer inlet. You may calculate $x_{\text{H}_2\text{O}_\text{meas}}$ from measurements of dew point, $T_{\text{dew}}$, and absolute pressure, $p_{\text{total}}$. $x_{\text{H}_2\text{O}_\text{meas}}$

(8) Use good engineering judgment to prevent condensation in the transfer lines, fittings, or valves from the point where $x_{\text{H}_2\text{O}_\text{meas}}$ is measured to the analyzer. We recommend that you design your system so the wall temperatures in the transfer lines, fittings, and valves from the point where $x_{\text{H}_2\text{O}_\text{meas}}$ is measured to the analyzer are at least 5 °C above the local sample gas dew point.

(9) Measure the humidified NO span gas concentration with the CLD analyzer. Allow time for the analyzer response to stabilize. Stabilization time may include time to purge the transfer line and to account for analyzer response. While the analyzer measures the sample’s concentration, record the analyzer’s output for 30 seconds. Calculate the arithmetic mean of these data, $X_{\text{NO}_\text{wet}}$. Record $X_{\text{NO}_\text{wet}}$ and use it in the quench verification calculations in §1065.675.

(f) Corrective action. If the sum of the H$_2$O quench plus the CO$_2$ quench is less than –2% or greater than +2%, take corrective action by repairing or replacing the analyzer. Before running emission tests, verify that the corrective action successfully restored the analyzer to proper functioning.

(g) Exceptions. The following exceptions apply:

(1) You may omit this verification if you can show by engineering analysis that for your NOX sampling system and your emission calculation procedures, the combined CO$_2$ and H$_2$O interference for your NOX CLD analyzer always affects your brake-specific NOX emission results within no more than ±0.1% of the applicable NOX standard. If you certify to a combined emission standard (such as a NOX + NMHC standard), scale your NOX results to the combined standard based on the measured results (after incorporating deterioration factors, if applicable). For example, if your final NOX + NMHC value is half of the emission standard, double the NOX result to estimate the level of NOX emissions corresponding to the applicable standard.

(2) You may use a NOX CLD 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.