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 $CO_2$ and $H_2O$ 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 deficiency does not adversely affect your ability to show that engines comply with all applicable emission standards.

## § 1065.372 NDUV analyzer HC and $H_2O$ interference verification.

(a) *Scope and frequency.* If you measure $NO_X$ using an NDUV analyzer, verify the amount of $H_2O$ and hydrocarbon interference after initial analyzer installation and after major maintenance.

(b) *Measurement principles.* Hydrocarbons and $H_2O$ 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 $H_2O$ 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 $H_2O$ 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.

## § 1065.376 Chiller $NO_2$ penetration.

(a) *Scope and frequency.* If you use a chiller to dry a sample upstream of a

$NO_X$ measurement instrument, but you don't use an $NO_2$-to-NO converter upstream of the chiller, you must perform this verification for chller $NO_2$ penetration. Perform this verification after initial installation and after major maintenance.

(b) *Measurement principles.* A chiller removes water, which can otherwise interfere with a $NO_X$ measurement. However, liquid water in an improperly designed chiller can remove $NO_2$ from the sample. If a chiller is used without an $NO_2$-to-NO converter upstream, it could therefore remove $NO_2$ from the sample prior $NO_X$ measurement.

(c) *System requirements.* A chiller must allow for measuring at least 95% of the total $NO_2$ at the maximum expected concentration of $NO_2$.

(d) *Procedure.* Use the following procedure to verify chiller performance:

(1) *Instrument setup.* Follow the analyzer and chiller manufacturers' start-up and operating instructions. Adjust the analyzer and chiller as needed to optimize performance.

(2) *Equipment setup.* Connect an ozonator's inlet to a zero-air or oxygen source and connect its outlet to one port of a three-way tee fitting. Connect an NO span gas to another port of the tee. Connect a heated line at 100 °C to the last port, and connect a heated three-way tee to the other end of the line. Connect a dewpoint generator, set at a dewpoint of 50 °C, to one end of a heated line at 100 °C. Connect the other end of the line to the heated tee and connect a third 100 °C heated line to the chiller inlet. Provide an overflow vent line at the chiller inlet.

(3) *Adjustments.* For the following adjustment steps, set the analyzer to measure only NO (i.e., NO mode), or only read the NO channel of the analyzer:

(i) With the dewpoint generator and the ozonator off, adjust the NO and zero-gas flows so the NO concentration at the analyzer is at least two times the peak total $NO_X$ concentration expected during testing at the standard. Verify that gas is flowing out of the overflow vent line.

(ii) Turn on the dewpoint generator and adjust its flow so the NO concentration at the analyzer is at least at the peak total $NO_X$ concentration expected during testing at the standard. Verify that gas is flowing out of the overflow vent line.

(iii) Turn on the ozonator and adjust the ozonator so the NO concentration measured by the analyzer decreases by the same amount as the maximum concentration of $NO_2$ expected during testing. This ensures that the ozonator is generating $NO_2$ at the maximum concentration expected during testing.

(4) *Data collection.* Maintain the ozonator adjustment in paragraph (d)(3) of this section, and keep the $NO_X$ analyzer in the NO only mode or only read the NO channel of the analyzer.

(i) Allow for stabilization, accounting only for transport delays and instrument response.

(ii) Calculate the mean of 30 seconds of sampled data from the analyzer and record this value as $NO_{ref}$.

(iii) Switch the analyzer to the total $NO_X$ mode, (that is, sum the NO and $NO_2$ channels of the analyzer) and allow for stabilization, accounting only for transport delays and instrument response.

(iv) Calculate the mean of 30 seconds of sampled data from the analyzer and record this value as $NOx_{meas}$.

(v) Turn off the ozonator and allow for stabilization, accounting only for transport delays and instrument response.

(vi) Calculate the mean of 30 seconds of sampled data from the analyzer and record this value as $NO_{xref}$.

(5) *Performance evaluation.* Divide the quantity of $(NO_{xmeas} - NO_{ref})$ by the quantity of $(NO_{xref} - NO_{ref})$. If the result is less than 95%, repair or replace the chiller.

(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 chiller 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 chiller 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.

### § 1065.378 $NO_2$-to-NO converter conversion verification.

(a) *Scope and frequency.* If you use an analyzer that measures only NO to determine $NO_X$, you must use an $NO_2$-to-NO converter upstream of the analyzer. Perform this verification after installing the converter, after major maintenance and within 35 days before an emission test. This verification must be repeated at this frequency to verify that the catalytic activity of the $NO_2$-to-NO converter has not deteriorated.

(b) *Measurement principles.* An $NO_2$-to-NO converter allows an analyzer that measures only NO to determine total $NO_X$ by converting the $NO_2$ in exhaust to NO.

(c) *System requirements.* An $NO_2$-to-NO converter must allow for measuring at least 95% of the total $NO_2$ at the maximum expected concentration of $NO_2$.

(d) *Procedure.* Use the following procedure to verify the performance of a $NO_2$-to-NO converter:

(1) *Instrument setup.* Follow the analyzer and $NO_2$-to-NO converter manufacturers' start-up and operating instructions. Adjust the analyzer and converter as needed to optimize performance.

(2) *Equipment setup.* Connect an ozonator's inlet to a zero-air or oxygen source and connect its outlet to one port of a 4-way cross fitting. Connect an NO span gas to another port. Connect the $NO_2$-to-NO converter inlet to another port, and connect an overflow vent line to the last port.

(3) *Adjustments.* Take the following steps to make adjustments:

(i) With the $NO_2$-to-NO converter in the bypass mode (i.e., NO mode) and the ozonator off, adjust the NO and zero-gas flows so the NO concentration at the analyzer is at the peak total $NO_X$ concentration expected during testing. Verify that gas is flowing out of the overflow vent.

(ii) With the $NO_2$-to-NO converter still in the bypass mode, turn on the ozonator and adjust the ozonator so the NO concentration measured by the analyzer decreases by the same amount as maximum concentration of $NO_2$ expected during testing. This ensures that the ozonator is generating $NO_2$ at the maximum concentration expected during testing.

(4) *Data collection.* Maintain the ozonator adjustment in paragraph (d)(3) of this section, and keep the $NO_X$ analyzer in the NO only mode (i.e., bypass the $NO_2$-to-NO converter).

(i) Allow for stabilization, accounting only for transport delays and instrument response.

(ii) Calculate the mean of 30 seconds of sampled data from the analyzer and record this value as $NO_{ref}$.

(iii) Switch the analyzer to the total $NO_X$ mode (that is, sample with the $NO_2$-to-NO converter) and allow for stabilization, accounting only for transport delays and instrument response.

(iv) Calculate the mean of 30 seconds of sampled data from the analyzer and record this value as $NO_{xmeas}$.

(v) Turn off the ozonator and allow for stabilization, accounting only for transport delays and instrument response.

(vi) Calculate the mean of 30 seconds of sampled data from the analyzer and record this value as $NO_{xref}$.

(5) *Performance evaluation.* Divide the quantity of $(NO_{xmeas} - NO_{ref})$ by the quantity of $(NO_{xref} - NO_{ref})$. If the result is less than 95%, repair or replace the $NO_2$-to-NO converter.

(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 converter 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 converter 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.

## PM Measurements

### § 1065.390 PM balance verifications and weighing process verification.

(a) *Scope and frequency.* This section describes three verifications. The first