

Environmental Protection Agency

§ 1065.360

convenience of the user, the revised text is set forth as follows:

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

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(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 humidified CO₂ test gas by bubbling a CO₂ span gas 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). Use a CO₂ span gas concentration at least as high as the maximum expected during testing.

(3) Introduce the humidified CO₂ 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 CO₂ 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 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 its output for 30 seconds. Calculate the arithmetic mean of this data.

(8) The analyzer meets the interference verification if the result of paragraph (d)(7) of this section meets the tolerance in paragraph (c) of this section.

(9) You may also run interference procedures for CO₂ and H₂O separately. If the CO₂ and H₂O levels used are higher than the maximum levels expected during testing, you may scale down each observed interference value by multiplying the observed interference by the ratio of the maximum expected concentration value to the actual value used during this procedure. You may run the separate interference procedures concentrations of H₂O (down to 0.025 mol/mol H₂O content) that are lower than the maximum levels expected during testing, but you must scale up the observed H₂O interference by multiplying the observed interference by the ratio of the maximum expected H₂O concentration value to the actual value used during this procedure. The sum of the two

scaled interference values must meet the tolerance in paragraph (c) of this section.

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HYDROCARBON MEASUREMENTS

§ 1065.360 FID optimization and verification.

(a) *Scope and frequency.* For all FID analyzers perform the following steps:

(1) Calibrate a FID upon initial installation. Repeat the calibration as needed using good engineering judgment.

(2) Optimize a FID's response to various hydrocarbons after initial analyzer installation and after major maintenance.

(3) Determine a FID's methane (CH₄) response factor after initial analyzer installation and after major maintenance.

(4) Verify methane (CH₄) response within 185 days before testing.

(b) *Calibration.* Use good engineering judgment to develop a calibration procedure, such as one based on the FID-analyzer manufacturer's instructions and recommended frequency for calibrating the FID. Alternately, you may remove system components for off-site calibration. Calibrate using C₃H₈ calibration gases that meet the specifications of §1065.750. We recommend FID analyzer zero and span gases that contain approximately the flow-weighted mean concentration of O₂ expected during testing. If you use a FID to measure methane (CH₄) downstream of a nonmethane cutter, you may calibrate that FID using CH₄ calibration gases with the cutter. Regardless of the calibration gas composition, calibrate on a carbon number basis of one (C₁). For example, if you use a C₃H₈ span gas of concentration 200 µmol/mol, span the FID to respond with a value of 600 µmol/mol.

(c) *FID response optimization.* Use good engineering judgment for initial instrument start-up and basic operating adjustment using FID fuel and zero air. Heated FIDs must be within their required operating temperature ranges. Optimize FID response at the most common analyzer range expected during emission testing. Optimization involves adjusting flows and pressures

of FID fuel, burner air, and sample to minimize response variations to various hydrocarbon species in the exhaust. Use good engineering judgment to trade off peak FID response to propane calibration gases to achieve minimal response variations to different hydrocarbon species. For an example of trading off response to propane for relative responses to other hydrocarbon species, see SAE 770141 (incorporated by reference in §1065.1010). Determine the optimum flow rates for FID fuel, burner air, and sample and record them for future reference.

(d) *CH₄ response factor determination.* Since FID analyzers generally have a different response to CH₄ versus C₃H₈, determine each FID analyzer's CH₄ response factor, RF_{CH_4} , after FID optimization. Use the most recent RF_{CH_4} measured according to this section in the calculations for HC determination described in §1065.660 to compensate for CH₄ response. Determine RF_{CH_4} as follows, noting that you do not determine RF_{CH_4} for FIDs that are calibrated and spanned using CH₄ with a nonmethane cutter:

(1) Select a C₃H₈ span gas that meets the specifications of §1065.750. Record the C₃H₈ concentration of the gas.

(2) Select a CH₄ span gas that meets the specifications of §1065.750. Record the CH₄ concentration of the gas.

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

(4) Confirm that the FID analyzer has been calibrated using C₃H₈. Calibrate on a carbon number basis of one (C₁). For example, if you use a C₃H₈ span gas of concentration 200 µmol/mol, span the FID to respond with a value of 600 µmol/mol.

(5) Zero the FID with a zero gas that you use for emission testing.

(6) Span the FID with the C₃H₈ span gas that you selected under paragraph (d)(1) of this section.

(7) Introduce at the sample port of the FID analyzer, the CH₄ span gas that you selected under paragraph (d)(2) of this section.

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

(9) While the analyzer measures the CH₄ concentration, record 30 seconds of sampled data. Calculate the arithmetic mean of these values.

(10) Divide the mean measured concentration by the recorded span concentration of the CH₄ calibration gas. The result is the FID analyzer's response factor for CH₄, RF_{CH_4} .

(e) *FID methane (CH₄) response verification.* If the value of RF_{CH_4} from paragraph (d) of this section is within ±5.0% of its most recent previously determined value, the FID passes the methane response verification. For example, if the most recent previous value for RF_{CH_4} was 1.05 and it changed by +0.05 to become 1.10 or it changed by -0.05 to become 1.00, either case would be acceptable because +4.8% is less than +5.0%.

(1) Verify that the pressures and flow rates of FID fuel, burner air, and sample are each within ±0.5% of their most recent previously recorded values, as described in paragraph (c) of this section. You may adjust these flow rates as necessary. Determine a new RF_{CH_4} as described in paragraph (d) of this section.

(2) If RF_{CH_4} is still not within ±5.0% of its most recently determined value after adjusting flow rates, re-optimize the FID response as described in paragraph (c) of this section.

(3) Determine a new RF_{CH_4} as described in paragraph (d) of this section. Use this new value of RF_{CH_4} in the calculations for HC determination, as described in §1065.660.

EFFECTIVE DATE NOTE: At 73 FR 37308, June 30, 2008, §1065.360 was revised, effective July 7, 2008. For the convenience of the user, the revised text is set forth as follows:

§ 1065.360 FID optimization and verification.

(a) *Scope and frequency.* For all FID analyzers, calibrate the FID upon initial installation. Repeat the calibration as needed using good engineering judgment. For a FID that measures THC, perform the following steps:

(1) Optimize the response to various hydrocarbons after initial analyzer installation and after major maintenance as described in paragraph (c) of this section.

(2) Determine the methane (CH₄) response factor after initial analyzer installation and after major maintenance as described in paragraph (d) of this section.

(3) Verify the methane (CH_4) response within 185 days before testing as described in paragraph (e) of this section.

(b) *Calibration.* Use good engineering judgment to develop a calibration procedure, such as one based on the FID-analyzer manufacturer's instructions and recommended frequency for calibrating the FID. Alternately, you may remove system components for off-site calibration. For a FID that measures THC, calibrate using C_3H_8 calibration gases that meet the specifications of §1065.750. For a FID that measures CH_4 , calibrate using CH_4 calibration gases that meet the specifications of §1065.750. We recommend FID analyzer zero and span gases that contain approximately the flow-weighted mean concentration of O_2 expected during testing. If you use a FID to measure methane (CH_4) downstream of a nonmethane cutter, you may calibrate that FID using CH_4 calibration gases with the cutter. Regardless of the calibration gas composition, calibrate on a carbon number basis of one (C_1). For example, if you use a C_3H_8 span gas of concentration 200 $\mu\text{mol/mol}$, span the FID to respond with a value of 600 $\mu\text{mol/mol}$. As another example, if you use a CH_4 span gas with a concentration of 200 $\mu\text{mol/mol}$, span the FID to respond with a value of 200 $\mu\text{mol/mol}$.

(c) *THC FID response optimization.* This procedure is only for FID analyzers that measure THC. Use good engineering judgment for initial instrument start-up and basic operating adjustment using FID fuel and zero air. Heated FIDs must be within their required operating temperature ranges. Optimize FID response at the most common analyzer range expected during emission testing. Optimization involves adjusting flows and pressures of FID fuel, burner air, and sample to minimize response variations to various hydrocarbon species in the exhaust. Use good engineering judgment to trade off peak FID response to propane calibration gases to achieve minimal response variations to different hydrocarbon species. For an example of trading off response to propane for relative responses to other hydrocarbon species, see SAE 770141 (incorporated by reference in §1065.1010). Determine the optimum flow rates and/or pressures for FID fuel, burner air, and sample and record them for future reference.

(d) *THC FID CH_4 response factor determination.* This procedure is only for FID analyzers that measure THC. Since FID analyzers generally have a different response to CH_4 versus C_3H_8 , determine each THC FID analyzer's CH_4 response factor, $RF_{\text{CH}_4[\text{THC-FID}]}$, after FID optimization. Use the most recent $RF_{\text{CH}_4[\text{THC-FID}]}$ measured according to this section in the calculations for HC determination described in §1065.660 to compensate for CH_4 response. Determine $RF_{\text{CH}_4[\text{THC-FID}]}$ as follows, noting that you do not determine $RF_{\text{CH}_4[\text{THC-FID}]}$ for FIDs that are calibrated and

spanned using CH_4 with a nonmethane cutter:

(1) Select a C_3H_8 span gas concentration that you use to span your analyzers before emission testing. Use only span gases that meet the specifications of §1065.750. Record the C_3H_8 concentration of the gas.

(2) Select a CH_4 span gas concentration that you use to span your analyzers before emission testing. Use only span gases that meet the specifications of §1065.750. Record the CH_4 concentration of the gas.

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

(4) Confirm that the FID analyzer has been calibrated using C_3H_8 . Calibrate on a carbon number basis of one (C_1). For example, if you use a C_3H_8 span gas of concentration 200 $\mu\text{mol/mol}$, span the FID to respond with a value of 600 $\mu\text{mol/mol}$.

(5) Zero the FID with a zero gas that you use for emission testing.

(6) Span the FID with the C_3H_8 span gas that you selected under paragraph (d)(1) of this section.

(7) Introduce at the sample port of the FID analyzer, the CH_4 span gas that you selected under paragraph (d)(2) of this section.

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

(9) While the analyzer measures the CH_4 concentration, record 30 seconds of sampled data. Calculate the arithmetic mean of these values.

(10) Divide the mean measured concentration by the recorded span concentration of the CH_4 calibration gas. The result is the FID analyzer's response factor for CH_4 , $RF_{\text{CH}_4[\text{THC-FID}]}$.

(e) *THC FID methane (CH_4) response verification.* This procedure is only for FID analyzers that measure THC. If the value of $RF_{\text{CH}_4[\text{THC-FID}]}$ from paragraph (d) of this section is within $\pm 5.0\%$ of its most recent previously determined value, the THC FID passes the methane response verification. For example, if the most recent previous value for $RF_{\text{CH}_4[\text{THC-FID}]}$ was 1.05 and it changed by ± 0.05 to become 1.10 or it changed by -0.05 to become 1.00, either case would be acceptable because $\pm 4.8\%$ is less than $\pm 5.0\%$. Verify $RF_{\text{CH}_4[\text{THC-FID}]}$ as follows:

(1) First verify that the flow rates and/or pressures of FID fuel, burner air, and sample are each within $\pm 0.5\%$ of their most recent previously recorded values, as described in paragraph (c) of this section. You may adjust these flow rates as necessary. Then determine the $RF_{\text{CH}_4[\text{THC-FID}]}$ as described in paragraph (d) of this section and verify that it is within the tolerance specified in this paragraph (e).

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(2) If $RF_{CH_4[THC-FID]}$ is not within the tolerance specified in this paragraph (e), re-optimize the FID response as described in paragraph (c) of this section.

(3) Determine a new $RF_{CH_4[THC-FID]}$ as described in paragraph (d) of this section. Use this new value of $RF_{CH_4[THC-FID]}$ in the calculations for HC determination, as described in § 1065.660.

§ 1065.362 Non-stoichiometric raw exhaust FID O₂ interference verification.

(a) *Scope and frequency.* If you use FID analyzers for raw exhaust measurements from engines that operate in a non-stoichiometric mode of combustion (e.g., compression-ignition, lean-burn), verify the amount of FID O₂ interference upon initial installation and after major maintenance.

(b) *Measurement principles.* Changes in O₂ concentration in raw exhaust can affect FID response by changing FID flame temperature. Optimize FID fuel, burner air, and sample flow to meet this verification. Verify FID performance with the compensation algorithms for FID O₂ interference that you have active during an emission test.

(c) *System requirements.* Any FID analyzer used during testing must meet the FID O₂ interference verification according to the procedure in this section.

(d) *Procedure.* Determine FID O₂ interference as follows:

(1) Select two span reference gases that meet the specifications in § 1065.750 and contain C₃H₈ near 100% of span for HC. You may use CH₄ span reference gases for FIDs calibrated on CH₄ with a nonmethane cutter. Select the two balance gas concentrations such that the concentrations of O₂ and N₂ represent the minimum and maximum O₂ concentrations expected during testing.

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

(3) Start and operate the FID analyzer as you would before an emission test. Regardless of the FID burner's air source during testing, use zero air as the FID burner's air source for this verification.

(4) Zero the FID analyzer using the zero gas used during emission testing.

(5) Span the FID analyzer using the span gas used during emission testing.

(6) Check the zero response of the FID analyzer using the zero gas used during emission testing. If the mean zero response of 30 seconds of sampled data is within ±0.5% of the span reference value used in paragraph (d)(5) of this section, then proceed to the next step; otherwise restart the procedure at paragraph (d)(4) of this section.

(7) Check the analyzer response using the span gas that has the minimum concentration of O₂ expected during testing. Record the mean response of 30 seconds of stabilized sample data as X_{O_2minHC} .

(8) Check the zero response of the FID analyzer using the zero gas used during emission testing. If the mean zero response of 30 seconds of stabilized sample data is within ±0.5% of the span reference value used in paragraph (d)(5) of this section, then proceed to the next step; otherwise restart the procedure at paragraph (d)(4) of this section.

(9) Check the analyzer response using the span gas that has the maximum concentration of O₂ expected during testing. Record the mean response of 30 seconds of stabilized sample data as X_{O_2maxHC} .

(10) Check the zero response of the FID analyzer using the zero gas used during emission testing. If the mean zero response of 30 seconds of stabilized sample data is within ±0.5% of the span reference value used in paragraph (d)(5) of this section, then proceed to the next step; otherwise restart the procedure at paragraph (d)(4) of this section.

(11) Calculate the percent difference between X_{O_2maxHC} and its reference gas concentration. Calculate the percent difference between X_{O_2minHC} and its reference gas concentration. Determine the maximum percent difference of the two. This is the O₂ interference.

(12) If the O₂ interference is within ±1.5%, then the FID passes the O₂ interference check; otherwise perform one or more of the following to address the deficiency:

(i) Select zero and span gases for emission testing that contain higher or lower O₂ concentrations.

(ii) Adjust FID burner air, fuel, and sample flow rates. Note that if you adjust these flow rates to meet the O₂ interference verification, you must re-verify with the adjusted flow rates that