

APPENDIX A TO SUBPART S OF PART 51—  
CALIBRATIONS, ADJUSTMENTS AND  
QUALITY CONTROL

## (I) Steady-State Test Equipment

States may opt to use transient emission test equipment for steady-state tests and follow the quality control requirements in paragraph (II) of this appendix instead of the following requirements.

(a) Equipment shall be calibrated in accordance with the manufacturers' instructions.

(b) *Prior to each test*—(1) *Hydrocarbon hang-up check.* Immediately prior to each test the analyzer shall automatically perform a hydrocarbon hang-up check. If the HC reading, when the probe is sampling ambient air, exceeds 20 ppm, the system shall be purged with clean air or zero gas. The analyzer shall be inhibited from continuing the test until HC levels drop below 20 ppm.

(2) *Automatic zero and span.* The analyzer shall conduct an automatic zero and span check prior to each test. The span check shall include the HC, CO, and CO<sub>2</sub> channels, and the NO and O<sub>2</sub> channels, if present. If zero and/or span drift cause the signal levels to move beyond the adjustment range of the analyzer, it shall lock out from testing.

(3) *Low flow.* The system shall lock out from testing if sample flow is below the acceptable level as defined in paragraph (I)(b)(6) of appendix D to this subpart.

(c) *Leak check.* A system leak check shall be performed within twenty-four hours before the test in low volume stations (those performing less than the 4,000 inspections per year) and within four hours in high-volume stations (4,000 or more inspections per year) and may be performed in conjunction with the gas calibration described in paragraph (I)(d)(1) of this appendix. If a leak check is not performed within the preceding twenty-four hours in low volume stations and within four hours in high-volume stations or if the analyzer fails the leak check, the analyzer shall lock out from testing. The leak check shall be a procedure demonstrated to effectively check the sample hose and probe for leaks and shall be performed in accordance with good engineering practices. An error of more than  $\pm 2\%$  of the reading using low range span gas shall cause the analyzer to lock out from testing and shall require repair of leaks.

(d) *Gas calibration.* (1) On each operating day in high-volume stations, analyzers shall automatically require and successfully pass a two-point gas calibration for HC, CO, and CO<sub>2</sub> and shall continually compensate for changes in barometric pressure. Calibration shall be checked within four hours before the test and the analyzer adjusted if the reading is more than 2% different from the span gas value. In low-volume stations, analyzers

shall undergo a two-point calibration within seventy-two hours before each test, unless changes in barometric pressure are compensated for automatically and statistical process control demonstrates equal or better quality control using different frequencies. Gas calibration shall be accomplished by introducing span gas that meets the requirements of paragraph (I)(d)(3) of this appendix into the analyzer through the calibration port. If the analyzer reads the span gas within the allowable tolerance range (*i.e.*, the square root of sum of the squares of the span gas tolerance described in paragraph (I)(d)(3) of this appendix and the calibration tolerance, which shall be equal to 2%), no adjustment of the analyzer is necessary. The gas calibration procedure shall correct readings that exceed the allowable tolerance range to the center of the allowable tolerance range. The pressure in the sample cell shall be the same with the calibration gas flowing during calibration as with the sample gas flowing during sampling. If the system is not calibrated, or the system fails the calibration check, the analyzer shall lock out from testing.

(2) *Span points.* A two point gas calibration procedure shall be followed. The span shall be accomplished at one of the following pairs of span points:

- (A) 300—ppm propane (HC)
- 1.0—% carbon monoxide (CO)
- 6.0—% carbon dioxide (CO<sub>2</sub>)
- 1000—ppm nitric oxide (if equipped with NO)
- 1200—ppm propane (HC)
- 4.0—% carbon monoxide (CO)
- 12.0—% carbon dioxide (CO<sub>2</sub>)
- 3000—ppm nitric oxide (if equipped with NO)
- (B) —ppm propane
- 0.0—% carbon monoxide
- 0.0—% carbon dioxide
- 0—ppm nitric oxide (if equipped with NO)
- 600—ppm propane (HC)
- 1.6—% carbon monoxide (CO)
- 11.0—% carbon dioxide (CO<sub>2</sub>)
- 1200—ppm nitric oxide (if equipped with NO)

(3) *Span gases.* The span gases used for the gas calibration shall be traceable to National Institute of Standards and Technology (NIST) standards  $\pm 2\%$ , and shall be within two percent of the span points specified in paragraph (d)(2) of this appendix. Zero gases shall conform to the specifications given in § 86.114-79(a)(5) of this chapter.

(e) *Dynamometer checks*—(1) *Monthly check.* Within one month preceding each loaded test, the accuracy of the roll speed indicator shall be verified and the dynamometer shall be checked for proper power absorber settings.

(2) *Semi-annual check.* Within six months preceding each loaded test, the road-load response of the variable-curve dynamometer or the frictional power absorption of the dynamometer shall be checked by a coast down

procedure similar to that described in §86.118-78 of this chapter. The check shall be done at 30 mph, and a power absorption load setting to generate a total horsepower (hp) of 4.1 hp. The actual coast down time from 45 mph to 15 mph shall be within  $\pm 1$  second of the time calculated by the following equation:

$$\text{Coast Down Time} = \frac{0.0508 \times W}{\text{HP}}$$

where W is the total inertia weight as represented by the weight of the rollers (excluding free rollers), and any inertia flywheels used, measured in pounds. If the coast down time is not within the specified tolerance the dynamometer shall be taken out of service and corrective action shall be taken.

(f) *Other checks.* In addition to the above periodic checks, these shall also be used to verify system performance under the following special circumstances.

(1) *Gas Calibration.* (A) Each time the analyzer electronic or optical systems are repaired or replaced, a gas calibration shall be performed prior to returning the unit to service.

(B) In high-volume stations, monthly multi-point calibrations shall be performed. Low-volume stations shall perform multi-point calibrations every six months. The calibration curve shall be checked at 20%, 40%, 60%, and 80% of full scale and adjusted or repaired if the specifications in appendix D(I)(b)(1) to this subpart are not met.

(2) *Leak checks.* Each time the sample line integrity is broken, a leak check shall be performed prior to testing.

#### (II) Transient Test Equipment

(a) *Dynamometer.* Once per week, the calibration of each dynamometer and each fly wheel shall be checked by a dynamometer coast-down procedure comparable to that in §86.118-78 of this chapter between the speeds of 55 to 45 mph, and between 30 to 20 mph. All rotating dynamometer components shall be included in the coast-down check for the inertia weight selected. For dynamometers with uncoupled rolls, the uncoupled rollers may undergo a separate coast-down check. If a vehicle is used to motor the dynamometer to the beginning coast-down speed, the vehicle shall be lifted off the dynamometer rolls before the coast-down test begins. If the difference between the measured coast-down time and the theoretical coast-down time is greater than +1 second, the system shall lock out, until corrective action brings the dynamometer into calibration.

(b) *Constant volume sampler.* (1) The constant volume sampler (CVS) flow calibration shall be checked daily by a procedure that identifies deviations in flow from the true

value. Deviations greater than  $\pm 4\%$  shall be corrected.

(2) The sample probe shall be cleaned and checked at least once per month. The main CVS venturi shall be cleaned and checked at least once per year.

(3) Verification that flow through the sample probe is adequate for the design shall be done daily. Deviations greater than the design tolerances shall be corrected.

(c) *Analyzer system—(1) Calibration checks.*

(A) Upon initial operation, calibration curves shall be generated for each analyzer. The calibration curve shall consider the entire range of the analyzer as one curve. At least 6 calibration points plus zero shall be used in the lower portion of the range corresponding to an average concentration of approximately 2 gpm for HC, 30 gpm for CO, 3 gpm for NO<sub>x</sub>, and 400 gpm for CO<sub>2</sub>. For the case where a low and a high range analyzer is used, the high range analyzer shall use at least 6 calibration points plus zero in the lower portion of the high range scale corresponding to approximately 100% of the full-scale value of the low range analyzer. For all analyzers, at least 6 calibration points shall also be used to define the calibration curve in the region above the 6 lower calibration points. Gas dividers may be used to obtain the intermediate points for the general range classifications specified. The calibration curves generated shall be a polynomial of no greater order than 4th order, and shall fit the data within 0.5% at each calibration point.

(B) For all calibration curves, curve checks, span adjustments, and span checks, the zero gas shall be considered a down-scale reference gas, and the analyzer zero shall be set at the trace concentration value of the specific zero gas used.

(2) The basic curve shall be checked monthly by the same procedure used to generate the curve, and to the same tolerances.

(3) On a daily basis prior to vehicle testing—

(A) The curve for each analyzer shall be checked by adjusting the analyzer to correctly read a zero gas and an up-scale span gas, and then by correctly reading a mid-scale span gas within 2% of point. If the analyzer does not read the mid-scale span point within 2% of point, the system shall lock out. The up-scale span gas concentration for each analyzer shall correspond to approximately 80 percent of full scale, and the mid-point concentration shall correspond to approximately 15 percent of full scale; and

(B) After the up-scale span check, each analyzer in a given facility shall analyze a sample of a random concentration corresponding to approximately 0.5 to 3 times the cut point (in gpm) for the constituent. The value of the random sample may be determined by a gas blender. The deviation in analysis from the sample concentration for

each analyzer shall be recorded and compared to the historical mean and standard deviation for the analyzers at the facility and at all facilities. Any reading exceeding 3 sigma shall cause the analyzer to lock out.

(4) *Flame ionization detector check.* Upon initial operation, and after maintenance to the detector, each Flame Ionization Detector (FID) shall be checked, and adjusted if necessary, for proper peaking and characterization. Procedures described in SAE Paper No. 770141 are recommended for this purpose. A

copy of this paper may be obtained from the Society of Automotive Engineers, Inc. (SAE), 400 Commonwealth Drive, Warrendale, Pennsylvania, 15096-0001. Additionally, every month the response of each FID to a methane concentration of approximately 50 ppm CH<sub>4</sub> shall be checked. If the response is outside of the range of 1.10 to 1.20, corrective action shall be taken to bring the FID response within this range. The response shall be computed by the following formula:

$$\text{Ratio of Methane Response} = \frac{\text{FID response in ppmC}}{\text{ppm methane in cylinder}}$$

(5) *Spanning frequency.* The zero and up-scale span point shall be checked, and adjusted if necessary, at 2 hour intervals following the daily mid-scale curve check. If the zero or the up-scale span point drifts by more than 2% for the previous check (except for the first check of the day), the system shall lock out, and corrective action shall be taken to bring the system into compliance.

(6) *Spanning limit checks.* The tolerance on the adjustment of the up-scale span point is 0.4% of point. A software algorithm to perform the span adjustment and subsequent calibration curve adjustment shall be used. However, software up-scale span adjustments greater than ±10% shall cause the system to lock out, requiring system maintenance.

(7) *Integrator checks.* Upon initial operation, and every three months thereafter, emissions from a randomly selected vehicle with official test value greater than 60% of the standard (determined retrospectively) shall be simultaneously sampled by the normal integration method and by the bag method in each lane. The data from each method shall be put into a historical data base for determining normal and deviant performance for each test lane, facility, and all facilities combined. Specific deviations exceeding ±5% shall require corrective action.

(8) *Interference.* CO and CO<sub>2</sub> analyzers shall be checked prior to initial service, and on a yearly basis thereafter, for water interference. The specifications and procedures used shall generally comply with either § 86.122-78 or § 86.321-79 of this chapter.

(9) *NO<sub>x</sub> converter check.* The converter efficiency of the NO<sub>2</sub> to NO converter shall be checked on a weekly basis. The check shall generally conform to § 86.123-78 of this chapter, or EPA MVEL Form 305-01. Equivalent methods may be approved by the Administrator.

(10) *NO/NO<sub>x</sub> flow balance.* The flow balance between the NO and NO<sub>x</sub> test modes shall be checked weekly. The check may be combined

with the NO<sub>x</sub> convertor check as illustrated in EPA MVEL Form 305-01.

(11) *Additional checks.* Additional checks shall be performed on the HC, CO, CO<sub>2</sub>, and NO<sub>x</sub> analyzers according to best engineering practices for the measurement technology used to ensure that measurements meet specified accuracy requirements.

(12) *System artifacts (hang-up).* Prior to each test a comparison shall be made between the background HC reading, the HC reading measured through the sample probe (if different), and the zero gas. Deviations from the zero gas greater than 10 parts per million carbon (ppmC) shall cause the analyzer to lock out.

(13) *Ambient background.* The average of the pre-test and post-test ambient background levels shall be compared to the permissible levels of 10 ppmC HC, 20 ppm CO, and 1 ppm NO<sub>x</sub>. If the permissible levels are exceeded, the test shall be voided and corrective action taken to lower the ambient background concentrations.

(14) *Analytical gases.* Zero gases shall meet the requirements of § 86.114-79(a)(5) of this chapter. NO<sub>x</sub> calibration gas shall be a single blend using nitrogen as the diluent. Calibration gas for the flame ionization detector shall be a single blend of propane with a diluent of air. Calibration gases for CO and CO<sub>2</sub> shall be single blends using nitrogen or air as a diluent. Multiple blends of HC, CO, and CO<sub>2</sub> in air may be used if shown to be stable and accurate.

#### (III) Purge Analysis System

On a daily basis each purge flow meter shall be checked with a simulated purge flow against a reference flow measuring device with performance specifications equal to or better than those specified for the purge meter. The check shall include a mid-scale rate check, and a total flow check between 10 and 20 liters. Deviations greater than ±5% shall be corrected. On a monthly basis, the

calibration of purge meters shall be checked for proper rate and total flow with three equally spaced points across the flow rate and the totalized flow range. Deviations exceeding the specified accuracy shall be corrected. The dynamometer quality assurance checks required under paragraph (II) of this appendix shall also apply to the dynamometer used for purge tests.

(IV) *Evaporative System Integrity Test Equipment*

(a) On a weekly basis pressure measurement devices shall be checked against a reference device with performance specifications equal to or better than those specified for the measurement device. Deviations exceeding the performance specifications shall be corrected. Flow measurement devices, if any, shall be checked according to paragraph III of this appendix.

(b) Systems that monitor evaporative system leaks shall be checked for integrity on a daily basis by sealing and pressurizing.

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APPENDIX B TO SUBPART S OF PART 51—  
TEST PROCEDURES

(I) *Idle test*

(a) *General requirements*—(1) *Exhaust gas sampling algorithm.* The analysis of exhaust gas concentrations shall begin 10 seconds after the applicable test mode begins. Exhaust gas concentrations shall be analyzed at a minimum rate of two times per second. The measured value for pass/fail determinations shall be a simple running average of the measurements taken over five seconds.

(2) *Pass/fail determination.* A pass or fail determination shall be made for each applicable test mode based on a comparison of the short test standards contained in appendix C to this subpart, and the measured value for HC and CO as described in paragraph (I)(a)(1) of this appendix. A vehicle shall pass the test mode if any pair of simultaneous measured values for HC and CO are below or equal to the applicable short test standards. A vehicle shall fail the test mode if the values for either HC or CO, or both, in all simultaneous pairs of values are above the applicable standards.

(3) *Void test conditions.* The test shall immediately end and any exhaust gas measurements shall be voided if the measured concentration of CO plus CO<sub>2</sub> falls below six percent or the vehicle's engine stalls at any time during the test sequence.

(4) *Multiple exhaust pipes.* Exhaust gas concentrations from vehicle engines equipped with multiple exhaust pipes shall be sampled simultaneously.

(5) This test shall be immediately terminated upon reaching the overall maximum test time.

(b) *Test sequence.* (1) The test sequence shall consist of a first-chance test and a second-chance test as follows:

(i) The first-chance test, as described under paragraph (c) of this section, shall consist of an idle mode.

(ii) The second-chance test as described under paragraph (I)(d) of this appendix shall be performed only if the vehicle fails the first-chance test.

(2) The test sequence shall begin only after the following requirements are met:

(i) The vehicle shall be tested in as-received condition with the transmission in neutral or park and all accessories turned off. The engine shall be at normal operating temperature (as indicated by a temperature gauge, temperature lamp, touch test on the radiator hose, or other visual observation for overheating).

(ii) For all pre-1996 model year vehicles, a tachometer shall be attached to the vehicle in accordance with the analyzer manufacturer's instructions. For 1996 and newer model year vehicles the OBD data link connector will be used to monitor RPM. In the event that an OBD data link connector is not available or that an RPM signal is not available over the data link connector, a tachometer shall be used instead.

(iii) The sample probe shall be inserted into the vehicle's tailpipe to a minimum depth of 10 inches. If the vehicle's exhaust system prevents insertion to this depth, a tailpipe extension shall be used.

(iv) The measured concentration of CO plus CO<sub>2</sub> shall be greater than or equal to six percent.

(c) *First-chance test.* The test timer shall start (tt=0) when the conditions specified in paragraph (I)(b)(2) of this appendix are met. The first-chance test shall have an overall maximum test time of 145 seconds (tt=145). The first-chance test shall consist of an idle mode only.

(1) The mode timer shall start (mt=0) when the vehicle engine speed is between 350 and 1100 rpm. If engine speed exceeds 1100 rpm or falls below 350 rpm, the mode timer shall reset zero and resume timing. The minimum mode length shall be determined as described under paragraph (I)(c)(2) of this appendix. The maximum mode length shall be 90 seconds elapsed time (mt=90).

(2) The pass/fail analysis shall begin after an elapsed time of 10 seconds (mt=10). A pass or fail determination shall be made for the vehicle and the mode shall be terminated as follows:

(i) The vehicle shall pass the idle mode and the test shall be immediately terminated if, prior to an elapsed time of 30 seconds (mt=30), measured values are less than or equal to 100 ppm HC and 0.5 percent CO.